Te Poutama Tau 2006: Trends and Patterns

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This paper reports on the analysis of the 2006 data from the Māori-medium numeracy project, Te Poutama Tau. In general, student performance improved throughout 2006. However, performance on the addition, subtraction, and proportion domains was somewhat disappointing, particularly progress at years 3 and 4. Additionally, there is still a proportion of students who made minimal stage gain. Analyses of patterns of performance and progress over time from 2003 to 2006 show there have been positive longitudinal trends in most areas of the Number Framework. Students also made greater progress in the earlier stages relative to their ages. Significantly, the longitudinal trends show that, where there have been areas of concern, additional focus on these areas in subsequent years has improved performance.

Background

The New Zealand Numeracy Development Projects (NDP) were developed in response to concerns about the quality of mathematics teaching and as a result of the achievement of New Zealand students in the Third International Mathematics and Science Study (TIMMS) (Garden, 1996, 1997). Although Māori-medium kura did not participate in the TIMMS study (the study was only available in the medium of English), the Te Poutama Tau project was subsequently developed in recognition of the fact that the teaching of numeracy is a complex area and that teachers of mathematics in the medium of Māori require support. The primary aim of the Te Poutama Tau project is to improve student performance in pāngarau (mathematics) through improving the professional capability of teachers. The first Te Poutama Tau project began in 2002 as a pilot and was further extended into a range of Māori-medium kura the following year (Christensen, 2003). Te Poutama Tau is based upon the Number Framework developed for New Zealand schools (Ministry of Education, 2006a). The Framework provides a clear description of the key concepts and the progressions of learning for students. In the absence of a wide range of Māori-medium resources to assist teachers in the interpretation of the Māori-medium national curriculum statements, the Te Poutama Tau professional learning programme provides significant support for teachers who are teaching mathematics in the medium of Māori.

Teachers from 31 schools participating in Te Poutama Tau during 2006 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 (Ministry of Education, 2006b).

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

- What overall progress did students make on the Number Framework in 2006?
- In which areas of the Framework did students perform well in 2006 and in which areas did they perform poorly in 2006? Why is this so?
- How do patterns of performance and progress of students involved in the 2006 project compare with the 2004, 2005, and 2006 patterns?
- What areas of the Framework have they performed well or poorly over the four years? Why is this so?

Method

The results for each Te Poutama Tau 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 Framework between the initial and 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 for the subsequent year(s). Teachers can use the data to group students according to ability and use activities that will support students in both strategy and knowledge development.

Participants

The following summaries of the data were restricted to only those students with both diagnostic interview results. In 2005, 496 students completed both the initial and final diagnostic interview and in 2006, there was complete data for 1153 students.

The low number of students recorded as participating in 2005 was due essentially to a range of issues around data entry. The redesigned database at the end of 2004 made it difficult to identify Te Poutama Tau schools. If participating teachers did not enter data into the language fields, there was no easy means of identifying the participating Māori-medium kura. English-medium schools that participated in the Te Poutama Tau project also had to tick a box identifying the data as Te Poutama Tau data. A number of schools failed to do this and consequently were not identified.

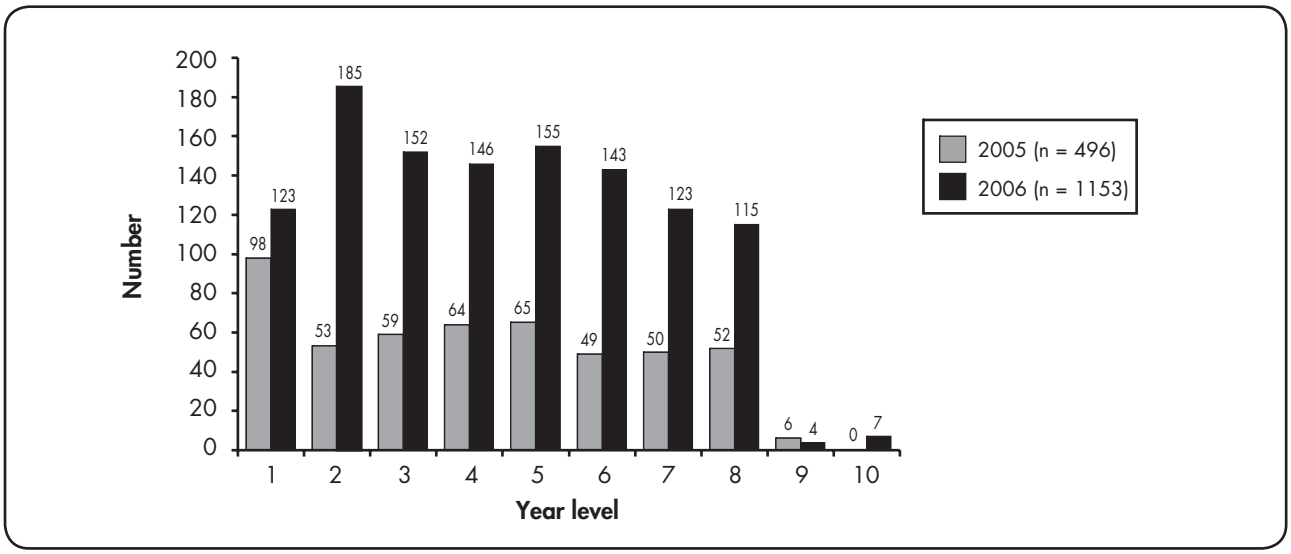


Figure 1: Distribution of Te Poutama Tau students across year levels

Overview of Student Progress 2006

Progress of students in the Te Poutama Tau schools was very positive in the areas of NID, fractions, grouping, and place value. In previous years, the results in these areas have not been as positive (Trinick & Stevenson, 2005, 2006). However, as a key component of the professional learning programme in 2005–2006, Te Poutama Tau facilitators and teachers gave particular attention to these areas. Proportion continues to be a challenge, particularly when students are in transition to stage 5 (early additive). The behavioural indicator for this stage requires students to find a unit fraction of a number mentally using addition facts, that is, $\frac{1}{3}$ of 12 as 4 + 4 + 4 = 12. The issue may be the strategy itself. This will need to be considered in future studies.

