Performance on the Number Framework

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Introduction

In 2005, the Ministry of Education offered New Zealand secondary schools an opportunity to improve the teaching and learning of number concepts and skills through the Secondary Numeracy Pilot Project (SNP), a professional development programme for teachers.

The overall aim of the SNP is to develop teachers' knowledge of number concepts, student strategies for operating with number, and instructional practice in order to improve student achievement in year 9.

For the SNP, the Numeracy Development Project (NDP) diagnostic interview used to assess students against the Framework in both strategy and knowledge was modified to better suit the needs of secondary schools. SNP teachers have only one set of strategy questions to use in their individual interviews with students at the beginning of the project (term 1) and at the end (term 4). The knowledge domains are assessed as a pen-and-paper whole-class assessment.

A key aspect of the evaluation of the SNP is to quantify any improvement. This chapter aims to address the following research questions:

- 1. Do SNP students make progress on the Number Framework?
- 2. How does this progress compare to that of year 8 students in NDP schools?
- 3. What demographic factors impact on the progress and performance of SNP students?
- 4. Is there a relationship between students' number knowledge profiles and their progress on the multiplicative strategy domain?

The results in this chapter are divided into three sections:

- The performance of students on the strategy domains. This describes students' abilities to operate with number.
- The performance of students on the knowledge domains. This describes the key items of number knowledge.
- The relationship between students' use of strategies and their number knowledge.

Where overall differences are described between groups, a T-test has been carried out to verify a difference to at least the 95% confidence level. In addition, differences in percentages of students at particular levels of each domain are not reported unless they are greater than 5%. It needs to be noted that, in some instances, the figures show some significantly different mean gains that may be smaller than other gains in the same figures that are not statistically significant due to differences in sample size. In all tables, percentages are rounded. Percentages less than 0.5% are therefore shown as 0%, and where there are no students represented, the cell is left blank.

Sample

The results reported in this chapter were obtained by downloading data from the online Numeracy Database on 23 January 2006. Results from all students in SNP schools were included, providing these results included an initial and final entry for each of the seven domains assessed.

Of the 43 schools that participated in the SNP in 2005, results were available at this time for 3975 students from 31 schools. Table 1 comprises a breakdown of these students by ethnicity. Two-thirds (66%) of the students were of New Zealand European origin, 20% identified as Māori, and approximately 5% identified as each of Pasifika, Asian, or other. There were more male students than female (57% compared with 43%). (This gender imbalance in the results was caused by the data from several girls' schools not being available at the time that data for this evaluation was downloaded.)

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Ethnicity	Percentage
NZ European	66
Màori	20
Pasifika	5
Asian	4
Other	5
Total	3975

Table 1 Profile of SNP Students by Ethnicity

Performance on the Strategy Domains

Additive Domain

Tables 2–5 and figures 1–3 present the results of SNP students on the additive domain, which describes students' strategies for solving addition and subtraction problems.

Table 2, comparing initial and final additive stages, shows that the percentage of students at the top two stages (6 and 7) of the additive domain increased from 45% at the start of the project to 69% by the final assessment. These students are able to use a range of mental part–whole strategies to solve addition and subtraction problems. Correspondingly, the percentage of students still exclusively using counting strategies (stage 4 or lower) decreased from 15% to 5% over the course of the project. There were still 5% of students unable to partition numbers mentally, and this is a cause for concern.

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	% initial additive	% final additive
0: Emergent	0	0
1: One-to-one counting	0	
2: Counting from one on materials	0	0
3: Counting from one by imaging	1	0
4: Advanced counting	14	5
5: Early additive part-whole	39	26
6: Advanced additive part-whole	37	46
7: Advanced multiplicative part-whole	8	23
Number of students	3975	3975

Table 2 Initial and Final Additive Stages

Table 3 shows the initial and final additive stages of students by ethnicity. Both at the start and at the end of the project, New Zealand European students were more likely than Māori or Pasifika students to be at the higher stages of the additive domain, with 72%, 53%, and 57% respectively reaching the top two stages by the end of project.

	NZ European		Māori		Pasi	fika
Additive stage	% initial	% final	% initial	% final	% initial	% final
0: Emergent	0		0	0		
1: One-to-one counting	0					
2: Counting from one on materials	0	0	1	0	1	
3: Counting from one by imaging	1	0	2	1	2	1
4: Advanced counting	12	5	22	9	29	6
5: Early additive part-whole	38	23	45	37	42	36
6: Advanced additive part-whole	40	47	27	42	24	45
7: Advanced multiplicative part-whole	9	25	4	11	2	12
Number of students	2642	2642	783	783	193	193

Table 3 Initial and Final Additive Stage by Ethnicity

Note: Percentages may not total to 100 due to rounding.

