An Evaluation of Te Poutama Tau 2004

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Te Poutama Tau was initially developed in 2002 to support teachers in Māori-medium schools in the teaching of numeracy. It is based around the Number Framework developed for New Zealand schools. This paper analyses student data from Te Poutama Tau to examine students' progress on the Number Framework in 2004. Areas where students performed well and areas where progress has not been as positive are highlighted. The patterns of performance and progress of students involved in the 2004 project are compared with those of 2002 and 2003. The results of this study will inform the future implementation and foci of Te Poutama Tau in Māori-medium schools.

Background

For a number of years, there had been some discussion on the challenges teachers in Māori medium had in interpreting the learning outcomes of the Māori-medium mathematics curriculum statement. A possible solution to the problem was the development of a resource that would show more explicitly the content that students progress through. It was therefore of much interest to those working in Māori-medium education to observe the development of the Number Framework and its associated professional development programme, initially in the Count Me In Too and Early Numeracy projects (see Book 1: *The Number Framework*, 2003). However, concerns were raised in terms of the effectiveness of the professional development model, resources, and so on in relation to Māori-medium schools. Consequently, in 2002, a pilot numeracy project, Te Poutama Tau, was initiated as a component of a key government initiative aimed at raising student achievement by building teacher capability in the teaching and learning of numeracy.

Te Poutama Tau

Te Poutama Tau is based upon the Number Framework developed for New Zealand schools. The framework is divided into two key components, knowledge and strategy. The knowledge section describes the key items of knowledge that students need to learn. The strategy section describes the mental processes that students use to estimate answers and solve operational problems with numbers.

Teachers from 33 schools participated in Te Poutama Tau during 2004. Students were assessed individually at the beginning of the programme, using a diagnostic interview, and again at the end of the year.

The aim of this paper is to examine the following questions:

- What overall progress did the students make on the Number Framework in 2004?
- In which areas of the framework did the students perform well, and in which areas did they perform poorly, in 2004? Why is this so?
- How do the patterns of performance and progress of the students involved in the 2004 project compare with those for 2002 and 2003?
- What are the areas of the framework that they have performed well or poorly in over the three years? Why is this so?

Methodology and data analysis

The results for each Numeracy Development Project student, classroom, and school are entered on the national database (www.nzmaths.co.nz). The database shows the progress that students have made on the Number Framework between the initial and final diagnostic interviews. The time between the two interviews is about 20 weeks of teaching. Schools can access their own data on the national database to establish targets for planning and reporting purposes. Teachers can use the data to group students according to ability and choose activities that will support students in both strategy and knowledge development. The following summaries of the data were restricted to only those students who had both test and re-test results. In 2003, 1667 students completed both the initial and final diagnostic interviews, and in 2004, 1295 students participated.

Figure 1 shows that there was some difference in student numbers between the years 2003 and 2004, although there are insufficient numbers in the year levels 9 and 10 to make valid comparisons.