For the two forms of number-word sequencing, students make positive progress in the earlier stages, but there still appears to be an issue around the "large" numbers at stages 5 (early additive) and 6 (advanced additive), as noted in earlier studies (Trinick & Stevenson, 2005, 2006). However, there were positive stage gains in numeral identification. Hopefully, this will translate into more positive results for number sequencing.

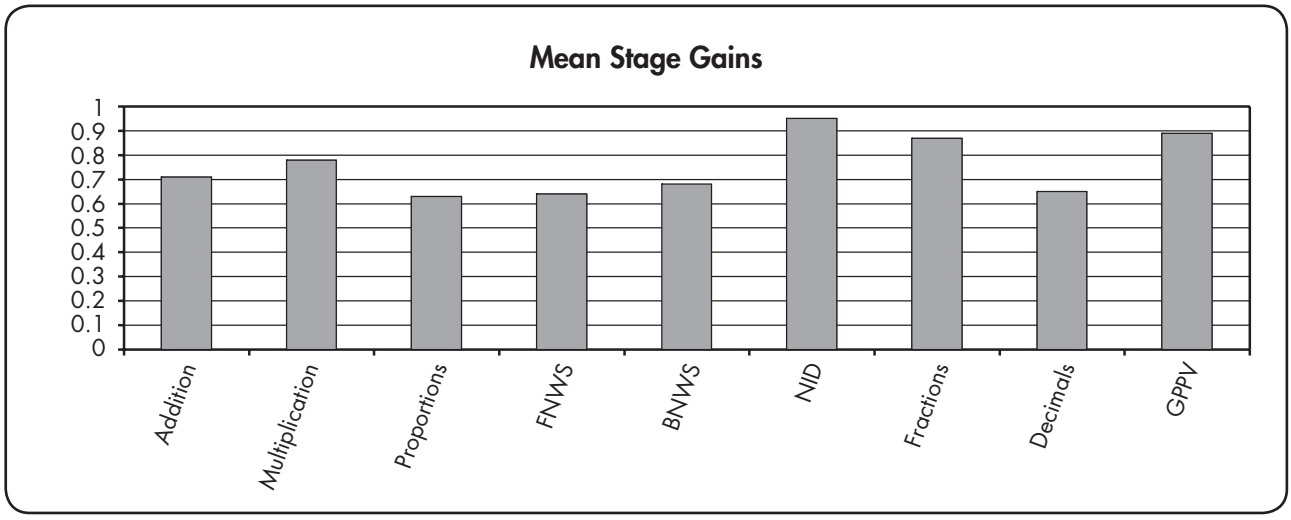


Figure 2: 2006 mean stage gains across the Number Framework

Student Achievement and Year Level

The graphs in Figure 3 on the following pages show variation in the mean gain for each domain of the Framework across the year levels. For example, students at years 0–1 made a mean stage gain of 1.25 for proportion and at year 3, a mean gain of 0.26 (Figure 3.3). There were no clear patterns common to all domains of the Framework. However, there are patterns within a number of related domains, particularly knowledge domains.

Strategy Domains

Although positive for addition and subtraction in the early stages (Figure 3.1), there is a significant slow down in later stages. This is due to a number of factors, including the complexity of upper levels and the number of students in the older year groups (6–8) who are already at stages 5–6.

There were no mean stage gains for multiplication for year 1 students and large gains for year 2 (Figure 3.2). This can be explained by the low numbers of students at years 1–2 who were tested using the multiplicative test items. The majority of years 1–2 were tested using Uiui A (NumPA) where there are no test items for multiplication. It is quite likely that the few year 2 students who made large gains were the high achievers. The results for proportion can be explained similarly. There were large stage gains at years 0–1 and at year 2 for proportion (Figure 3.3). However, there were only eight students who were tested for proportion in these year groups, and it is likely that these students may well be high achievers. There is a large dip in progress at year 3, where approximately 80 students had both initial and final data entered.

Knowledge Areas

In FNWS, BNWS, and NID, there is significant growth in the earlier years, with a similar pattern of regression in later years. This is not surprising, considering these areas are closely related. In order for students to count forwards or backwards or locate numbers, they need to be able to identify

numbers. The regression can be attributed to a number of key factors. For example, a number of students in the older age groups may already be at the upper stages. 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 test A to tests 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 stages but has been subsumed as part of ordering numbers. As already stated, in order for students to count forwards or backwards or locate numbers, they need to be able to identify numbers.

In general, there were positive results for fractions across the year groups (Figure 3.7). As noted earlier, this has been an area of focus for facilitators and teachers in the Te Poutama Tau project in 2006. However, the very positive results for the years 0–1 students can also be explained by the low numbers of students tested and the fact that they were likely to be the high achievers. In general, there were positive results across the GPPV and basic facts domains (Figure 3.8). One of the problematic areas in basic facts seems to be around the division facts at stage 7 and common factors and multiples at stage 8 (Figure 3.9).