Table 4 shows that male students (26%) were more likely than female students (18%) to reach the top stage of the additive domain. Similar percentages (5% and 6% respectively) remained at the advanced counting stage or lower.

Table 4 Initial and Final Additive Stage by Gender

	M	ale	Fem	ale	
Additive stage	% initial	% final	% initial	% final	
0: Emergent	0		0	0	
1: One-to-one counting			0		
2: Counting from one on materials	0	0	0	0	
3: Counting from one by imaging	1	0	1	0	
4: Advanced counting	12	5	18	6	
5: Early additive part-whole	35	22	44	31	
6: Advanced additive part-whole	42	46	30	45	
7: Advanced multiplicative part-whole	10	26	6	18	
Number of students	2248	2248	1727	1727	

Table 5, a breakdown of additive performance by school decile band, shows that students in the high-decile bands performed better than students in either medium- or low-decile bands, with 30% reaching stage 7, compared with 19% of students in medium-decile and 14% of students in low-decile bands.

	Low		Medium		High	
Additive stage	% initial	% final	% initial	% final	% initial	% final
0: Emergent	1		0		0	0
1: One-to-one counting			0			
2: Counting from one on materials	0		0	0	0	0
3: Counting from one by imaging	1	1	1	0	1	0
4: Advanced counting	20	8	17	7	9	3
5: Early additive part-whole	47	33	39	28	37	22
6: Advanced additive part-whole	26	45	36	46	41	45
7: Advanced multiplicative part-whole	5	14	6	19	12	30
Number of students	435	435	2059	2059	1481	1481

Table 5 Initial and Final Additive Stage by Decile

Note: Percentages may not total to 100 due to rounding.

Figure 1 compares the numbers of stages that SNP students gained on the additive domain with the numbers of stages gained from the same starting stage by year 8 students participating in the NDP. For both samples, the numbers of students initially rated at stages 0–3 were very small, so these results have been excluded from the following figures. The pattern of students' performance initially rated at stages 4–6 is similar for the two samples, with a higher proportion of SNP students initially at stage 5 progressing to at least stage 6 (p < 0.01) and a higher proportion of year 8 students initially at stage 6 progressing to stage 7 (p < 0.001).



Figure 2 shows the progress made on the additive domain by students' initial stage and ethnicity. A significantly higher proportion of New Zealand European students than Māori students progressed from stage 5 (p < 0.001) and from stage 6 (p < 0.001).



Figure 3 shows that students from high-decile schools are significantly more likely than mediumdecile (p < 0.05) or low-decile (p < 0.01) students to make progress from stage 5 on the additive domain. The same pattern applies to students initially at stage 6 (p < 0.001 and p < 0.05respectively). The proportions of students from medium- and low-decile schools who made progress were similar.



Tables 6–9 and figures 4–6 present the results of SNP students on the multiplicative domain, which describes students' strategies for solving multiplication and division problems.

Table 6 compares the initial and final multiplicative stages and shows that the percentage of students at the top two stages (7 and 8) of the multiplicative domain increased from 25% at the start of the project to 46% by the final assessment. These students are able to use a range of advanced mental strategies to solve multiplication and division problems. Correspondingly, the percentage of students still exclusively using counting strategies (stage 4 or lower) decreased from 14% to 6% over the course of the project. There were still 6% of students who used skipcounting as their most advanced multiplicative strategy, and this is a cause for concern.

	% initial multiplicative	% final multiplicative
2–3: Counting from one	2	0
4: Advanced counting	12	6
5: Early additive part-whole	27	16
6: Advanced additive part-whole	34	32
7: Advanced multiplicative part-who	le 20	30
8: Advanced proportional part-whole	e 5	16
Number of students	3975	3975

Table 6 Initial and Final Multiplicative Stage

Table 7 shows the initial and final multiplicative stages of students by ethnicity. Both at the start and at the end of the project, New Zealand European students were considerably more likely than Māori or Pasifika students to be at the higher stages of the multiplicative domain, with 51%, 30%, and 27% respectively reaching the top two stages by the end of the project.

