An Evaluation of Te Poutama Tau 2005

Tony Trinick
The University of Auckland
Faculty of Education
<t.trinick@auckland.ac.nz>

Brendan Stevenson
Massey University
Māori Studies
<b.s.stevenson@massey.ac.nz>

The Te Poutama Tau project is a professional development programme for teachers in Māori-medium education who are teaching numeracy. It is based around the Number Framework developed for New Zealand schools. This paper analyses student data from the Te Poutama Tau project in order to examine students' progress on the Number Framework in 2005. 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 2005 project are compared with those of 2003 and 2004. The results of this study will inform the future implementation and foci of Te Poutama Tau in Māori-medium schools.

Background

Teachers in Māori-medium mathematics have struggled for a number of years to interpret the learning outcomes of the Marautanga Pāngarau (Māori-medium curriculum statement) (Christensen, 2003; Trinick & Stephenson [*sic*], 2005). Essentially, the outcomes describe how and at what level students must demonstrate mathematical knowledge and skills. However, in a large number of examples, the outcomes do not make explicit the underpinning mathematical knowledge and concepts. The interpretation of the outcomes for planning purposes is thus left to the professional knowledge of the teacher and the associated learning and teaching resources. This is somewhat problematic. As noted in a number of writings, teacher mathematical content knowledge is lacking in a number of areas in Aotearoa (Christensen, 2003; McMurchy–Pilkington, 2004). Combined with the the challenges of the newly developed Māori language mathematics discourse, additional burdens are placed on teachers in Māori-medium education.

A part solution to the challenges faced by teachers in Māori-medium mathematics education has been the use of the Number Framework developed for New Zealand schools (Ministry of Education, 2006) and an associated professional development programme, Te Poutama Tau. Initiated as a pilot in 2002, Te Poutama Tau is a component of a key government initiative aimed at raising student achievement by building teacher capability in the teaching and learning of numeracy.

The Number Framework is divided into two key components – mātauranga (knowledge) and rautaki (strategies). The knowledge section describes for teachers 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. The Framework provides a much more explicit detail of the key concepts and the progressions of learning for students than does the Marautanga Pāngarau. This provides significantly more support for teachers who are not greatly confident in the teaching and learning of mathematics in the medium of Māori.

Resources are also provided by the Ministry of Education in the medium of Māori to support the project and are closely linked to the Number Framework. These resources make explicit the knowledge and strategies that are required and provide examples of good models of linguistic structures for teachers to talk about and to use in teaching the concepts and activities.

Teachers from 27 schools taking part in Te Poutama Tau during 2005 provided data for this paper. 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 students make on the Number Framework in 2005?
- In which areas of the Framework did students perform well in 2005 and in which areas did they perform poorly in 2005? Why is this so?
- How do patterns of performance and progress of students involved in the 2005 project compare with the 2003 and 2004 patterns?
- What areas of the Framework have they performed well or poorly in over the three years? Why is this so?

Methodology and Data Analysis

The results for each 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 the final diagnostic interview. 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 use activities that will support students in both strategy and knowledge development. The following summaries of the data were restricted to only those students with both test and re-test results. In 2004, 1295 students completed both the initial and the final diagnostic interview and the te reo Māori proficiency component, and in 2005, there was complete data for 496 students.

Figure 1 reveals that there was some considerable difference in student numbers between the years 2004 and 2005, although there are insufficient numbers in years 8, 9, and 10 to make valid comparisons. The complete numeracy data sets for many other students were available but not used for the analysis because the te reo Māori component had not been entered. The matter has been resolved for 2006.