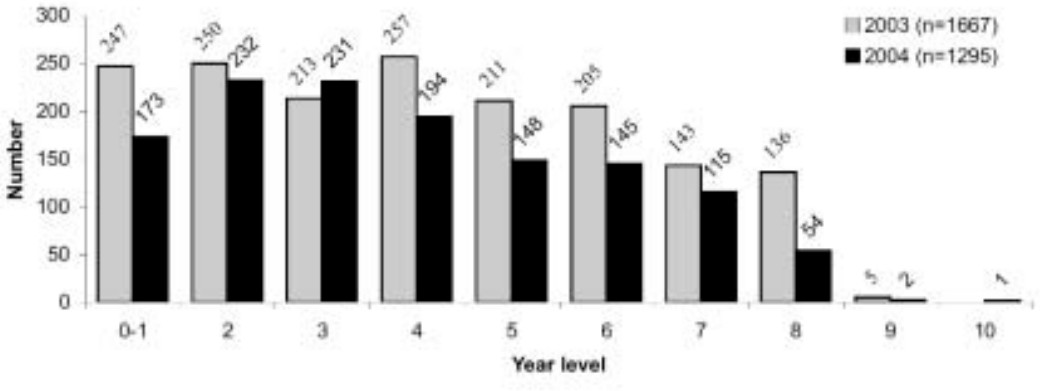


Figure 1. Distribution of Te Poutama Tau students across year levels

Overview of Student Progress 2004

Overall, the trend in student progress for 2004 was relatively consistent with the 2003 results (see Figure 6.1). However, there were minimal mean stage gains in numeral identification, multiplication, fractions, and proportion (see Figure 2). The complexity of the concept of proportion is closely linked to the building blocks of fractions (English & Halford, 1995) and multiplicative thinking (Behr, Harel, Post, & Lesh, 1992). Therefore, it is not surprising that students continue to struggle with proportion, considering the minimal stage gains in multiplication. Why there was minimal stage gain in numeral identification is not clear. Earlier NDP research (Irwin, 2003, and Young-Loveridge, 2004) suggested that such a result would be due to students entering at a higher level of the framework: the higher levels of the framework are more complex, and therefore progress is not as rapid as expected through the lower stages. However, a closer examination of the data shows that, in fact, the initial mean stage for 2004 Te Poutama Tau students was at stage 3, a fraction lower than 2003, in which the entry level was 3.2. (See Figure 6.2.) One explanation may well be that "big numbers", that is, those over 1000, are rarely used and heard in Māori outside of the classroom. As well, most big numbers are figured in the majority of resources, rather than spelt out as words. In the diagnostic interview, students are required to read and produce numbers before and after a number in a given range, in words.

There were significant stage gains made in decimals knowledge. This was recognised as an area of weakness in 2002 and 2003 and was the subject of major focus in both teacher and facilitator workshops during 2004. Understanding decimals is a multidimensional task. Students need to co-ordinate place value concepts with aspects of whole number and fraction knowledge. Making the transition to understanding decimals relies on having a thorough understanding of previous concepts, particularly base 10. Grouping and place value was one of the major focus areas for 2003. This has possibly had an influence on the positive mean stage gains for decimals in 2004.

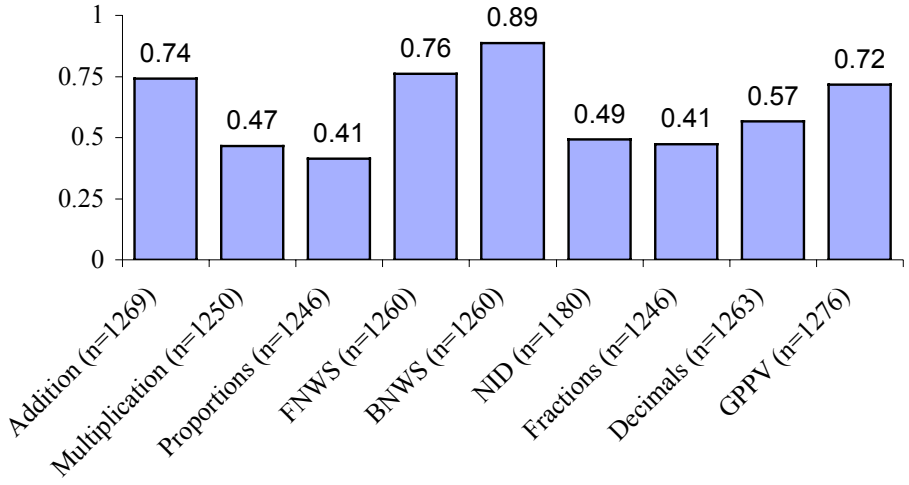


Figure 2. Mean stage gains across the Number Framework

Student Achievement and Year Level

The graphs below (Figure 3) show the variation in the mean gain for each aspect of the Number Framework across the year levels. There was no clear pattern common to all aspects of the Number Framework. Four of the aspects, addition, forward number word sequence (FNWS), backward number word sequence (BNWS), and numeral word identification decimals (NID), showed a "diminishing returns" pattern, where advancement was more difficult for students at successively higher year levels. The distribution for multiplication, proportions, and fractions resembled a more normal curve. Christensen (2004) explained that these aspects were "mainly connected with the higher stages of the framework" and so, when students at lower year levels were assessed, their progress would initially be limited due to the complex nature of these aspects. Students at year levels 3 or higher are quite possibly more able to work with these aspects and so were more able to advance. Generally, however, older students were at higher stages of the Number Framework (as was found and commented upon in the evaluation of Te Poutama Tau 2003 [Christensen, 2004]) and given that higher stages of the framework are larger and more complex, it would be more difficult for students at higher year levels to advance to the next stage of the Number Framework. The Number Framework aspects, decimals and grouping and place value (GPPV), while also related to higher stages of the framework, had a relatively flat distribution, with slightly smaller mean gains at higher year levels.