Table 7 Initial and Final Multiplicative Stage by Ethnicity

	NZ European		Māori		Pasif	ika
Multiplicative stage	% initial	% final	% initial	% final	% initial	% final
2–3: Counting from one	1	0	3	1	5	1
4: Advanced counting	9	5	20	10	24	11
5: Early additive part-whole	25	14	33	23	36	20
6: Advanced additive part-whole	35	31	31	37	23	41
7: Advanced multiplicative part-whole	23	33	11	23	11	22
8: Advanced proportional part-whole	6	18	2	7	2	5
Number of students	2642	2642	783	783	193	193

Table 8 shows that male students (53%) were more likely than female students (39%) to reach the top two stages of the multiplicative domain. Similar percentages (5% and 6% respectively) remained at the advanced counting stage or lower.

	Male		Female		
Multiplicative stage	% initial	% final	% initial	% final	
2–3: Counting from one	2	0	2	0	
4: Advanced counting	10	5	14	6	
5: Early additive part-whole	23	13	33	19	
6: Advanced additive part-whole	35	29	32	36	
7: Advanced multiplicative part-whole	23	33	15	28	
8: Advanced proportional part-whole	7	20	3	11	
Number of students	2248	2248	1727	1727	

Table 8Initial and Final Multiplicative Stage by Gender

Note: Percentages may not total to 100 due to rounding.

Table 9 presents a breakdown of additive performance by decile band. Students from highdecile schools performed better than students from either medium- or low-decile schools, with 58% reaching stage 7 or higher compared with 41% of students from medium-decile schools and 32% from low-decile schools. At the lower stages of the domain, only 3% of students from highdecile schools and 6% of students from medium-decile schools remained at the advanced counting stage or lower, compared with 13% from low-decile schools.

Table 9 Initial and Final Multiplicative Stage by Decile

	Low		Medium		High	
Multiplicative stage	% initial	% final	% initial	% final	% initial	% final
2–3: Counting from one	4	1	2	0	1	0
4: Advanced counting	21	12	14	6	6	3
5: Early additive part-whole	32	20	29	18	23	11
6: Advanced additive part-whole	27	35	34	34	36	28
7: Advanced multiplicative part-whole	14	24	18	30	25	34
8: Advanced proportional part-whole	2	8	4	11	9	24
Number of students	435	435	2059	2059	1481	1481

Figure 4 compares the numbers of stages that SNP students gained on the multiplicative domain with the numbers of stages gained from the same starting stage by year 8 students from schools participating in the NDP (many year 8 students were in their second year of the Intermediate Numeracy Project). Again, the numbers of students initially rated below stage 4 were very low and have been excluded from the following figures. The pattern of performance of students initially rated at stages 4–7 was very similar for the two samples, with SNP students initially at stage 6 making significantly greater gains (p < 0.01) than year 8 students.



Figure 5 compares progress made on the multiplicative domain by students' initial stage and ethnicity. A significantly higher proportion of New Zealand European students than Māori students made progress from stage 6 (p < 0.001) and from stage 7 (p < 0.01).



Figure 6 shows that a significantly higher proportion of students from high-decile schools made progress from stage 6 on the multiplicative domain than medium-decile (p < 0.001) or low-decile (p < 0.001) students. A significantly higher proportion of high-decile than medium-decile students also made progress from stage 7 (p < 0.001).



Proportional Strategy Domain

Tables 10–13 and figures 7–9 show the results of SNP students on the proportional domain, which describes students' ability to solve problems involving ratios and proportions.

Table 10, comparing initial and final proportional stages, shows that the percentage of students at the top two stages (7 and 8) of the proportional domain increased from 36% in the initial assessment to 53% by the end of the year. These students use multiplication and division to find fractions of numbers. Correspondingly, the percentage of students still exclusively using counting strategies (stage 4 or lower) decreased from 17% to 6% over the course of the project. There were still 6% of students who needed to share out objects to find fractions of a set, and this is a cause for concern.

Table 10 Initial and Final Proportional Stage

	% initial proportional	% final proportional
1: Unequal sharing	1	0
2–4: Equal sharing	16	6
5: Early additive part–whole	29	23
6: Advanced additive part-whole	17	17
7: Advanced multiplicative part-who	le 31	41
8: Advanced proportional part-who	e 5	12
Number of students	3975	3975

Note: Percentages may not total to 100 due to rounding.

Table 11 shows the initial and final proportional stages of students by ethnicity. Both at the start and at the end of the project, New Zealand European students were more likely than Māori or Pasifika students to be at the higher stages of the proportional domain, with 60%, 34%, and 26% respectively reaching the top two stages.