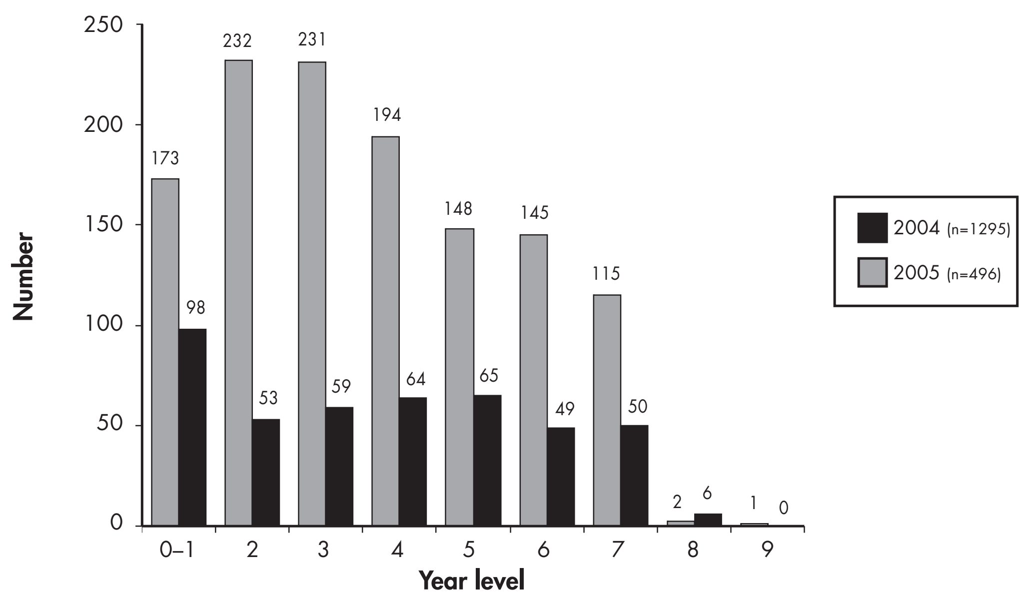


Figure 1. Distribution of Te Poutama Tau students across year levels

Overview of Student Progress 2005

Over the last three years (2003, 2004, and 2005), there was evidence of improved stage gains for addition, forward-number-word-sequence (FNWS), and backward-number-word-sequence (BNWS) knowledge. Despite improved gains made in 2003 and 2004 for decimal knowledge, stage gains were down in 2005. For multiplication, proportions, numeral-identification (NID), fractions, and grouping and place value (GPPV) knowledge, reduced gains from 2003 to 2004 were reversed in 2005, although the 2005 gains were not quite as large as those in 2004.

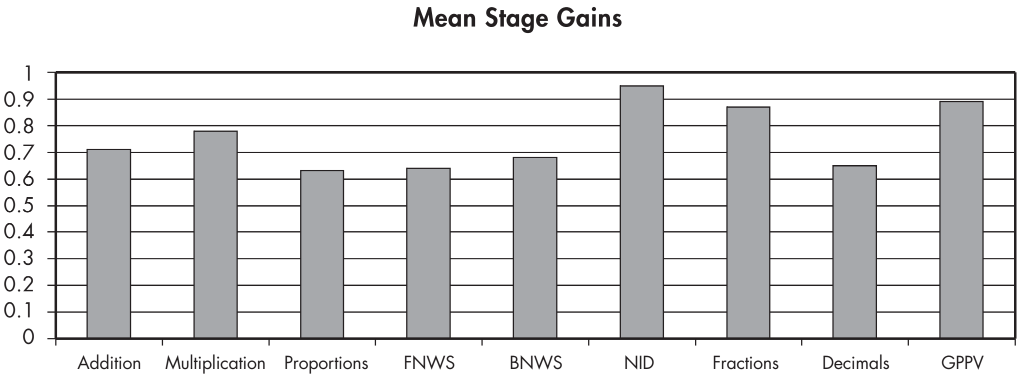


Figure 2. 2005 Mean stage gains across the Number Framework

The positive mean stage gains for numeral identification (NID) occurred mainly in years 1, 2, and 3 (see Figures 3 and 4 NID). This is very much as expected, as previous evaluations have shown (Christensen, 2003). It is also pleasing to see positive mean stage gains continuing in grouping and place value. It has been noted that understanding place value has been a key component of numeracy learning for some time (Resnick, 1983). But with the increased emphasis on part–whole understanding, the ability to manipulate groupings of quantities efficiently is also critical. Many writers have stressed the importance for students of coming to understand the "additive composition of numbers" (Young-Loveridge, 2001). The Te Poutama Tau project has supported this key idea by labelling the split parts of a group the "tauhono-joining numbers" (Ministry of Education, 2006), thus providing a linguistic clue to the learners.

Mean Change Differences Between Girls and Boys in Tests of Significance

The table below assesses whether or not there were significant differences between girls and boys in how well they performed. While none of the results were significant (at the 0.05 level), it appears that girls performed better in the multiplication (F = 3.01, p = 0.084) and decimals (F = 3.006, p = 0.084) interviews and possibly for the proportions (F = 2.254, p = 0.134) diagnostic interview. Given a larger sample, it would be expected that these three interview results would reach significance.

