Performance of SNP Students on the Number Framework

Andrew Tagg
Maths Technology Ltd
<andrew@nzmaths.co.nz>

Gill Thomas
Maths Technology Ltd
<gill@nzmaths.co.nz>

This paper presents the third year of analysis of the performance and progress of students in the Secondary Numeracy Project (SNP), measured against the Number Framework. With the SNP in its third year of implementation in 2007, comparisons can be made with the effects of the SNP for students in 2005 and 2006. The findings indicate that the SNP continues to have a positive impact on student achievement in year 9. Consistent with previous findings, significant shifts were achieved in raising the proportion of the student population rated at the top stages of all domains of the Number Framework. These gains are very similar to those achieved in previous years. Demographic factors were again shown to impact on the performance of students. In particular, New Zealand European students performed better than Māori students, who in turn performed better than Pasifika students, and students from high-decile schools performed better than those from medium-decile schools, while the performance of students from low-decile schools was weaker than either of the other deciles. The end-of-year results of year 10 students were very similar to those of year 9 students, despite these students having been exposed to an additional year of SNP practices. The proportion of students in both year 9 and year 10 who remain at stage 5 or lower on both the strategy and knowledge domains is again concerning.

Background

Since 2000, the Numeracy Development Projects (NDP) have aimed to raise the mathematics achievement of students by improving the quality of the teaching and learning of mathematics. The Secondary Numeracy Project (SNP) provides similar support to that provided to primary and intermediate teachers through the NDP, although the structure of the SNP support is organised differently. In NDP schools, the support is provided by external facilitators, who run workshops for the teachers and provide in-class modelling and feedback. In the SNP, a member of the school's own mathematics department is provided with training and operates as an in-school facilitator (ISF). The role of the ISF includes running workshops for other teachers, observing and modelling lessons, and providing support to peers in teaching numeracy. The ISFs are supported by a regional facilitator and work as part of a cluster of participating SNP schools. In small secondary schools, an ISF from one school may also act as the facilitator for one or two other nearby schools.

In 2005, the SNP pilot project provided professional development in 42 schools, aimed at enhancing the teaching of year 9 mathematics. In 2006, teachers in the same 42 schools were supported in consolidating their teaching of year 9 mathematics and in developing their teaching of year 10 mathematics. An additional 37 schools participated in the SNP for 2006. These schools received support of a similar nature to that given in the pilot project the previous year. 2007 was the third year of implementing the SNP, with 47 new schools participating.

This paper analyses the results of year 9 students in schools participating in the SNP for the first time in 2007 and of year 10 students in the schools that first participated in 2005 or 2006. The aim of this research is to quantify any improvement made in students' number knowledge and strategies. The research questions specifically addressed in this paper are as follows:

- What progress have year 9 students in first-year SNP schools made on the Number Framework in 2007?
- How does this progress compare to that made by year 9 students in 2005 and 2006?

- What is the numeracy profile of year 10 students in schools that are in their second or third year of the SNP?
- What demographic factors impact on the progress and performance of SNP students?

Method

Participants

The results reported in this paper were obtained from the online numeracy database on 17 December 2007 by downloading all the data entered by SNP schools. The schools were required to enter both initial and final data on the three strategy domains and the four knowledge domains of the Number Framework for year 9 students, while for year 10 students, only final data on the seven domains was required. Students were only included in this analysis if complete data had been entered for them.

Unless otherwise stated, this paper describes the results of the 5093 year 9 students in schools participating in the SNP for the first time in 2007 and the 2355 year 10 students in schools that have implemented the SNP for at least two years. Table 1 summarises the number of complete sets of data available for each year level in schools in each year of participation in the SNP. The 5093 year 9 students in first-year schools represent 83% of the year 9 students in those schools for whom complete initial data was entered. (Some schools had not managed to complete the entry of this data in time to be included in this analysis.)

Table 1
Summary of SNP Results by Year Level and School's Year in Project

	Year 9	**Year 10**
First year	5093	178
Second year	825	2261
Third year	243	94
Total	6161	2533

Table 2 comprises a breakdown by year, gender, and ethnicity of the SNP students included for analysis. National data from 2007 is provided for comparison (Ministry of Education, 2008). Sixty-three percent of the SNP students were of New Zealand European origin, 17% identified as Māori, and approximately 7% identified as Pasifika. There were more female year 9 students than male (54% compared with 46%).