Figure 3.1. Mean stage gain for addition and subtraction and year level

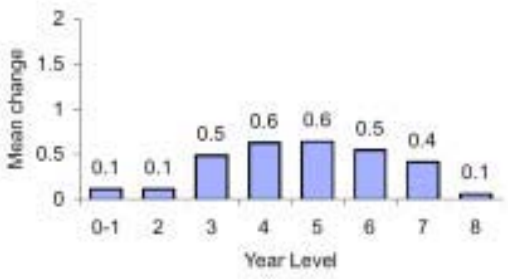


Figure 3.2. Mean stage gain for multiplication and division and year level

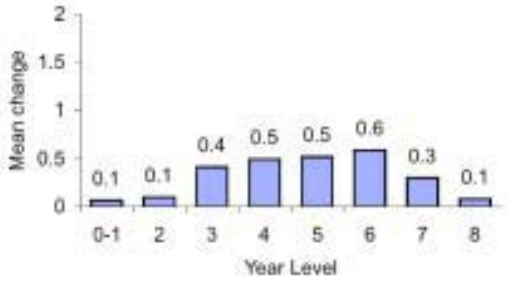


Figure 3.3. Mean stage gain for proportion

Figure 3.4. Mean stage gain for forward number word sequence and year level

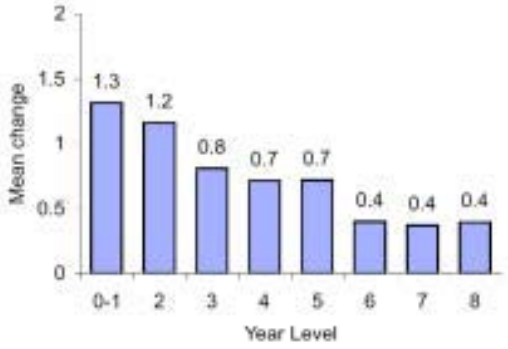


Figure 3.5. Mean stage gain for backward number word sequence and year level

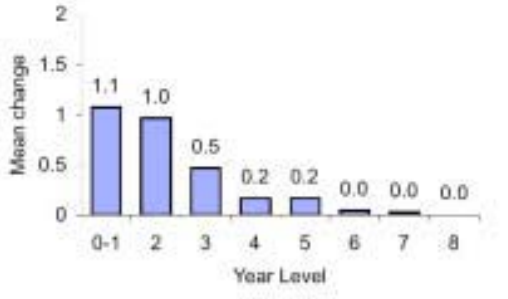


Figure 3.6. Mean stage gain for numeral identification and year level

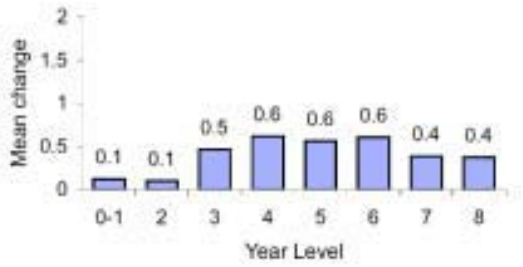


Figure 3.7. Mean stage gain for fractions and year level

Figure 3.8. Mean stage gain for decimals and year level

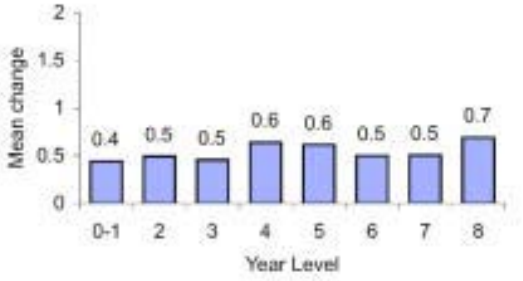
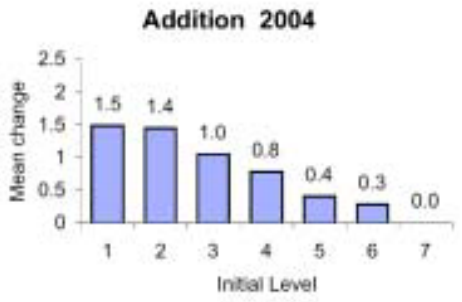
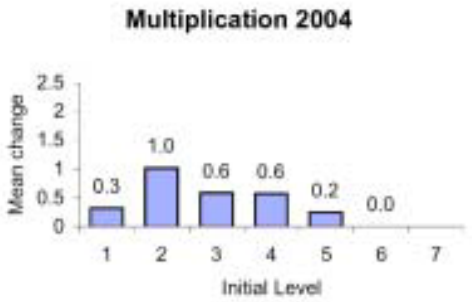