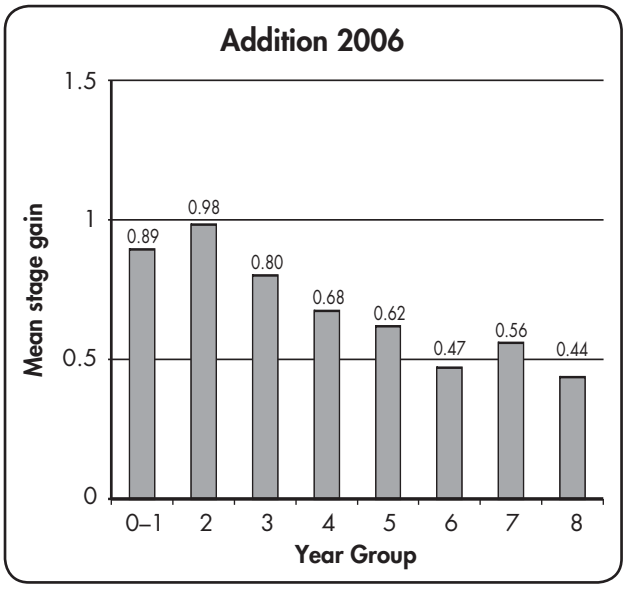


Figure 3.1: Mean stage gain for addition and subtraction

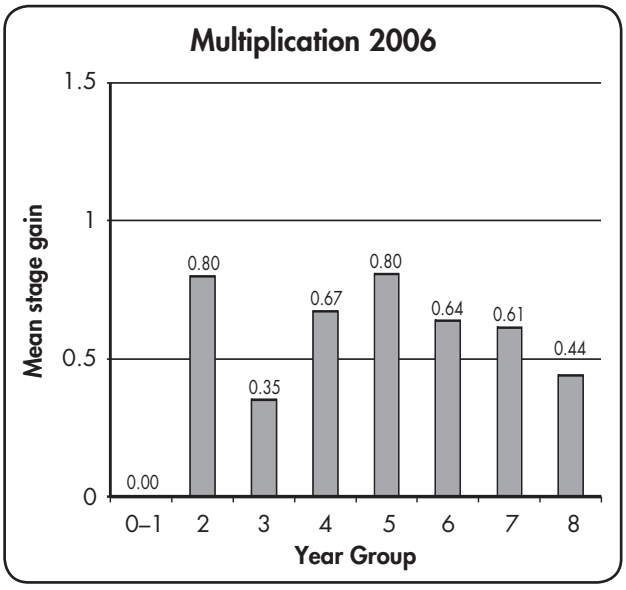


Figure 3.2: Mean stage gain for multiplication and division

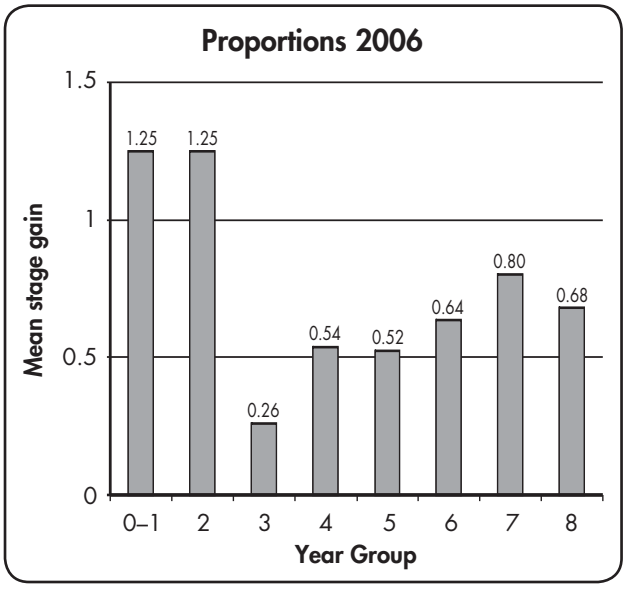


Figure 3.3: Mean stage gain for proportions

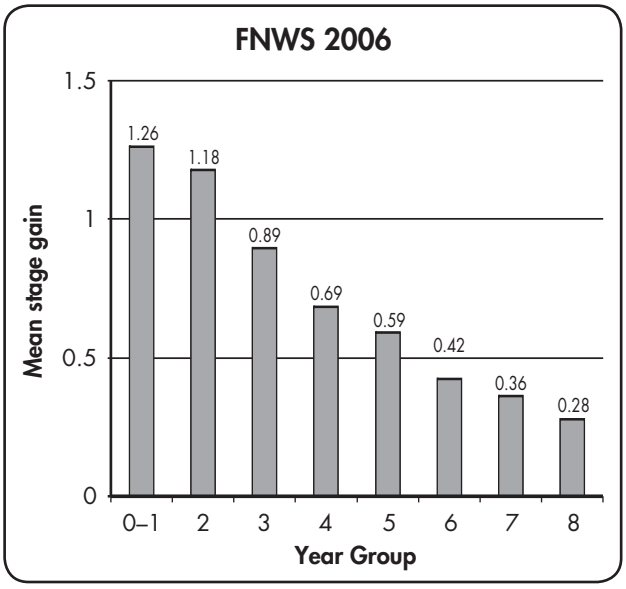