	NZ European		Māori		Pasif	ika
Proportional stage	% initial	% final	% initial	% final	% initial	% final
1: Unequal sharing	1	0	2	1	2	
2—4: Equal sharing	12	5	27	12	33	12
5: Early additive part-whole	26	19	35	35	41	34
6: Advanced additive part-whole	18	15	15	17	11	27
7: Advanced multiplicative part-whole	36	46	19	30	11	22
8: Advanced proportional part-whole	5	14	2	4	1	4
Number of students	2642	2642	783	783	193	193

Table 11Initial and Final Proportional Stage by Ethnicity

Note: Percentages may not total to 100 due to rounding.

Table 12 shows that male students (59%) are more likely than female students (47%) to reach the top two stages of the proportional domain. Similar percentages (6% and 7% respectively) remained at the advanced counting stage or lower (stages 1–4).

Table 12 Initial and Final Proportional Stage by Gender

	Ma	ıle	Fen		
Proportional stage	% initial	% final	% initial	% final	
1: Unequal sharing	1	0	2	0	
2—4: Equal sharing	15	6	18	7	
5: Early additive part–whole	27	20	32	26	
6: Advanced additive part-whole	16	15	19	19	
7: Advanced multiplicative part-whole	34	43	27	39	
8: Advanced proportional part-whole	7	16	2	8	
Number of students	2248	2248	1727	1727	

Note: Percentages may not total to 100 due to rounding.

Table 13 presents a breakdown of performance on the proportional domain by decile band, showing that students from high-decile schools performed better than students from either medium- or low-decile schools, with 65% reaching stage 7 or higher compared with 48% of students from medium-decile schools and 39% from low-decile schools. At the lower stages of the domain, only 4% of students from high-decile schools remained at the equal sharing stage or

lower, compared with 7% of students from medium-decile schools and 16% of students from low-decile schools.

	Low		Medium		High	
Proportional stage	% initial	% final	% initial	% final	% initial	% final
1: Unequal sharing	5	1	2	0	1	0
2–4: Equal sharing	21	15	20	7	10	4
5: Early additive part-whole	37	29	30	26	25	16
6: Advanced additive part-whole	12	16	19	18	17	15
7: Advanced multiplicative part-whole	23	33	26	39	40	47
8: Advanced proportional part-whole	2	6	4	9	7	18
Number of students	435	435	2059	2059	1481	1481

Table 13 Initial and Final Proportional Stage by Decile

Note: Percentages may not total to 100 due to rounding.

Figure 7 compares the numbers of stages gained on the proportional domain by SNP students with the numbers of stages gained from the same starting stage by year 8 students from schools participating in the NDP. The small numbers of students initially rated below stages 2–4 have been excluded from the following figures. The pattern of performance of students initially rated at stages 2–4 and higher is similar for the two samples. Because of the higher proportions of students gaining more than one stage, the mean gains of SNP students initially at stage 5 are significantly greater than those of year 8 students (p < 0.05).



Figure 8 shows the progress made on the proportional domain by students' initial stage and ethnicity. A significantly higher proportion of NZ European students than Māori students made progress from stage 5 (p < 0.001) and from stage 7 (p < 0.001). A significantly higher proportion of Pasifika students than Māori students made progress from stage 5 (p < 0.05).



Figure 9 shows that a significantly higher proportion of students from high-decile schools than low-decile schools made progress from stages 2 to 4 (p < 0.05), 5 (p < 0.01), and 6 (p < 0.05). A significantly higher proportion of students from medium-decile schools than from low-decile schools made progress from stages 5 (p < 0.01) and 6 (p < 0.05). A significantly higher proportion of students from medium-decile schools made progress from stages 7 (p < 0.05).



Comparison of Strategy Domains

Table 14 shows the percentages of students at each stage at the final assessment for all three strategy domains. It would be expected that students would be more likely to be at the higher stages of the additive domain than of the multiplicative domain and more likely to be at the higher stages of the multiplicative domain than of the proportional domain. While there were similar proportions of students still at the counting stages of each domain, the proportions at the higher stages were mixed, with only 23% of students rated at stage 7 of the additive domain, compared with 46% and 53% at either stage 7 or 8 of the multiplicative and proportional domains respectively.

Table 14 Final Strategy Stages – All Domains

	Domain						
Stage	% additive	% multiplicative	% proportional				
< 4: Counting from one	1	0	1				
4: Advanced counting	5	6	6				
5: Early additive part-whole	26	16	23				
6: Advanced additive part-whole	46	32	17				
7: Advanced multiplicative part-whole	23	30	41				
8: Advanced proportional part-whole	N/A	16	12				

Note: Percentages may not total to 100 due to rounding.

Performance on the Knowledge Domains

Forward Number Word Sequence

Tables 15–18 present the results of SNP students on the Forward Number Word Sequence (FNWS) domain, which describes students' ability to identify the number after a given number.