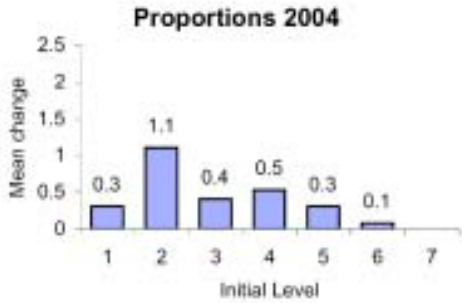
Figure 3.9. Mean stage gains for grouping and place value

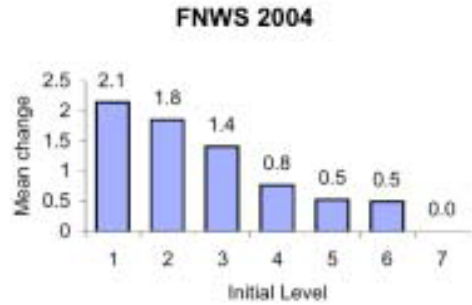
Student Achievement and Initial Stage Assessment

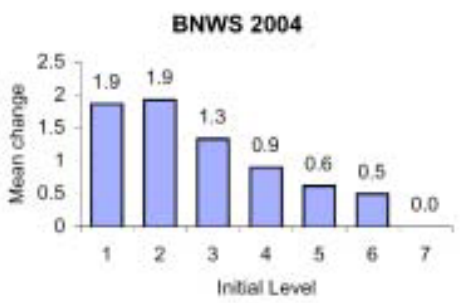
The following graphs (Figure 4) show how improvement in performance was related to the stage at which students were initially diagnosed. There was a consistent pattern across all nine aspects of the Number Framework, with improvements in performance being more difficult to achieve for those with higher initial scores. Students with an initial stage 2 level made the most gains, with this decreasing as the stages become higher. This can be attributed to higher stages of the Number Framework being larger and more complex, making it more difficult for students to advance to the next stage. However, Christensen (2004) made the point that this may also "indicate that teachers and facilitators were more effective at the lower levels" (p. 16).


Addition 2004
Mean change
2.5
2
1.5
1
0.5
0
1.5
1.4
1.0
0.8
0.4
0.3
0.0
1
2
3
4
5
6
7
Initial Level


Multiplication 2004
Mean change
2.5
2
1.5
1
0.5
0
0.3
1.0
0.6
0.6
0.2
0.0
1
2
3
4
5
6
7
Initial Level


Proportions 2004
Mean change
2.5
2
1.5
1
0.5
0
0.3
1.1
0.4
0.5
0.3
0.1
1
2
3
4
5
6
7
Initial Level


FNWS 2004
Mean change
2.5
2
1.5
1
0.5
0
2.1
1.8
1.4
0.8
0.5
0.5
0.0
1
2
3
4
5
6
7
Initial Level


BNWS 2004
Mean change
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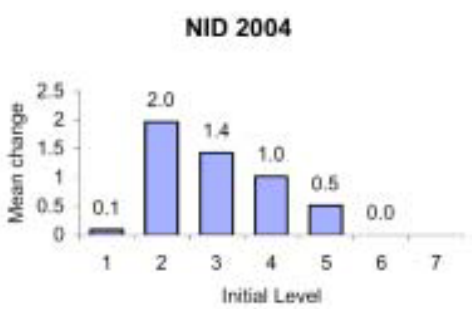
2
1.5
1
0.5
0
1.9
1.9
1.3
0.9
0.6
0.5
0.0
1
2
3
4
5
6
7
Initial Level


NID 2004
Mean change
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2
1.5
1
0.5
0
0.1
2.0
1.4
1.0
0.5
0.0
1
2
3
4
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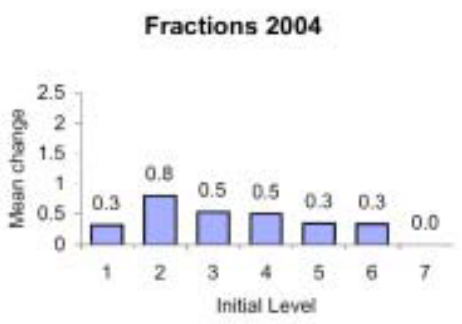
6
7
Initial Level


Fractions 2004
Mean change
2.5
2
1.5
1
0.5
0
0.3
0.8
0.5
0.5
0.3
0.3
0.0
1
2
3
4
5
6
7
Initial Level