Figure 3.4: Mean stage gain for forward number word sequence

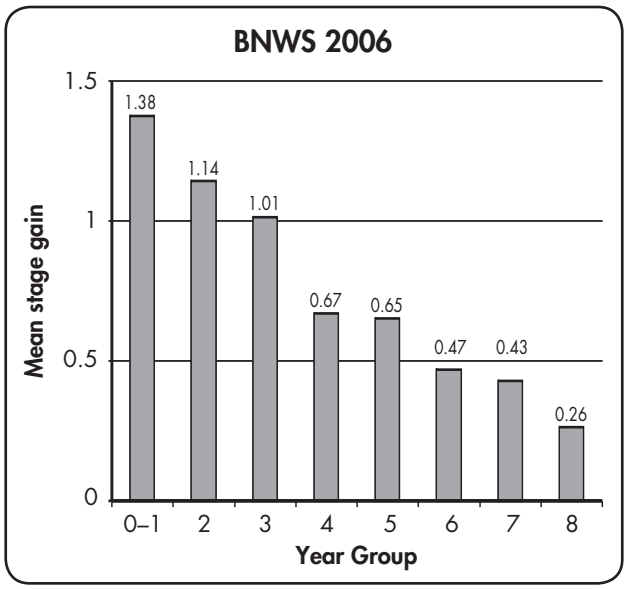


Figure 3.5: Mean stage gain for backward number word sequence

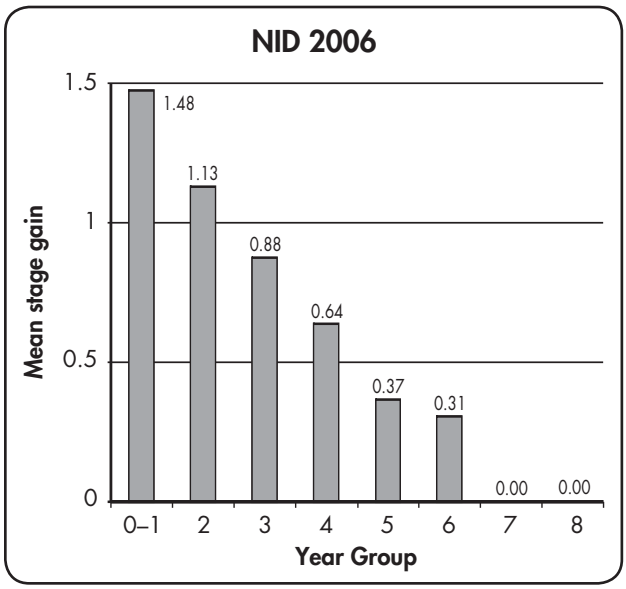


Figure 3.6: Mean stage gain for numeral identification

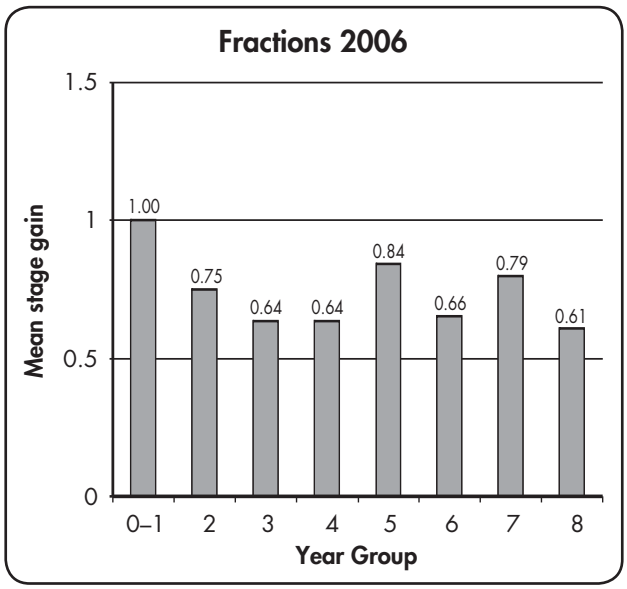


Figure 3.7: Mean stage gain for fractions