Table 2
Profile of SNP Students and Year 9 and 10 Students Nationally by Ethnicity and Gender

	Year 9				**Year 10**			
Ethnicity	**Male**		**Female**		**Male**		**Female**	
	SNP	National	SNP	National	SNP	National	SNP	National
NZ European	58%	57%	66%	58%	63%	58%	69%	58%
Māori	20%	23%	15%	23%	18%	21%	14%	22%
Pasifika	8%	9%	6%	9%	9%	9%	8%	9%
Asian	7%	8%	7%	8%	4%	8%	3%	8%
Other	7%	2%	6%	2%	5%	2%	6%	2%
Total	2232	31 817	2861	29 636	1207	31 843	1148	30 175

The decile groups of the participating students were not evenly distributed. Only 8% of the students in each year level came from low-decile (1–3) schools, 38% of the year 9 students and 24% of the year 10 students came from high-decile (8–10) schools, and the remainder came from medium-decile (4–7) schools.

Analysis

An independent samples T-test was used to compare the means of variables with only two categories (gender and year level), while an ANOVA (analysis of variance) test was used to compare the means of variables with three or more categories (decile band and ethnicity). Where statistically significant differences are described between groups, a difference has been verified to at least the 1% significance level, either by the T-test or by a post-hoc analysis using Tukey's honestly significant difference test. It needs to be noted that, in some instances, significantly different mean gains and effect sizes may be smaller than other gains and effect sizes shown that are not statistically significant due to differences in sample size.

All the tables (including the appendices) show rounded percentages. Percentages less than 0.5% are therefore shown as 0% and, where there are no students represented, the cell is left blank. Due to rounding, percentages in some tables may not total to 100.

Effect sizes, where used, have been calculated by dividing the average difference between two groups by the pooled standard deviation of the two groups. Effect sizes of 0.2 are considered "small", effect sizes of 0.5 are "medium", and effect sizes of 0.8 or higher are "large" (Cohen, cited in Coe, 2002). For the purposes of this paper, effect sizes of 0.2 or less are described as small, effect sizes between 0.2 and 0.8 are described as medium, and effect sizes of 0.8 or higher are described as large.

Findings

The results discussed in this paper are divided into three sections. The first section describes the performance and progress of year 9 students in schools participating in the SNP for the first time in 2007 and compares this with the performance of year SNP 9 students in previous years. The second section compares the 2007 end-of-year performance of year 10 students in second- or third-year SNP schools with the 2007 end-of-year performance of year 9 students in first-year SNP schools. The final section analyses the impacts of demographic factors (gender, decile, and ethnicity) on the performance and progress of all students.

Performance of Year 9 Students

This section describes the performance and progress of year 9 students in schools participating in the SNP for the first time in 2007 and compares this with the performance of year 9 SNP students in previous years.

Table 3 shows the initial and final percentages of year 9 students in first-year SNP schools at each stage of the three strategy domains. The final results of year 9 SNP students from 2005 and 2006 are provided for comparison (Tagg & Thomas, 2007).

Table 3
Performance of Year 9 Students on the Strategy Domains

	Additive				**Multiplicative**				**Proportional**			
Stage	**2007 initial**	**2007 final**	**2006 final**	**2005 final**	**2007 initial**	**2007 final**	**2006 final**	**2005 final**	**2007 initial**	**2007 final**	**2006 final**	**2005 final**
0–3	1%	0%	0%	1%	3%	1%	0%	0%	1%	0%	0%	1%
4	11%	4%	5%	5%	10%	4%	5%	6%	14%	6%	6%	6%
5	42%	27%	29%	26%	26%	14%	16%	16%	30%	22%	24%	23%
6	36%	42%	44%	46%	36%	35%	35%	32%	18%	18%	19%	17%
7	10%	21%	22%	23%	20%	31%	29%	30%	32%	41%	38%	41%
8	0%	5%	n/a	n/a	5%	14%	14%	16%	5%	13%	12%	12%
N =	5093	5093	5807	3975	5093	5093	5807	3975	5093	5093	5807	3975

The percentages of the 2007 year 9 students rated at stage 7 or 8 of the additive, multiplicative, and proportional strategy domains increased from 10% to 26%, 25% to 45%, and 37% to 54% respectively. Correspondingly, the percentages of students still rated as using counting strategies (stage 4 or below) decreased by 8% on the additive and multiplicative domains and 9% on the proportional domain. A comparison with the final scores from 2005 and 2006 shows that the performance of students was similar on all three domains.