Over the duration of the project, the proportion of students able to identify the number after a given number in the range 1 to 1 000 000 (stage 6) increased from 54% to 71% (see Table 15).

Table 15 Initial and Final FNWS Stage

	% initial FNWS	% final FNWS
0: Emergent	0	0
1: Initial to 10	0	
2: To 10	1	0
3: То 20	1	0
4: To 100	3	2
5: To 1000	41	27
6: To 1 000 000	54	71
Number of students	3975	3975

Table 16 shows that a higher proportion of New Zealand European students (74%) than either Māori (57%) or Pasifika (65%) students reached the top stage of the FNWS domain.

	NZ European		Māori		Pasif	ika
FNWS stage	% initial	% final	% initial	% final	% initial	% final
0: Emergent	0			0		
1: Initial to 10	0					
2: To 10	0	0	1	1	4	3
3: То 20	1	0	3	1		1
4: To 100	2	1	5	3	6	2
5: To 1000	39	25	51	37	47	31
6: To 1 000 000	58	74	40	57	43	65
Number of students	2642	2642	783	783	193	193

Table 16 Initial and Final FNWS Stage by Ethnicity

Note: Percentages may not total to 100 due to rounding.

Table 17 shows that a higher percentage of male (73%) than female (68%) students reached the top stage of the FNWS domain.

Table 17 Initial and Final FNWS Stage by Gender

	Male		Fem	ale
FNWS stage	% initial	% final	% initial	% final
0: Emergent	0			0
1: Initial to 10			0	
2: To 10	1	1	1	0
3: To 20	1	0	1	1
4: To 100	3	2	3	1
5: To 1000	38	24	45	30
6: To 1 000 000	57	73	51	68
Number of students	2248	2248	1727	1727

Table 18 shows that a higher proportion of students from high-decile schools (74%) than students from medium-decile (69%) or low-decile (64%) schools reached the top stage of the FNWS domain.

	Low		Medium		High	
FNWS stage	% initial	% final	% initial	% final	% initial	% final
0: Emergent			0			0
1: Initial to 10			0			
2: To 10	2	2	1	0	0	0
3: То 20	0		1	1	1	0
4: To 100	6	3	3	2	1	0
5: То 1000	46	31	40	27	40	24
6: To 1 000 000	46	64	53	69	57	75
Number of students	435	435	2059	2059	1481	1481

Table 18 Initial and Final FNWS Stage by Decile

Note: Percentages may not total to 100 due to rounding.

Fractions Domain

Tables 19–22 illustrate the performance of SNP students on the fractions domain, which describes students' ability to identify and order fractions.

Table 19 shows that the percentage of students able to identify equivalent fractions (stage 7 or 8) increased from 22% at the initial assessment to 40% by the final assessment. The percentage of students still unable to order unit fractions (stage 4 or lower) decreased from 18% to 9%.

Table 19 Initial and Final Fractions Stage

	% initial fractions	% final fractions
2–3: Non-fractions	5	2
4: Assigns unit fractions	13	7
5: Orders unit fractions	39	29
6: Co-ordinates numerators/denominators	21	23
7: Equivalent fractions	15	25
8: Orders fractions	7	15
Number of students	3975	3975

Table 20 shows that New Zealand European students performed better than Māori and Pasifika students on the fractions domain, with 46% reaching the top two stages of the domain, compared with 22% and 23% for Māori and Pasifika students respectively. Fewer Pasifika (11%) than Māori (17%) students remained unable to order unit fractions by the end of the project.

	NZ European		Māori		Pasif	ika
Fractions stage	% initial	% final	% initial	% final	% initial	% final
2–3: Non-fractions	4	1	11	3	8	4
4: Assigns unit fractions	11	5	19	14	15	7
5: Orders unit fractions	40	28	43	37	49	33
6: Co-ordinates numerators/denominators	s 22	21	17	24	20	34
7: Equivalent fractions	16	28	8	14	5	16
8: Orders fractions	8	18	2	8	2	7
Number of students	2642	2642	783	783	193	193

Table 20 Initial and Final Fractions Stage by Ethnicity

Note: Percentages may not total to 100 due to rounding.

Table 21 shows that while a higher percentage of male (18%) than female (12%) students reached the top stage of the fractions domain, similar percentages (9% and 8% respectively) remained unable to order unit fractions (stage 4 or lower).