Table 1
Mean Change Differences Between Girls and Boys in Tests of Significance

	Mean Change			
	Tama	Kotiro	F	Sig.
Addition	0.710	0.710	0.000	0.994
Multiplication	0.700	0.860	3.010	0.084
Proportions	0.570	0.690	2.254	0.134
FNWS	0.650	0.630	0.051	0.821
BNWS	0.650	0.700	0.359	0.549
NID	0.940	0.970	0.023	0.880
Fractions	0.870	0.880	0.016	0.901
Decimals	0.590	0.700	3.006	0.084
GPPV	0.870	0.910	0.148	0.700

Student Achievement and Year Level

The graphs in Figure 3 show the variation in the mean gain for each aspect of the Number Framework across the year levels. As with previous years, there was no clear pattern common to all aspects of the Number Framework. The aspects of FNWS, BNWS, and NID showed a "diminishing returns" pattern, where advancement was more difficult for students at successively higher year levels. It is also important to note that numeral identification (Figure 3.6) as a separate data section is only part of diagnostic interview A, so students who proceed beyond tests A to E or U will not register mean stage progress in NID. Figure 3.6 therefore only shows progress for students who were tested using test A. NID continues to be a critical aspect in the upper levels but has been subsumed as part of ordering. In order to count forward or backward or locate numbers, students need to be able to identify numbers.

Multiplication, proportions, and fractions showed an initial stage gain, a fall by the next year level, and a rise slowly thereafter, while stage gains for decimal knowledge were steadily greater at higher year levels. Multiplication and proportions and fractions are introduced further up the framework than addition and subtraction, so it is not surprising that there is no stage gain at years 0 to 1.