Table 4 gives the initial and final percentages of the 2007 year 9 students in first-year SNP schools at each stage of the four knowledge domains and shows a similar pattern to Table 3, with progress being made on all domains.

Table 4
Performance of the 2007 Year 9 Students on the Knowledge Domains

	FNWS		Fractions		Place Value		Basic Facts	
Stage	Initial	Final	Initial	Final	Initial	Final	Initial	Final
0–3	1%	1%	3%	1%	1%	0%	2%	1%
4	3%	1%	10%	6%	8%	3%	4%	2%
5	33%	22%	38%	25%	41%	25%	18%	12%
6	63%	77%	24%	23%	28%	28%	49%	39%
7	N/A	N/A	18%	31%	13%	20%	25%	41%
8	N/A	N/A	7%	14%	9%	23%	2%	5%
N =	5093	5093	5093	5093	5093	5093	5093	5093

While the proportions of students at the higher stages of all seven domains increased and the proportions of students at the lower stages decreased, it is concerning that between 15% and 32% of students on each domain finished year 9 still rated at stage 5 or below. This finding is consistent with SNP results from previous years (Tagg & Thomas, 2006, 2007). The mathematics and statistics learning area of *The New Zealand Curriculum* (Ministry of Education, 2007) includes objectives in the Number and Algebra strand that link closely to the Number Framework. Students in year 9 are expected to

be working at curriculum levels 4 or 5, which are equivalent to stages 7 and 8 of the Framework. Expectations provided on the nzmaths website (Maths Technology Ltd, n.d.) identify year 9 students still rated at stage 5 or below as "at risk" and describe them as being "sufficiently below expectations that their future learning in mathematics is in jeopardy" (Maths Technology Ltd, n.d.).

Figures 1–3 show the percentages of year 9 students gaining stages on each of the three strategy domains in 2005, 2006, and 2007, linked to their initial stage. The results from 2007 are very similar to those from 2005 and 2006. Generally, a higher percentage of students at lower initial stages made gains, although the proportion of students initially rated at stage 6 on the proportional domain making gains (57%) was slightly higher than that of students initially rated at stage 5 (49%).