Decimals 2004
Mean change
2.5
2
1.5
1
0.5
0
0.7
0.9
0.8
0.6
0.4
0.6
0.0
1
2
3
4
5
6
7
Initial Level

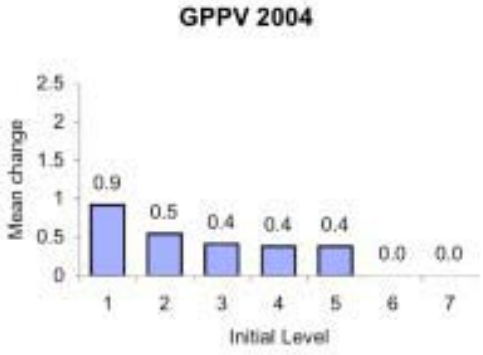


Figure 4. Student achievement and initial stage assessment

Student Achievement and Language Proficiency

There was little difference between 2003 and 2004 in how teachers rated te reo Māori proficiency of the students. The table below shows that 64% of the students were rated as either "proficient" or "very proficient", with 10% rated as "not very proficient" or having "poor proficiency".

Table 5.1
Language Proficiency of Students

	Language Proficiency				
%	Very proficient	Proficient	Reasonably proficient	Not very proficient	Poor proficiency
2004	13	51	26	8	2
2003	12	48	33	6	1

As in 2003, teachers were asked whether or not English was used during the diagnostic interview. The table below shows that for the great majority of interviews (90%), only Māori was spoken, with the remainder having little English spoken by the students during the interview and even less by the teacher.

Table 5.2
Language Used during Diagnostic Interviews

	Languages used				
%	Only Māori	Student used a little English	Student used quite a bit of English	Teacher and student used a little English	Teacher used a little English; student used quite a bit of English
2004	90	6	3	1	0.1

Longitudinal Patterns of Progress

This section examines patterns of performance over the three years of the implementation of Te Poutama Tau. 2002 was very much a developmental year, with considerable focus on the development of te reo Māori discourse, the supporting resources, the professional development models, and issues around the capacity of facilitators to support teachers. This is very much reflected in the 2002 results shown in Figure 6. As noted by Christensen (2003), the mean stage gains in grouping and place value, fractions, and decimals were disappointing. The results for fractions and decimals could be partly attributed to the fact that the majority of students in the 2002 project were years 1–4 and were being introduced to the lower stages of the Number Framework, where most of the focus is on whole numbers. The data showed that achievement in grouping and place value was a major concern (Christensen, 2003, p. 25). Consequently, this area was the subject of major focus for facilitators and teachers in 2003. The mean stage gains for grouping and place in 2003 in Figure 6.1 show considerable improvement as a result of the directed intervention.

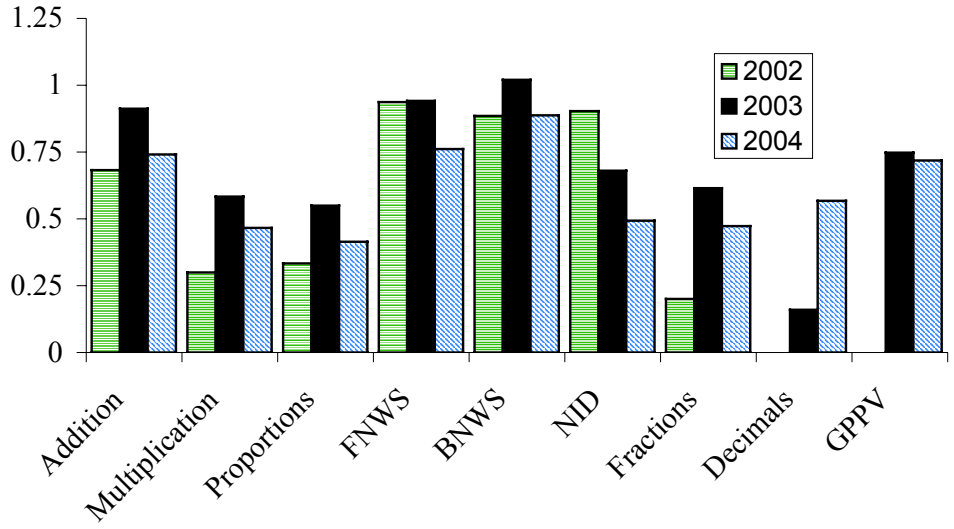


Figure 6.1. Longitudinal mean stage gains

In the table in Figure 6.2, two trends are immediately obvious: generally (with the exception of decimals), the mean improvement for 2004 was lower than for 2003, but the mean initial level for 2004 was higher than for 2003. This culminated in an improved mean final level result for 2004 when compared to 2003 for the Number Framework aspects of addition, FNWS, and BNWS, and in very large improvements made for decimals. There were small decrements in performance in the mean final assessment for multiplication, NID, and fractions, and a somewhat larger decrement for GPPV. There was a small decrease in performance for the proportions aspect of the Number Framework in 2004 when compared to 2003.