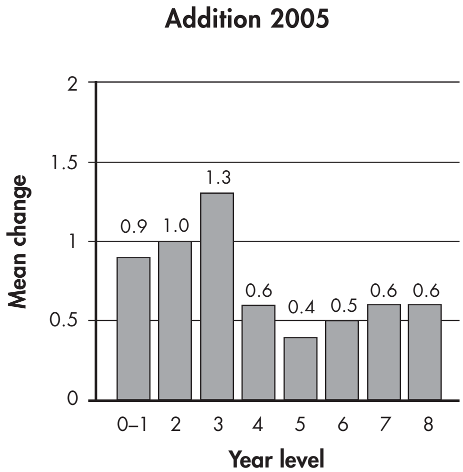


Figure 3.1. Mean stage gain for addition and subtraction

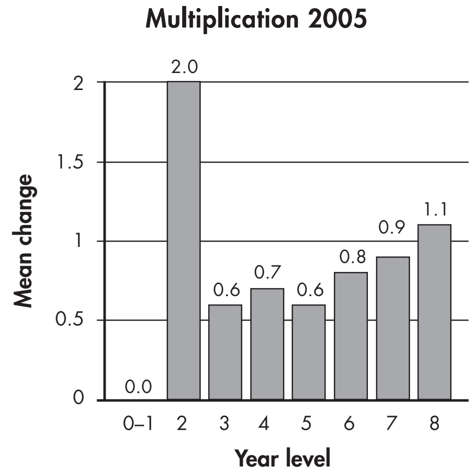


Figure 3.2. Mean stage gain for multiplication and division

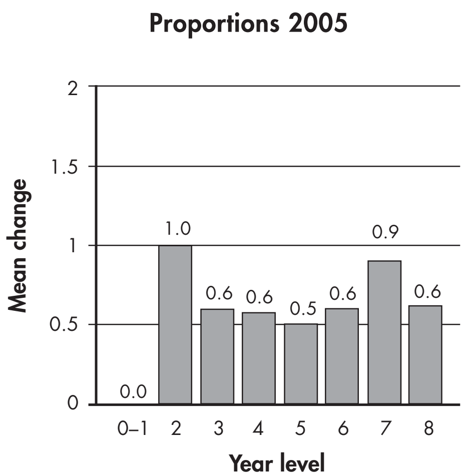


Figure 3.3. Mean stage gain for proportions and year level

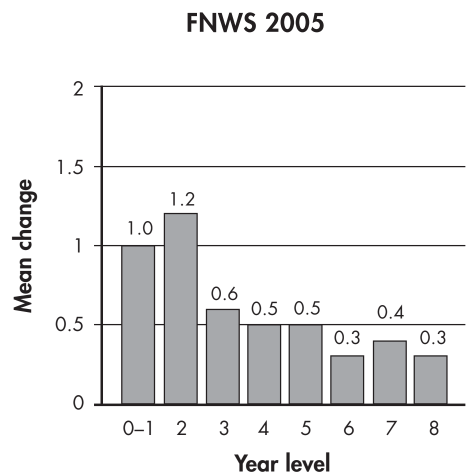


Figure 3.4. Mean stage gain for forward number word sequence

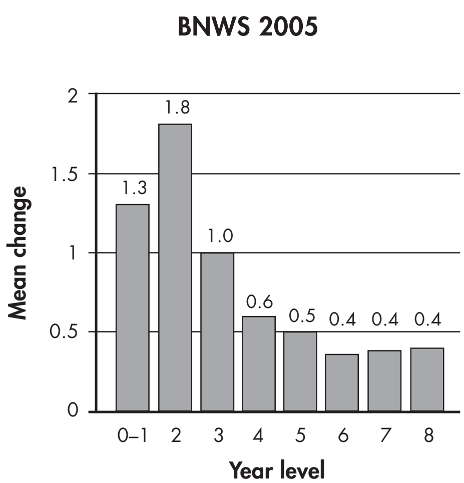


Figure 3.5. Mean stage gain for backward number word sequence

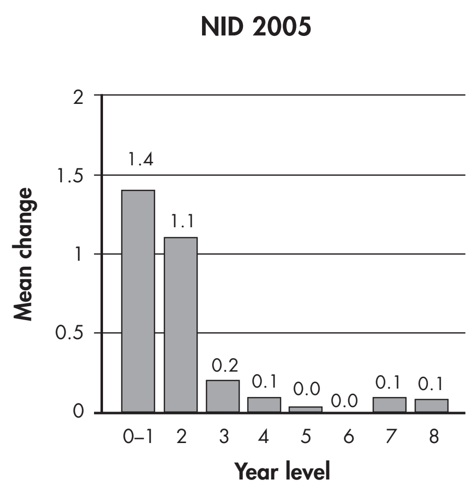


Figure 3.6. Mean stage gain for numeral identification

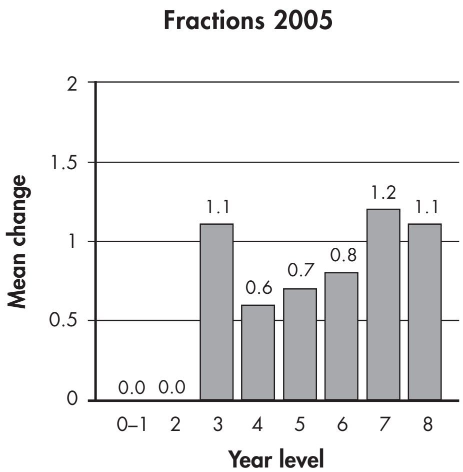


Figure 3.7. Mean stage gain for fractions

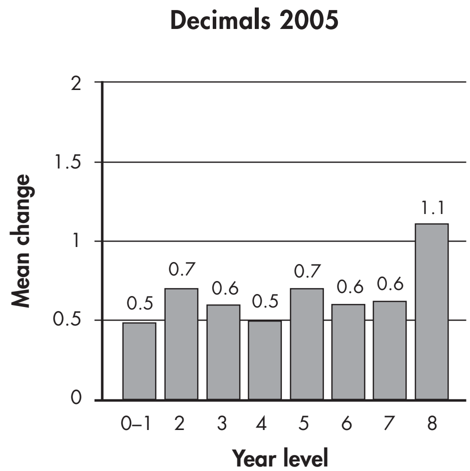


Figure 3.8. Mean stage gain for decimals

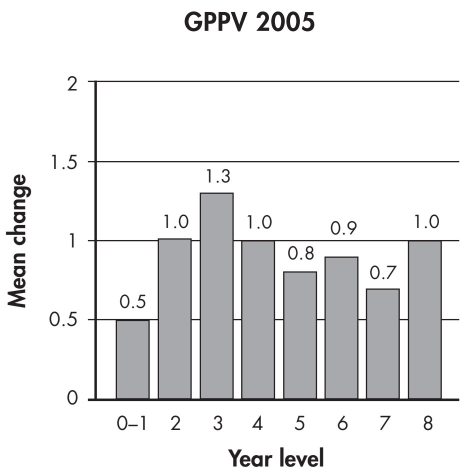
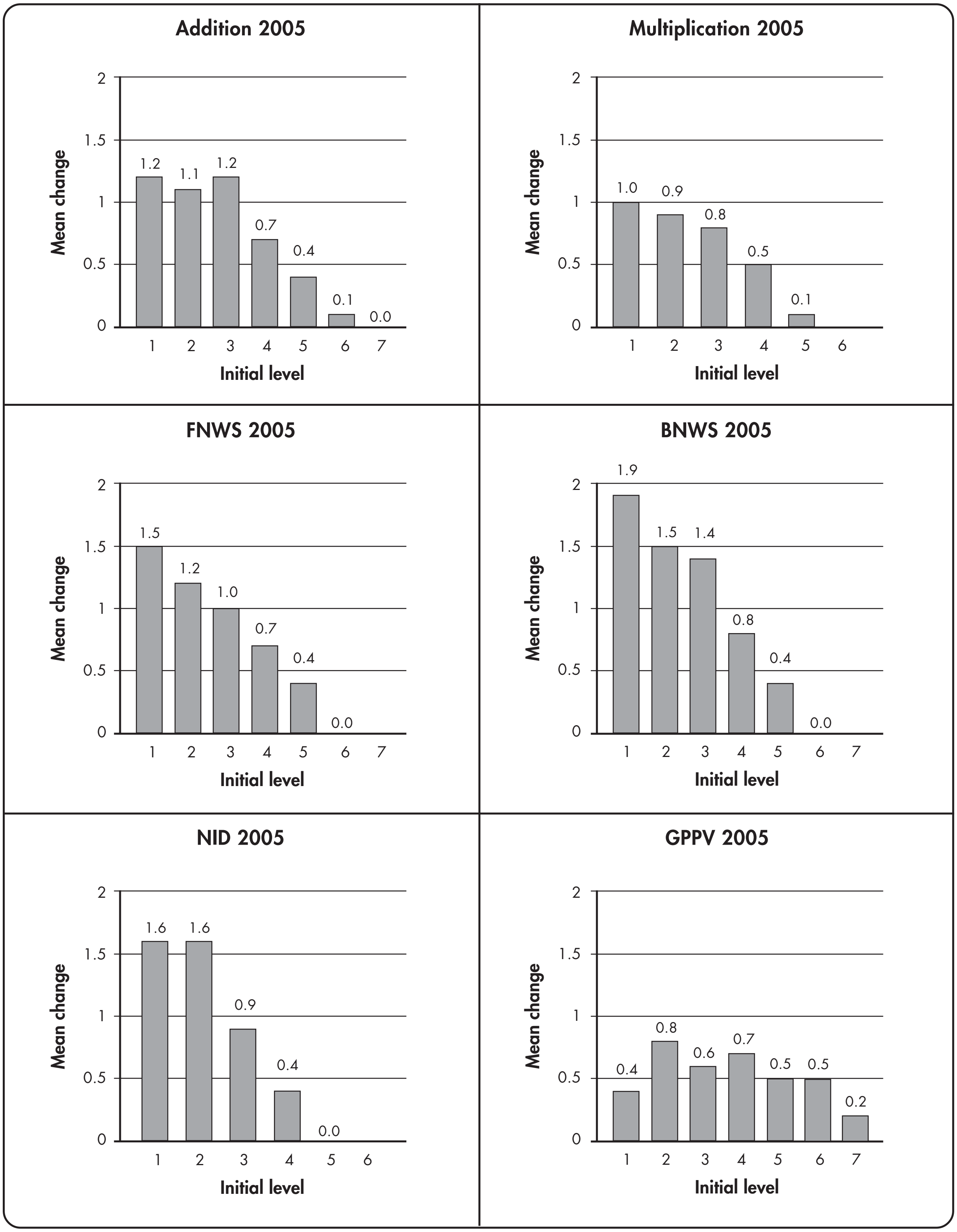


Figure 3.9. Mean stage gains for grouping and place value

Student Achievement and Initial Stage Assessment

The graphs in Figure 4 show how improvement in performance was related to the stage at which students were initially diagnosed. For example, those students who were judged to be at stage 1 for addition when initially tested made a mean stage gain of 1.2 (that