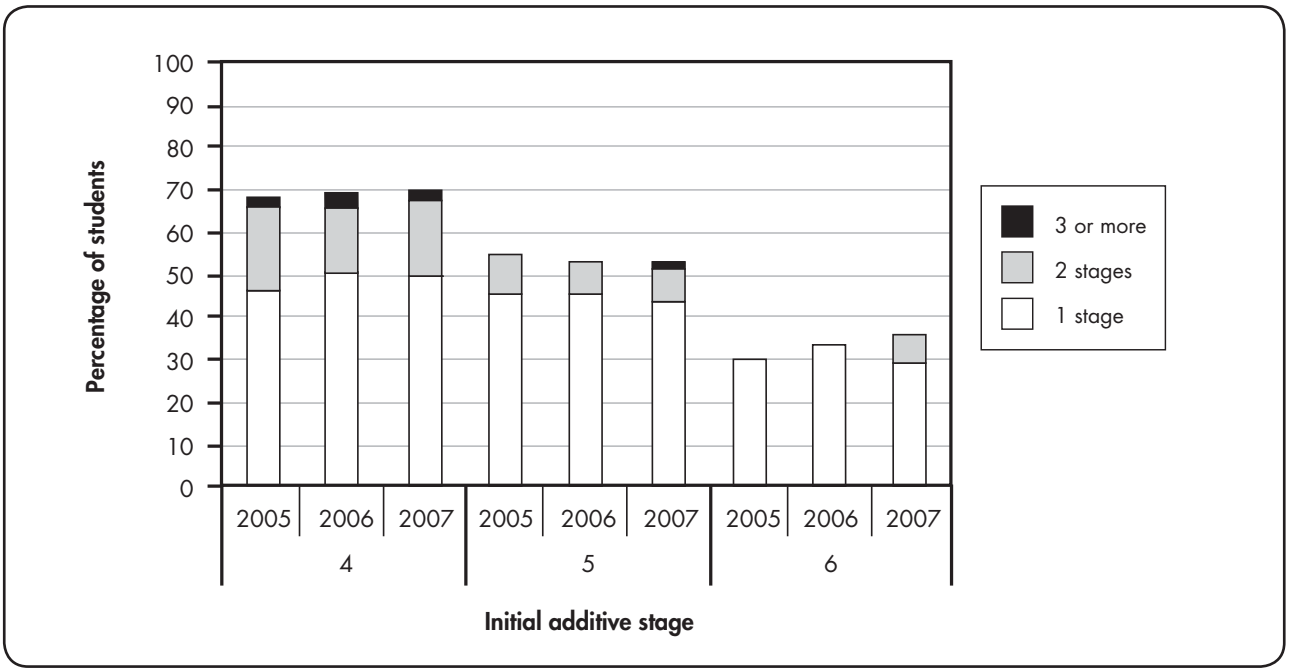

Figure 1. Number of stages gained from initial additive stage for year 9 students in 2005, 2006, and 2007

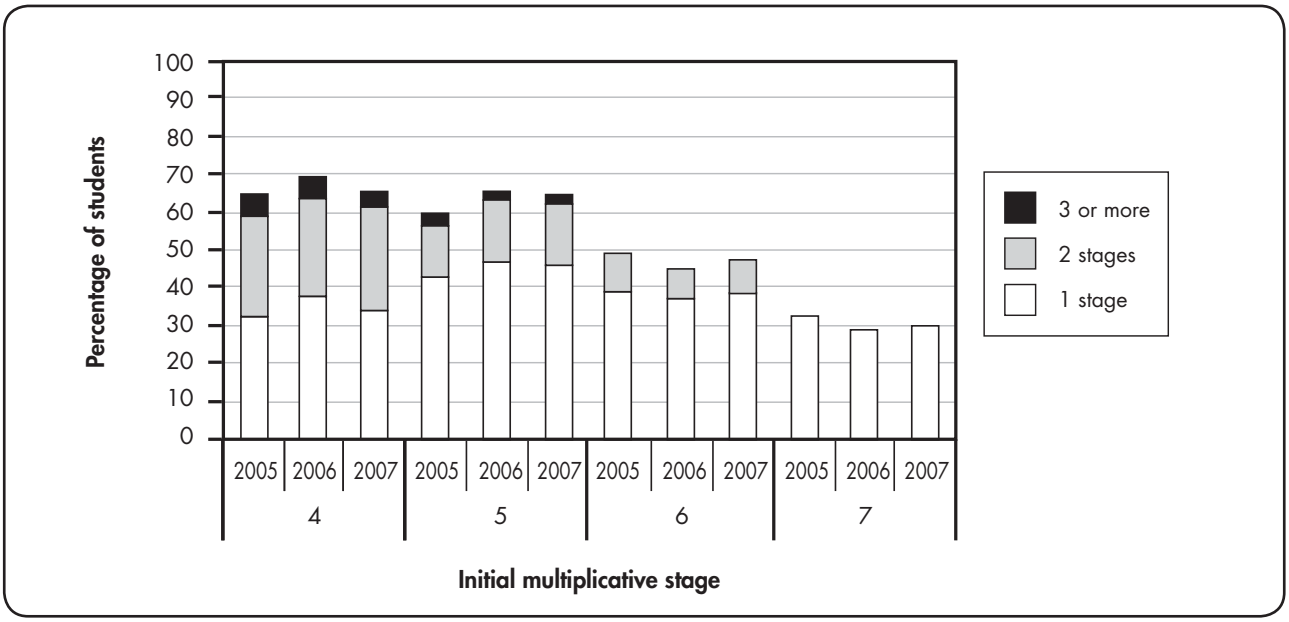

Figure 2. Number of stages gained from initial multiplicative stage for year 9 students in 2005, 2006, and 2007