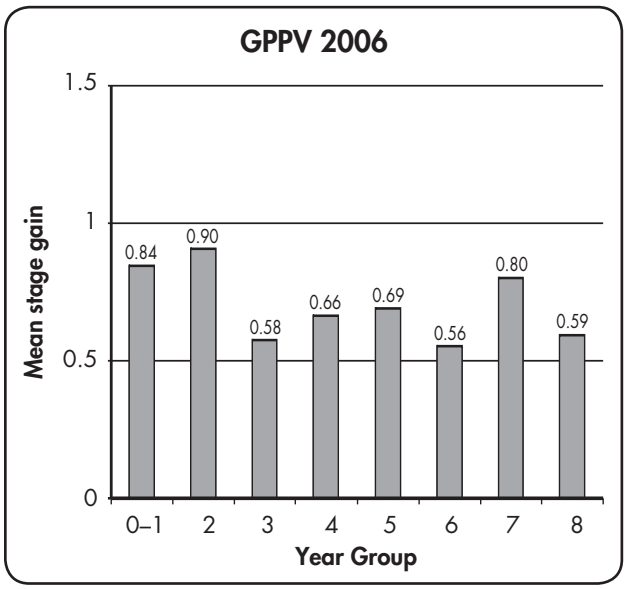


Figure 3.8: Mean stage gain for grouping and place value

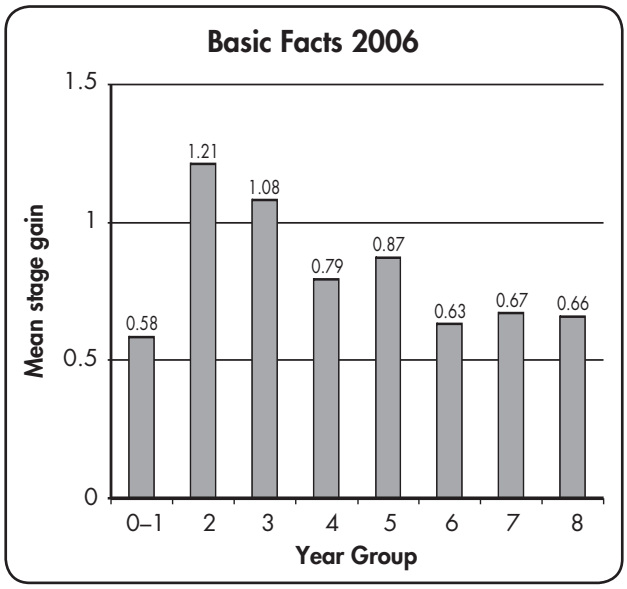
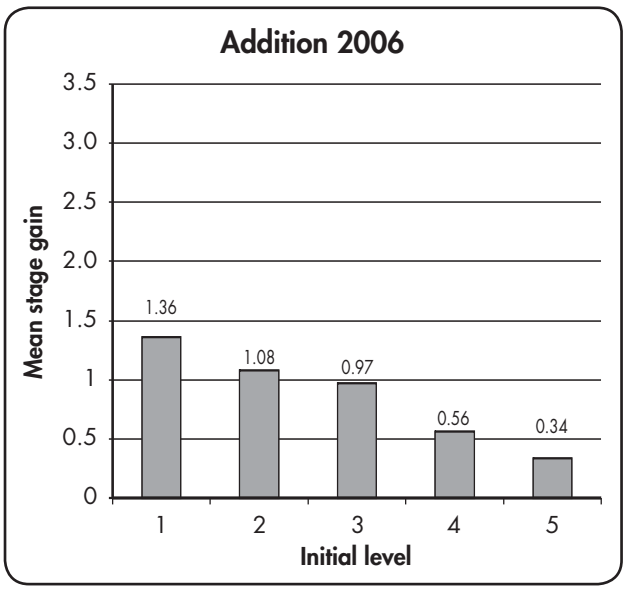


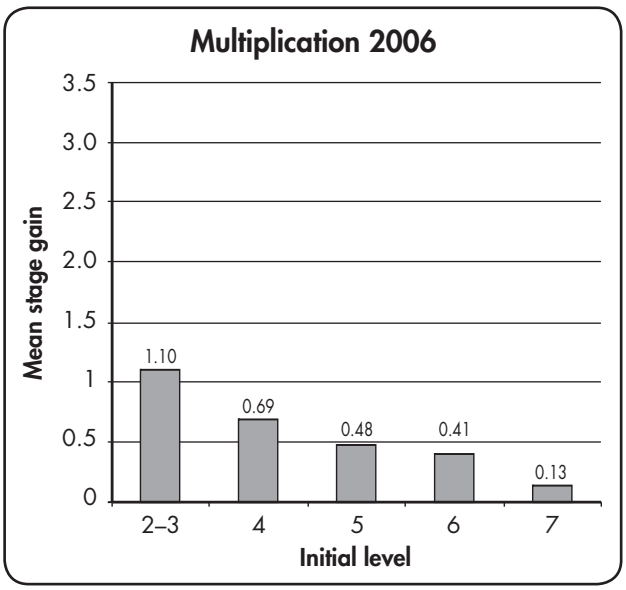
Figure 3.9: Mean stage gain for basic facts

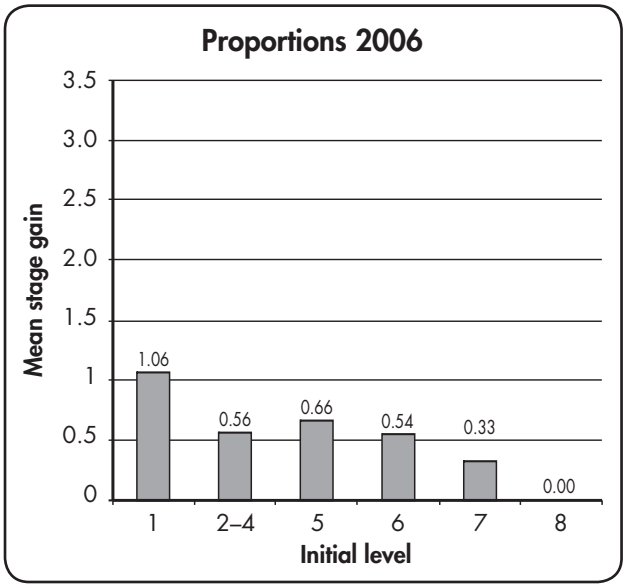
Student Achievement and Initial Stage Assessment