Table 21 Initial and Final Fractions Stage by Gender

	Ma	lle	Fen	nale	
Fractions stage	% initial	% final	% initial	% final	
2–3: Non-fractions	7	2	4	1	
4: Assigns unit fractions	12	7	13	7	
5: Orders unit fractions	37	27	42	30	
6: Co-ordinates numerators/denominators	19	21	23	25	
7: Equivalent fractions	17	25	12	25	
8: Orders fractions	8	18	5	12	
Number of students	2248	2248	1727	1727	

As shown in Table 22, students from high-decile schools performed better than students from medium-decile schools on the fractions domain and both performed better than students from low-decile schools, with 71%, 61%, and 46% respectively reaching at least stage 6 by the end of the project.

	Low		Medium		High	
Fractions stage	% initial	% final	% initial	% final	% initial	% final
2–3: Non-fractions	11	3	6	2	3	1
4: Assigns unit fractions	20	12	14	7	9	4
5: Orders unit fractions	40	38	43	30	35	24
6: Co-ordinates numerators/denominators	s 19	17	19	25	24	21
7: Equivalent fractions	7	17	12	23	20	30
8: Orders fractions	4	12	6	13	9	20
Number of students	435	435	2059	2059	1481	1481

Table 22 Initial and Final Fractions Stage by Decile

Note: Percentages may not total to 100 due to rounding.

Place Value Domain

Tables 23–26 present the results of SNP students on the place value domain, which describes students' ability to partition whole numbers and decimals using their place value.

Table 23 shows that the percentage of students at least able to identify the number of tenths in numbers and order decimals (stage 7 or 8) increased from 18% at the initial assessment to 35% by the end of the project.

Table 23 Initial and Final Place Value Stage

	% initial place value	% final place value
0–1: Non-counting	0	
2–3: Counts by ones	2	1
4: 10s to 100, order to 1000	11	5
5: 10s to 1000, order to 10 000	49	35
6: 10s, 100s, 1000s, orders whole numbe	rs 19	25
7: Tenths in and orders decimals	10	18
8: Tenths hundredths and thousandths	8	17
Number of students	3975	3975

Table 24 shows that a higher proportion of New Zealand European students (39%) than Pasifika (27%) or Māori (17%) students reached the top stages of the place value domain.

Table 24

	NZ European		Māori		Pasifika	
Place value stage	% initial	% final	% initial	% final	% initial	% final
0–1: Non-counting	0				1	
2–3: Counts by ones	2	0	4	1	4	3
4: 10s to 100, order to 1000	9	4	16	9	17	4
5: 10s to 1000, order to 10 000	48	32	56	46	58	41
6: 10s, 100s, 1000s, orders whole numbers	20	24	16	28	14	25
7: Tenths in and orders decimals	11	20	5	11	5	22
8: Tenths hundredths and thousandths	10	19	2	6	2	5
Number of students	2642	2642	783	783	193	193

Initial and Final Place Value Stage by Ethnicity

Note: Percentages may not total to 100 due to rounding.

Table 25 shows that while a higher percentage of male (37%) than female (32%) students reached at least stage 7 of the place value domain, a similar percentage of male (6%) to that of female (4%) students remained at stage 4 or lower.

Table 25

Initial a	nd Final	Place	Value	Stage	by	Gender
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	Male		Female		
Place value stage	% initial	% final	% initial	% final	
0–1: Non-counting	0		0		
2–3: Counts by ones	3	1	2	0	
4: 10s to 100, order to 1000	11	5	11	4	
5: 10s to 1000, order to 10 000	47	34	52	36	
6: 10s, 100s, 1000s, orders whole numbers	18	23	20	27	
7: Tenths in and orders decimals	10	17	10	19	
8: Tenths hundredths and thousandths	11	20	5	13	
Number of students	2248	2248	1727	1727	

Table 26 shows that students from high-decile schools were more likely to reach the higher stages of the place value domain than students from medium-decile schools and that both were more likely than students from low-decile schools.

	Lo	W	Med	lium	Hi	gh
Place value stage	% initial	% final	% initial	% final	% initial	% final
0–1: Non-counting	0		0			
2–3: Counts by ones	4	1	2	1	2	1
4: 10s to 100, order to 1000	21	8	10	5	9	4
5: 10s to 1000, order to 10 000	51	43	51	36	46	31
6: 10s, 100s, 1000s, orders whole number	s 17	24	20	27	17	21
7: Tenths in and orders decimals	6	17	9	17	12	20
8: Tenths hundredths and thousandths	2	7	6	14	13	24
Number of students	435	435	2059	2059	1481	1481

Table 26 Initial and Final Place Value Stage by Decile

Note: Percentages may not total to 100 due to rounding.