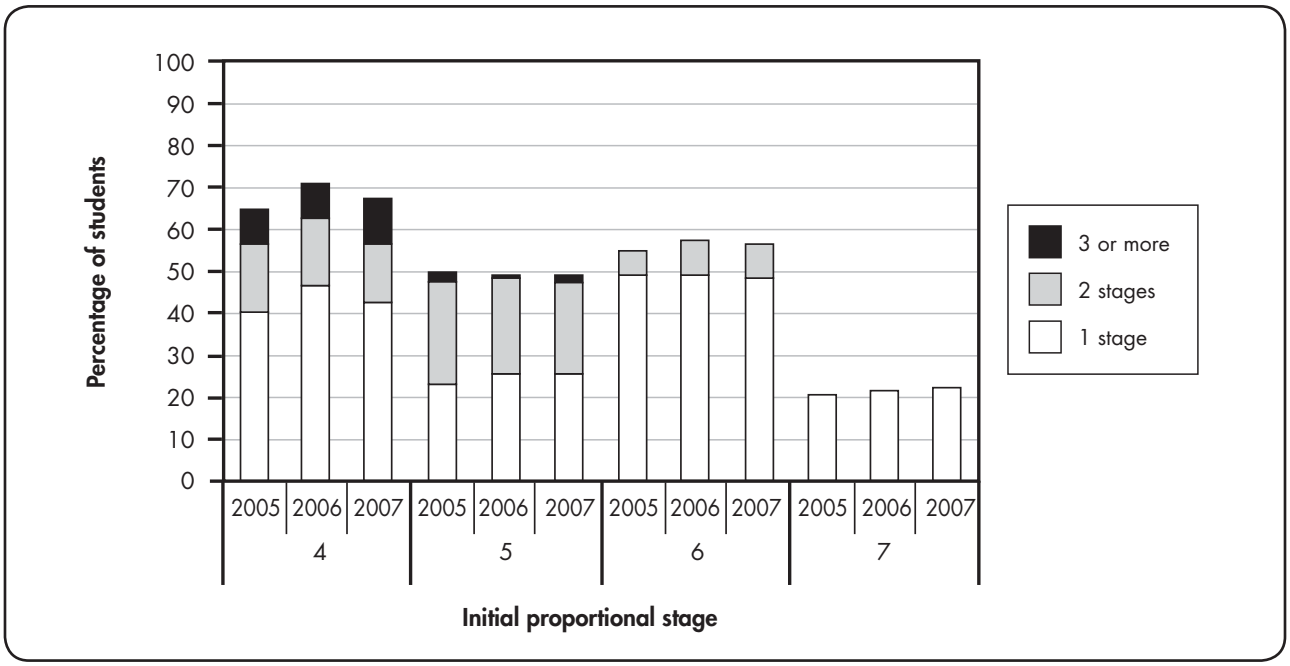

Figure 3. Number of stages gained from initial proportional stage for year 9 students in 2005, 2006, and 2007

Effect sizes were calculated to examine the magnitude of the impact of the SNP on year 9 students in 2007. Table 5 presents the mean stages and effect sizes for the seven domains.

Table 5
Effect sizes for Comparisons of Initial and Final Scores of Year 9 SNP Students in 2007

Domain	Mean Score		Mean Gain	Effect Size
	Initial	Final		
Additive	5.43	5.95	0.52	0.56
Multiplicative	5.76	6.34	0.58	0.52
Proportional	5.65	6.25	0.60	0.44
FNWS	5.58	5.74	0.16	0.28
Fractions	5.64	6.20	0.56	0.47
Place value	5.69	6.33	0.64	0.55
Basic facts	5.93	6.33	0.40	0.42

Mean gains of at least half a stage were made on all domains apart from FNWS (0.16) and basic facts (0.40). The apparent lack of progress on the FNWS domain can be explained by a ceiling effect, with 63% of all year 9 students rated at the top stage of this domain (stage 6) at the initial assessment. The relatively small gains on the basic facts domain may be partly explained by the fact that this was the domain with the highest mean initial stage (5.93), meaning that a ceiling effect again impacts on progress for many students.