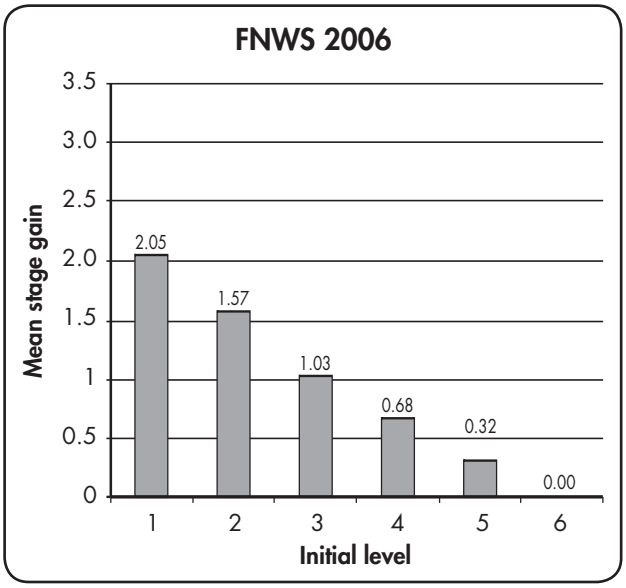
The graphs below (Figure 4) show the variation in the mean gain and initial stage level for each domain of the Number Framework. For example, students who initially tested at stage 1 for addition and subtraction made a mean stage gain of 1.36. Students who initially tested at stage 5 made a mean 0.34 stage gain. As with previous years, there was no clear pattern common to all aspects of the Framework. The domains of addition, multiplication, FNWS, BNWS, and NID showed a "diminishing returns" pattern, where advancement was more difficult for children at successively higher year levels. It is important to note that the stages on the Framework do not constitute an equal interval scale because the increments at the lower end of the Framework are smaller than those at the upper. Students tend to progress through the lower stages more quickly.

However, aspects such as fractions and GPPV are showing positive gains through most of the levels. It is particularly pleasing to note the very positive stage gains for fractions for students at stage 7.









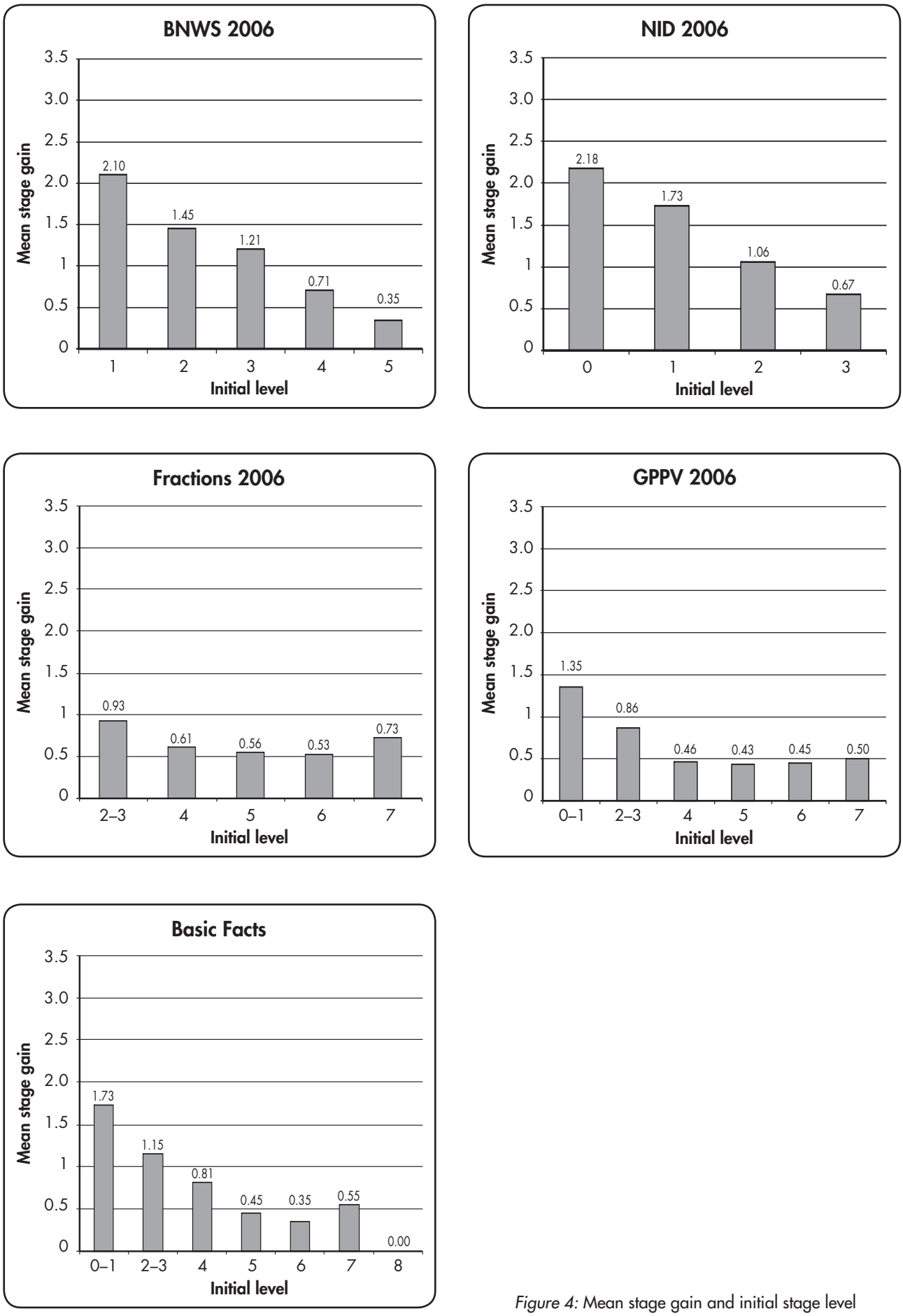


Figure 4: Mean stage gain and initial stage level

Reporting of Student Achievement Data

Individual schools and classrooms can use similar charts to analyse their own students' data. These types of charts can help teachers to identify patterns and trends at an individual school level, but teachers need to be aware that for small samples of students these charts can be very misleading. A useful addition to the NDP are guidelines for the use and reporting of student achievement data using expectations (www.nzmaths.co.nz/numeracy/Principals). This guide assists kura and teachers to identify students "at risk" and high achieving students.