is, they reached stage 2 by the second diagnostic interview). Students who were judged to be at stage 6 for addition when initially tested made a mean stage gain of 0.1. The highest stage for a number of the knowledge aspects, that is, FNWS and BNWS, is up to stage 6. Therefore students whose entry stage is stage 6 will show as 0.0 in the graphs. Similarly, the graph for NID only goes up to stage 4.

There was a consistent pattern across all nine aspects of the Number Framework, with improvements in performance being more difficult to achieve with higher initial scores. This can be attributed to higher stages of the Framework being larger and more complex, making it more difficult for students to advance to the next stage. As Christensen (2004) pointed out, this may also "indicate that teachers and facilitators were more effective at the lower levels" (p. 16).


Addition 2005
Mean change
Initial level
1.2
1.1
1.2
0.7
0.4
0.1
0.0
Multiplication 2005
Mean change
Initial level
1.0
0.9
0.8
0.5
0.1
FNWS 2005
Mean change
Initial level
1.5
1.2
1.0
0.7
0.4
0.0
BNWS 2005
Mean change
Initial level
1.9
1.5
1.4
0.8
0.4
0.0
NID 2005
Mean change
Initial level
1.6
1.6
0.9
0.4
0.0
GPPV 2005
Mean change
Initial level
0.4
0.8
0.6
0.7
0.5
0.5
0.2