Basic Facts Domain

Tables 27 to 30 illustrate the performance of SNP students on the basic facts domain, which rates students' ability to quickly recall basic number facts.

Table 27 shows that the percentage of students who knew at least their subtraction and multiplication basic facts (stage 6 or higher) increased from 71% at the initial assessment to 82% by the final assessment. At the end of the project, 4% of students were still unable to recall their multiplication facts for 2, 5, and 10 (that is, were still below stage 5).

Table 27 Initial and Final Basic Facts Stage

	% initial basic facts	% final basic facts
0–1: Non-grouping	1	0
2–3: Within and with five	2	1
4: Within 10, doubles, and teens	6	3
5: Addition, multiplication for 2, 5, 10	21	14
6: Subtraction and multiplication	47	44
7: Division	24	38
Number of students	3975	3975

Table 28 shows that New Zealand European students performed better than either Māori or Pasifika students on the basic facts domain. While a slightly higher proportion of Pasifika (78%) than Māori (73%) students knew their subtraction and multiplication facts (stage 6 or higher) by the end of the project, a similar proportion (7% compared with 5%) remained below stage 5.

	NZ European		Māori		Pasif	ika
Basic facts stage	% initial	% final	% initial	% final	% initial	% final
0–1: Non-grouping	1	0	1	0	1	
2–3: Within and with five	1	0	3	1	2	2
4: Within 10, doubles, and teens	5	3	8	4	9	5
5: Addition, multiplication for 2, 5, 10	21	13	27	20	23	16
6: Subtraction and multiplication	48	45	46	45	45	44
7: Division	24	39	16	28	21	34
Number of students	2642	2642	783	783	193	193

Table 28 Initial and Final Basic Facts Stage by Ethnicity

Note: Percentages may not total to 100 due to rounding.

Table 29 shows that female students performed similarly to male students on the basic facts domain, with 84% knowing their subtraction and multiplication basic facts (stage 6 or higher) by the end of the project and only 2% still unable to recall their multiplication facts for 2, 5, and 10 (stage 4 or lower), compared with 80% and 5% respectively of male students.

Table 29

	Male		Fen	nale
Basic facts stage	% initial	% final	% initial	% final
0–1: Non-grouping	1	0	0	0
2–3: Within and with five	2	1	1	0
4: Within 10, doubles, and teens	7	4	4	2
5: Addition, multiplication for 2, 5, 10	22	15	21	12
6: Subtraction and multiplication	45	41	50	46
7: Division	24	39	23	38
Number of students	2248	2248	1727	1727

Initial and Final Basic Facts Stage by Gender

Table 30 shows that students from high-decile schools performed better than students from medium-decile schools (86% compared with 81% at stage 6 or higher by the end of the project) on the basic facts domain and that both performed better than students from low-decile schools.

	Lo	W	Med	dium	Hi	gh
Place value stage	% initial	% final	% initial	% final	% initial	% final
0–1: Non-grouping	2	1	0	0	1	0
2–3: Within and with five	3	1	1	1	1	0
4: Within 10, doubles, and teens	8	5	6	3	5	2
5: Addition, multiplication for 2, 5, 10	30	16	22	15	17	12
6: Subtraction and multiplication	42	47	47	45	48	40
7: Division	15	29	22	36	28	46
Number of students	435	435	2059	2059	1481	1481

Table 30 Initial and Final Basic Facts Stage by Decile

Note: Percentages may not total to 100 due to rounding.

Comparison of Knowledge Domains

Table 31 presents the percentages of students at each stage of the four knowledge domains at the end of the project. That a small proportion of students remain at stage 4 or lower on each domain should be a cause for concern for teachers in SNP schools. At the higher stages, it can be seen that a similar percentage of students reached stage 7 and 8 on the fractions (40%), place value (35%), and basic facts (38%) domains.

Table 31 Final Knowledge Stages – All Domains

	Domain						
Stage	% FNWS	% Fractions	% Place value	% Basic facts			
<4	1	2	1	1			
4	2	7	5	3			
5	27	29	35	14			
6	71	23	25	44			
7	N/A	25	18	38			
8	N/A	15	17	N/A			

The Relationship between Strategy and Knowledge

Tables 32 and 33 explore the relationship between students' gains in strategy stage and their number knowledge. The tables present the knowledge results on the fractions, place value, and basic facts domains of students who were initially rated as advanced additive (stage 6) on the multiplicative domain. This subgroup of the students was chosen for two reasons. Firstly, because this is the stage at which the highest proportion (34) of SNP were initially assessed. Secondly, there was a relatively even split of students between those who made progress from stage 7 and those who did not. The students are separated into two groups: those who progressed to at least stage 7 (advanced multiplicative), and those who did not.