Longitudinal Patterns of Progress

This section examines patterns of performance over four years of implementation of Te Poutama Tau. Overall, the trend in student progress for 2006 was relatively consistent with 2005 results. With the exception of addition and subtraction, there have been positive longitudinal trends in most areas of the Framework. One possible explanation for the regression in addition/subtraction is that some students have achieved stage 6, in other words, a ceiling affect. Over the last three years (2003, 2004, and 2005), there was evidence of improved stage gains for proportions, numeral identification, and decimals. From 2005 to 2006, there is a slight regression in fractions and multiplication. This is partly due to students moving into the higher stages, which are more complex.

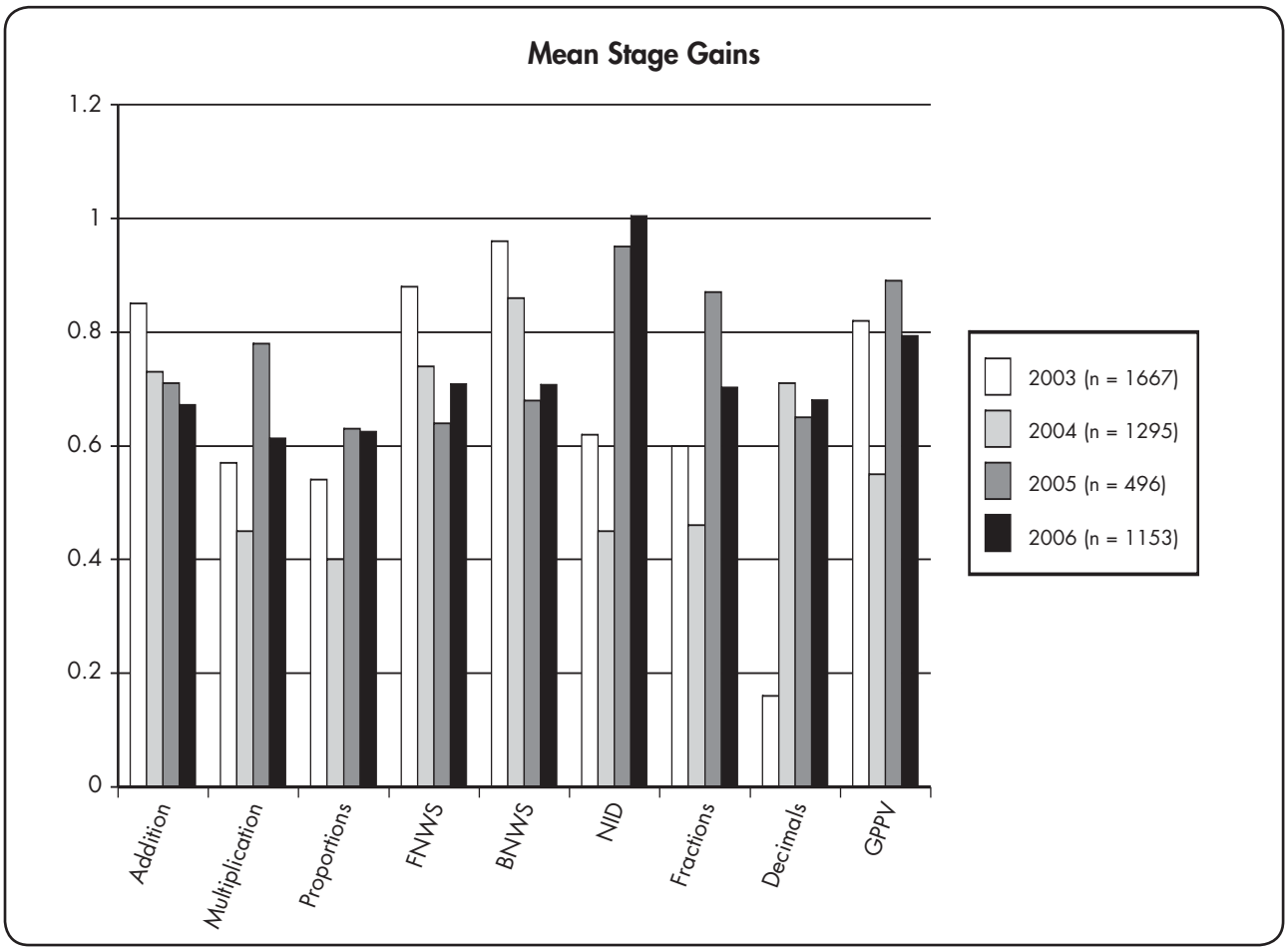


Figure 5: Mean stage gains across the Number Framework

A number of interesting trends show up in the following table. If the 2004 results are compared with the 2006 results (larger data sample sizes), the change difference in most of the domains of the Framework is greater. This in part can be attributed to increased teachers' and facilitators' confidence in the delivery and management of the project. In GPPV, for example, the trend is a 0.55 gain in 2004, a 0.89 gain in 2005, and a 0.79 gain in 2006. As noted in earlier studies (Trinick & Stevenson, 2005, 2006), grouping and place value underpin many of the key ideas of the Framework. It is not clear why there was a slight regression in addition and subtraction. As noted earlier, concern was raised in 2005 at the less than positive stage gain in NID. However, with a concentrated focus by teachers and facilitators on this domain, the mean stage gain of 1.00 is very encouraging.