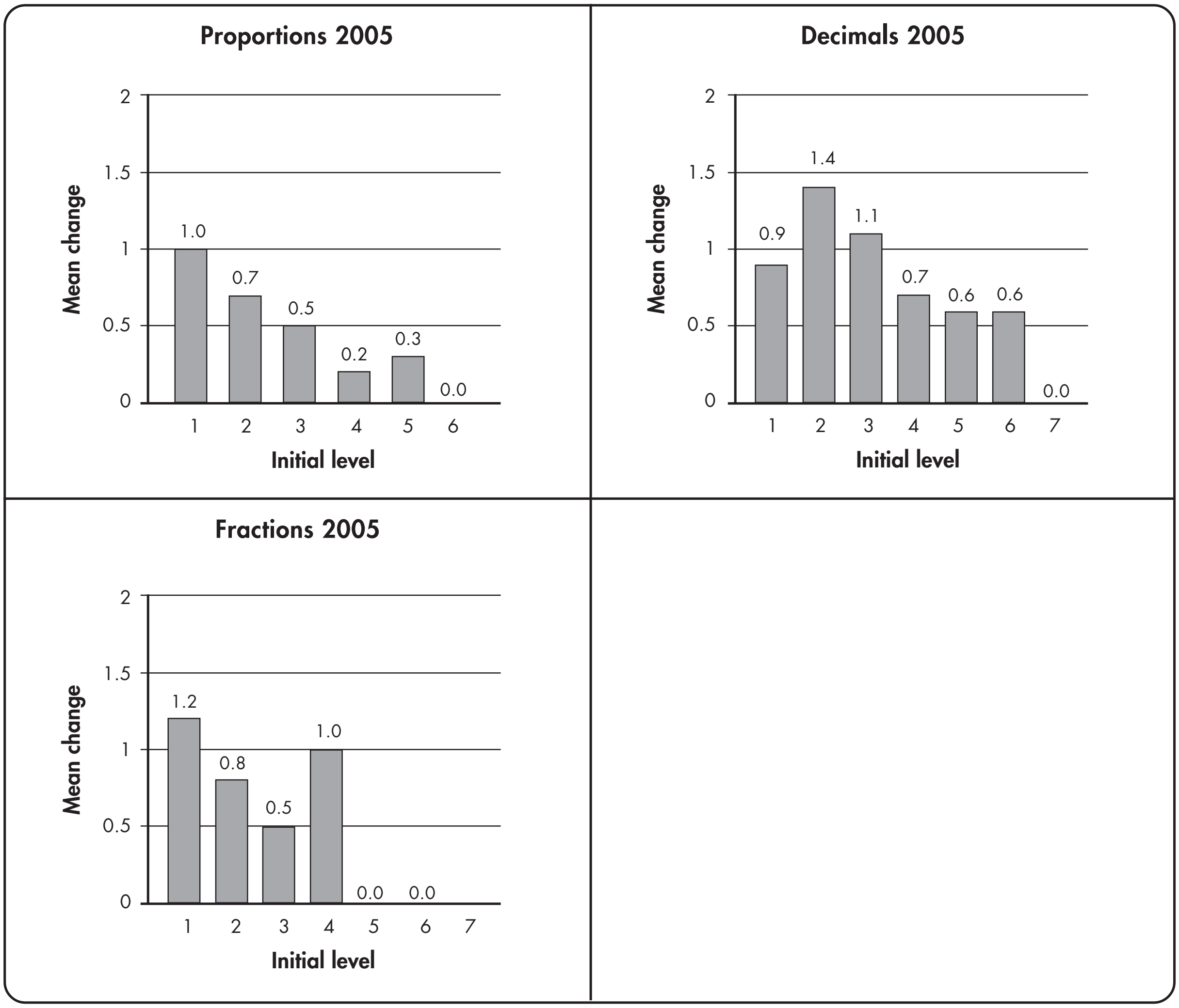


Figure 4. Mean stage gain and initial stage level

Student Achievement and Language Proficiency

There was little difference between 2003 and 2004 in how teachers rated te reo Māori proficiency of the students. However, those participating in 2005 had their language rated as being less proficient than in previous years. The table below shows that only 52% of the students were rated as either "proficient" or "very proficient", with 17% rated as "not very proficient" or having "poor proficiency".

Table 2
Language Proficiency of Students

	Language proficiency				
	Percentage				
	Very proficient	Proficient	Reasonably proficient	Not very proficient	Poor proficiency
2005	5	47	31	11	6
2004	13	51	26	8	2
2003	12	48	33	6	1

Longitudinal Patterns of Progress

This section examines how performance has changed from 2004 to 2005 and then longitudinally over the last three years of Te Poutama Tau. Although Te Poutama Tau data was initially collected in 2002, that was very much a developmental year, and so it would not be useful to compare those results with the results from 2003 to 2005.

Table 3 shows final test results for the years 2004 and 2005. There were improvements in mean numerical knowledge at the end of the year for 2005 when compared to 2004 in multiplication, proportions, NID, fractions, decimals, and GPPV. There were decrements in mean performance by the end of the year in addition, FNWS, and BNWS numerical knowledge.