Table 32 compares the end-of-project number knowledge profile of the two groups. In each knowledge domain, over half (57, 51, and 52 respectively) of the students who progressed were rated as at least stage 7. Contrastingly, less than a third (30, 25, and 32 respectively) of the students who did not progress were rated at stage 7 or 8 on the knowledge domains.

Table 32

Comparing the Number Knowledge Profile of Initially Advanced Additive Students Who Progressed to Advanced Multiplicative with Those Who Did Not

Number of students	680	661
	% remained advanced additive	% became multiplicative
Fractions		
2–3: Non-fractions	1	0
4: Assigns unit fractions	6	2
5: Orders unit fractions	33	19
6: Co-ordinates numerators/denominators	29	22
7: Equivalent fractions	21	33
8: Orders fractions	9	24
Place value		
2–3: Counts by ones	1	0
4: 10s to 100, order to 1000	4	1
5: 10s to 1000, order to 10 000	40	23
6: 10s, 100s, 1000s, orders whole numbe	ers 31	25
7: Tenths in and orders decimals	18	24
8: Tenths, hundredths, and thousandths	7	27
Basic facts		
0–1: Non-grouping	0	0
2–3: Within and with five	0	0
4: Within 10, doubles, and teens	3	2
5: Addition, multiplication for 2, 5, 10	15	5
6: Subtraction and multiplication	49	40
7: Division	32	52

Table 33 presents the same results, but in this case, the percentages represent the proportions of students finishing the project at each knowledge stage who did or did not progress on the multiplicative domain. Over half of those students who were rated at stage 7 or 8 on each knowledge domain progressed on the multiplicative domain, while over half of those who were rated below stage 7 on each knowledge domain remained advanced additive.

Table 33

Comparing the Proportions of Initially Advanced Additive Students at Each Knowledge Stage Who Progressed to Advanced Multiplicative with Those Who Did Not

	Number of students	% remained advanced additive	% became multiplicative
Fractions			
2–3: Non-fractions	10	80	20
4: Assigns unit fractions	50	78	22
5: Orders unit fractions	351	64	36
6: Co-ordinates numerators/denominators	345	58	42
7: Equivalent fractions	364	40	60
8: Orders fractions	221	29	71
Place value			
2–3: Counts by ones	7	86	14
4: 10s to 100, order to 1000	29	86	14
5: 10s to 1000, order to 10 000	423	64	36
6: 10s, 100s, 1000s, orders whole numbers	373	57	43
7: Tenths in and orders decimals	279	43	57
8: Tenths, hundredths, and thousandths	230	22	78
Basic facts			
0–1: Non-grouping	2	100	0
2–3: Within and with five	3	33	67
4: Within 10, doubles, and teens	34	59	41
5: Addition, multiplication for 2, 5, 10	134	75	25
6: Subtraction and multiplication	603	56	44
7: Division	565	39	61

Concluding Comment and Key Findings

Students in schools participating in the SNP made progress on all three strategy domains. More specifically, the findings were as follows:

- The percentages of students rated in the top two stages of the additive, multiplicative, and proportional domains increased from 45 to 69, 25 to 46, and 36 to 53 respectively.
- The percentages of students still rated stage 4 or lower on the additive, multiplicative, and proportional domains decreased from 15 to 5, 14 to 6, and 17 to 6 respectively.
- Greater percentages of New Zealand European students than Māori and Pasifika students were at higher initial and final stages across all three domains.
- A higher proportion of male students than female students reached the top stages of each strategy domain; similar proportions remained at the bottom stages.
- Students from high-decile schools performed better than students from medium-decile schools, who in turn performed better than students from low-decile schools.

Students also made progress on the four knowledge domains as shown below.

- New Zealand European students performed better than Māori or Pasifika students; the performance of Pasifika students was overall slightly better than that of Māori students, though this varied between domains.
- Male students generally performed slightly better than female students, the exception being in the basic facts domain, where they performed similarly.
- Students from high-decile schools performed better than students from medium-decile schools, who in turn performed better than students from low-decile schools.

A comparison of knowledge profiles of initially advanced additive students showed that those students who made progress on the multiplicative domain were more likely to be at the higher stages on the knowledge domains than those who did not.

References

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

Ministry of Education (2005–). "The Diagnostic Assessment." Unpublished (SNP strategy diagnostic test and whole-class knowledge test)