	Mean	2003 (n = 1667)			2004 (n = 1295)		
		Initial	Change	Final	Initial	Change	Final
Strategy	Addition	4.0	0.85	4.77	4.1	0.73	4.82
	Multiplication	2.1	0.57	2.60	2.1	0.45	2.52
	Proportions	1.9	0.54	2.42	2.1	0.40	2.41
Knowledge	FNWS	4.6	0.88	5.36	4.7	0.74	5.43
	BNWS	4.3	0.96	5.14	4.4	0.86	5.22
	NID	3.2	0.62	3.52	3.0	0.45	3.10
	Fractions	1.8	0.60	2.36	1.9	0.46	2.25
	Decimals	1.2	0.16	1.28	2.6	0.71	3.24
	GPPV	3.1	0.82	3.86	2.5	0.55	3.04

Figure 6.2. Comparison of mean gain for the nine strategy stages across years 2003 and 2004

Figure 6.3 shows how the average for the final result for all tests varies across year levels for 2003 and 2004. There was a small improvement in students' overall performance in the final tests in 2004 compared to 2003 across year level, apart from a very small dip for those in year 8. Results for years 9 and 10 should be disregarded due to the small sample size.

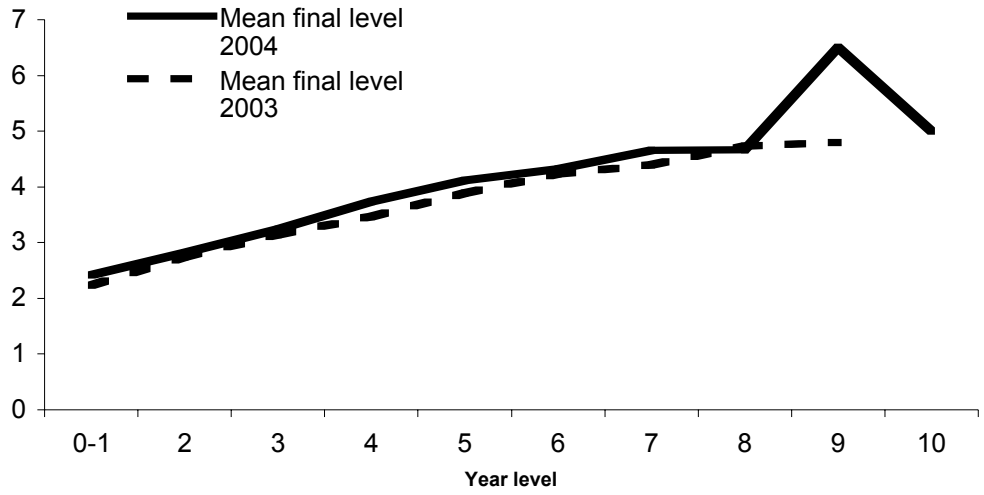


Figure 6.3. Comparison of average for final test across years 2003 and 2004

Recommendations

The following recommendations arise from the research that has been discussed in this report. A stronger emphasis for teachers' and numeracy facilitators' professional development in 2005 should be on:

- Providing more resources and activities to show numbers in word form and numbers up to and over a million. As well as assisting with numeral identification, this may well also help students to understand the part–whole concept. Syntactically, numbers in the word form in te reo Māori are written and said with their parts differentiated, that is, rua rau wha tekau mā whā (2 hundreds, 4 tens, and 4 ones).
- Maintaining an emphasis on grouping and place value. This concept underpins many of the mathematical concepts associated with numerical thinking.
- Developing multiplicative thinking (see Mulligan, 2002) and the appropriate Māori discourse.
- The higher stages of the framework – multiplication and division strategies, proportion and ratio, and knowledge of fractions.
- The relationship between te reo Māori and mathematical thinking. For example, which te reo Māori linguistic structures support or hinder students' ability to learn mathematics? How do students represent mathematical concepts linguistically?
- Improving the outcomes for those students who make little or no stage gains.

References

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