Table 3
Final Test Results 2004–2005

		2004 (n = 1295)			2005 (n = 427)		
	Mean	Initial	Change	Final	Initial	Change	Final
Strategy	Addition	4.1	0.73	4.85	3.7	0.71	4.22
	Multiplication	2.1	0.45	2.58	2.6	0.78	3.16
	Proportions	2.1	0.40	2.41	2.5	0.63	2.92
Knowledge	FNWS	4.7	0.74	5.46	4	0.64	4.55
	BNWS	4.4	0.86	5.27	4	0.68	4.66
	NID	3.0	0.45	3.46	2.9	0.95	3.78
	Fractions	1.9	0.46	2.31	2.0	0.87	2.69
	Decimals	2.6	0.71	3.26	2.8	0.65	3.41
	GPPV	2.5	0.55	3.08	3.0	0.89	3.83

Note: The initial data was rounded to 1 d.p. and the change to 2 d.p. The final was worked out by adding the initial as 2 d.p .to the change (2 d.p.), and then the final was rounded to 2 d.p.

Figure 5 shows how the average for the final result for all tests varies across year levels for 2003, 2004, and 2005. As can be seen in Figure 5, results for 2005 compare favourably with those from 2003 and 2004. Generally, the mean final level for 2005 was marginally improved from that of previous years, with the greatest improvement occurring for years 2 and 3. Results from years 9 and 10 were omitted due to the small numbers in these groups. There was little change across the three years in mean improvement for the majority of numerical knowledge, with marginally more students making no improvement for addition, FNWS, BNWS, and decimals. However, there were large improvements from previous years for multiplication, proportions, NID, and fractions. GPPV showed a slightly smaller improvement from previous years.

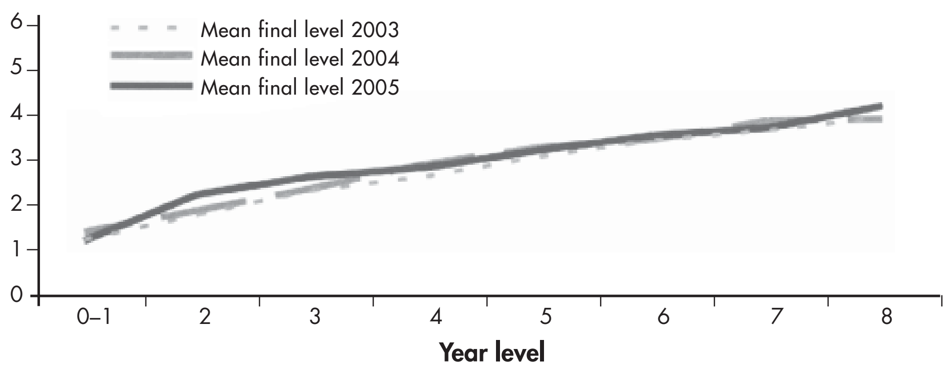


Figure 5. Comparison of students' average mean stage gain across 2003, 2004, and 2005.

Table 4 compares the percentages of students who have not shifted in the years 2003 to 2005. Of concern is the high percentage of students not making any stage gain between the initial and final diagnostic assessment. This issue was noted in the 2002 and 2003 evaluation reports (Christensen, 2003, 2004). One mitigating factor for the data was the larger proportion of students who were older and were generally assessed at a higher stage (Christensen, 2004). It is also acknowledged that significant learning could occur within a stage but show up as minimum mean stage gain.

However, one very positive aspect of the data has been the steadily declining percentage of students who have made no shift between 2003 and 2005. For example, 70% of students made no stage gain in multiplication in 2004. This was significantly reduced to 40% in 2005. This positive trend is also continued for fractions. Many teachers know from their own experiences that fractions are one of the most complex mathematical areas that students will encounter during their school years (Davis, Hunting, & Pearn, 1993). The fractions whānau (ordinary fractions, decimals, percentage) constitute a body of knowledge considered essential not only for higher mathematics but for everyday life skills. In Aotearoa, students' difficulties with fractions have been highlighted in evaluation reports from the Numeracy Development Projects and Te Poutama Tau (Christensen, 2004; Young-Loveridge, 2005).