Table 1
Comparison of Change Between Initial and Final Test Results

		2004 (n = 1295)			2005 (n = 427)			2006 (n = 1153)		
	Mean	Initial	Change	Final	Initial	Change	Final	Initial	Change	Final
Strategy	Addition	4.1	0.73	4.85	3.7	0.71	4.22	3.69	0.67	4.36
	Multiplication	2.1	0.45	2.58	2.6	0.78	3.16	2.63	0.61	3.25
	Proportions	2.1	0.40	2.41	2.5	0.63	2.92	2.49	0.63	3.12
Knowledge	FNWS	4.7	0.74	5.46	4.0	0.64	4.55	4.04	0.71	4.75
	BNWS	4.4	0.86	5.27	4.0	0.68	4.66	4.11	0.71	4.82
	NID	3.0	0.45	3.46	2.9	0.95	3.78	3.24	1.00	4.25
	Fractions	1.9	0.46	2.31	2.0	0.87	2.69	2.04	0.70	2.74
	Decimals	2.6	0.71	3.26	2.8	0.65	3.41	2.87	0.68	3.55
	GPPV	2.5	0.55	3.08	3.0	0.89	3.83	3.41	0.79	4.20

The following figure shows how the average for the final results for all domains varies across the year levels for 2003–2006. From year 4 onward, the trend is reasonably consistent. Large mean stage gains were made in the earlier year levels in 2006. However, as noted earlier, it is important to interpret these results cautiously because the stages do not constitute an interval scale. The large gains in the early years of 2006 can be attributed in part to the high mean stage gain in multiplication and proportions (Figure 3.3). However, the number of students who made the gains was very low. There has consistently been a dip at year 3 followed by a slight rise at year 4. It is at this point where many students are transitioning from using counting strategies to part–whole.

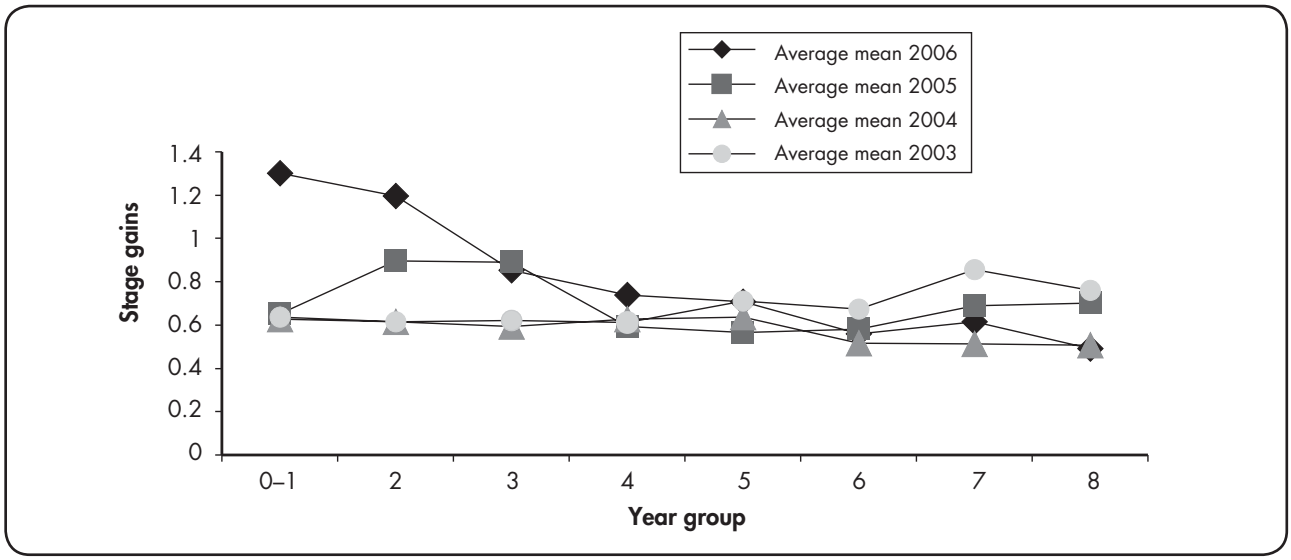


Figure 6: Comparison of students' average mean stage gain across years 2003, 2004, 2005, and 2006

Summary

As the corpus of data collected grows as a result of the Te Poutama Tau project over the last five years, there are many more questions raised, for example, the interrelationship between the domains, that is, the relationship between multiplication, division, fractions, and proportions. In order to carry out many fraction and proportion tasks, students need effective division and multiplicative strategies. Considerable work also remains in identifying the relationship between language proficiency and student achievement in Māori-medium mathematics. The following recommendations arise from the research that has been discussed in this report and discussions with Te Poutama Tau facilitators for particular focus in 2007:

- Focusing on older students who have made minimal stage gain, for example, year 4 students who have not progressed beyond the advanced counting stage for addition (these are year 5 in 2007)
- Focusing on the teaching of addition and proportion, particularly with the 2007 year 4 students
- Investigating the impact of the Te Poutama Tau project on Māori-medium mathematics generally, for example, investigating students' progress in other strands and/or using alternative tests, such as asTTLe
- Continuing to investigate the relationship between Māori language and mathematics
- Incorporating algebraic thinking into the Te Poutama Tau project. While it is unclear what the algebra objectives in the Marauatanga Pāngarau really mean for the younger students, the trickle-down effect of these objectives are clear: kura tuatahi teaching must focus greater attention on preparing all students for challenging wharekura mathematics programmes, particularly NCEA. Thus, "algebraic thinking" has become a catch-all phrase for the mathematics teaching and learning that will prepare students for successful experiences in algebra and beyond.

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