Table 4
Comparison of Students' Mean Stage Gain across the Aspects of the Number Framework for 2003, 2004, and 2005

	Percentage making stage gain						
Stage gain	0	1	2	3	4	5	6
Addition 2005	**49**	**35**	**12**	**4**	**0.2**		
Addition 2004	48	36	11	4	0.4	0.2	
Addition 2003	42	39	15	3	0.8	0.7	0.2
Multiplication 2005	**40**	**45**	**13**	**3**			
Multiplication 2004	70	18	10	2	0.3		
Multiplication 2003	63	23	10	3	0.7	0.2	
Proportions 2005	**47**	**44**	**8**	**1**			
Proportions 2004	73	16	10	1	0.07		
Proportions 2003	67	18	11	3	0.5	0.2	0.2
FNWS 2005	**52**	**36**	**9**	**3**	**0.2**		
FNWS 2004	49	36	9	4	2	0.2	
FNWS 2003	45	34	13	4	2	1	0.6
BNWS 2005	**49**	**38**	**11**	**3**	**0.3**		
BNWS 2004	44	37	12	4	3	0.3	
BNWS 2003	44	32	13	7	3	0.7	0.7
NID 2005	**42**	**30**	**17**	**10**			
NID 2004	70	20	6	3	0.5	0.2	
NID 2003	68	17	8	4	2	2	
Fractions 2005	**40**	**38**	**17**	**5**	**0.4**		
Fractions 2004	70	19	9	2	0.5	0.08	
Fractions 2003	63	20	13	3	0.7	0.7	
Decimals 2005	**49**	**40**	**11**	**0.8**	**0.2**		
Decimals 2004	47	37	13	2	0.3		
Decimals 2003	91	3	4	1	0.3		
GPPV 2005	**40**	**36**	**18**	**5**	**0.2**		
GPPV 2004	57	33	10	0.9	0.2		
GPPV 2003	43	38	14	4	0.8	0.5	

Recommendations

The following recommendations arise from the research that has been discussed in this report. A stronger emphasis for teacher and numeracy facilitators' professional development in 2006 should be focused on:

- Improving the outcomes for those students who make little or no stage gains (as noted in Table 4).
- Shifting students at stage 4 into stage 5 early additive part–whole. The data suggests many students are making steady progress through the counting stages but are having difficulties transitioning into part–whole stages.
- Maintaining an emphasis on grouping and place value. This concept underpins many of the mathematical concepts associated with numerical thinking, in particular part–whole thinking.
- Maintaining a focus on the higher stages of multiplication, decimals, fractions, and proportions. As noted in the discussion on Table 4, these concepts constitute a body of knowledge considered essential not only for higher mathematics but also for everyday life skills.
- Ensuring all participating schools enter complete initial and final data on the national database.
- Focusing on the relationship between te reo Māori and mathematical thinking. For example, what are the te reo Māori linguistic structures that support or hinder students' ability to learn mathematics? How do students represent mathematical concepts linguistically?

References

Berh, M., Harel, G., Post, T., & Lesh, R. (1992). Rational number, ratio and proportion. In D. Grouws (Ed.), *Handbook on research of teaching and learning* (pp. 296–333). New York: McMillan.

Christensen, I. (2003). *An evaluation of Te Poutama Tau 2002:* Exploring issues in mathematical education. Wellington: Ministry of Education.

Christensen, I. (2004). *An evaluation of Te Poutama Tau 2003:* Exploring issues in mathematical education. Wellington: Ministry of Education.

Davis, G., Hunting, R., & Pearn, C. (1993). What might a fraction mean to a child and how would a teacher know? *Journal of Mathematical Behavior,* 12, 63–76.

English, L., & Halford, G. (1995). *Mathematics education: Models and processes.* Mahwah, NJ: Lawrence Erlbaum.

McMurchy-Pilkington, C. (2004). *Literature review – Te Anga Marautanga o Aotearoa.* Wellington: Ministry of Education.

Ministry of Education (2005). *Book 1: The Number Framework.* Wellington: Ministry of Education.

Ministry of Education (2006). *Pukapuka tuatahi: Te Mahere Tau.* Wellington: Ministry of Education.

Mulligan, J. (2002). The role of structure in children's development of multiplicative reasoning. In B. Barton, K. C. Irwin, M. Pfannkuch, & M. Thomas (Eds), *Mathematics education in the South Pacific* (Proceedings of the 25th annual conference of the Mathematics Education Research Group of Australasia, Auckland, Vol. 2, pp. 497–503). Sydney: MERGA.

Resnick, L. (1983). A developmental theory of a number understanding. In H. P. Ginsburg (Ed.) *The Development of Mathematical Thinking* (pp.109–151). New York: Academic Press.

Trinick, T. & Stephenson [*sic*], B. (2005). An evaluation of Te Poutama Tau 2004. In *Findings from the New Zealand Numeracy Development Project 2004* (pp. 56–65). Wellington: Ministry of Education.

Young-Loveridge, J. (2001). Helping children move beyond counting to part–whole strategies. *Teachers and Curriculum*, 5, 72–78.

Young-Loveridge, J. (2005). Patterns of performance and progress: Analysis of 2004 data. In *Findings from the New Zealand Numeracy Development Project 2004* (pp. 5–20). Wellington: Ministry of Education.