An independent samples T-test was carried out, and effect sizes were calculated to compare the performance of year 9 students in first-year SNP schools with the 1068 year 9 students from second- or third-year SNP schools. The results are shown in Table 6. The shaded cells represent comparisons where the difference was not statistically significant at the 1% significance level.

Table 6
Comparisons of Performance of Year 9 students in First-year and Second/Third-year SNP Schools

Domain	Assessment	Mean Score		Difference	Effect Size
		2nd/3rd yr	1st yr		
Additive	Initial	5.46	5.43	0.03	0.03
	Final	5.74	5.76	–0.02	–0.04
Multiplicative	Initial	5.50	5.65	–0.15	–0.01
	Final	5.39	5.58	–0.19	–0.17
Proportional	Initial	5.48	5.64	–0.16	–0.10
	Final	5.56	5.69	–0.13	–0.20

The differences between the initial and final additive scores and the initial multiplicative scores of the two groups were not statistically significant. While the differences between the mean final stages of the two groups on the multiplicative and proportional domains were statistically significant, the effect sizes for the differences between the groups were small (0.2 or less). This indicates, in practical terms, that there is little difference in mean strategy stage and that the performance of year 9 students in SNP schools in the years following the initial implementation of the project remains at a similar level to that of year 9 students in schools in their first year of the SNP.

Comparison of Results of Year 9 (First-year SNP Schools) and Year 10 (Second/Third year SNP Schools)

This section compares the 2007 end-of-year performance of year 10 students in second- or third-year SNP schools with the 2007 end-of-year performance of year 9 students in first-year SNP schools.

Table 7 shows the percentages of these year 9 and year 10 students at each stage of the three strategy domains at the final assessment.

Table 7
Performance on the Strategy Domains of Year 9 Students in First-year and Year 10 Students in Second/Third-year SNP Schools

	Additive		Multiplicative		Proportional	
Stage	Yr 9	Yr 10	Yr 9	Yr 10	Yr 9	Yr 10
0–3	0%	0%	1%	0%	0%	1%
4	4%	6%	4%	5%	6%	7%
5	27%	22%	14%	13%	22%	24%
6	42%	45%	35%	31%	18%	16%
7	21%	22%	31%	33%	41%	37%
8	5%	5%	14%	16%	13%	15%
N =	5093	2355	5093	2355	5093	2355

Similar percentages of year 9 and year 10 students reached the top two stages of each of the three strategy domains with, for example, 26% of the year 9 students and 27% of the year 10 students reaching at least stage 7 on the additive domain. At the lower stages, the difference between the percentages

of students remaining at stage 4 or below was 2% or less on each domain. A T-test and analysis of effect sizes indicates that the differences between the two groups on the additive and proportional domains are not statistically significant ($p < 0.01$) and that, on all three domains, the effect size is small (less than 0.2). More specifically, the effect sizes for the difference between year 9 and year 10 students are 0.02 for the additive domain, 0.06 for the multiplicative domain, and –0.05 for the proportional domain. It is concerning that year 10 students who have had two years of teaching in schools that are implementing the SNP achieve at the same level as year 9 students who have had one year of exposure to the SNP.

Table 8 below shows the percentages of year 9 and year 10 students at each stage of the four knowledge domains at the final assessment.

Table 8
Performance on the Knowledge Domains of Year 9 Students in First-year and Year 10 Students in Second/Third-year SNP Schools

	FNWS		Fractions		Place Value		Basic Facts	
Stage	Yr 9	Yr 10	Yr 9	Yr 10	Yr 9	Yr 10	Yr 9	Yr 10
0–3	1%	1%	1%	1%	0%	0%	1%	1%
4	1%	2%	6%	8%	3%	4%	2%	3%
5	22%	22%	25%	28%	25%	26%	12%	15%
6	77%	76%	23%	23%	28%	26%	39%	39%
7	N/A	N/A	31%	29%	20%	17%	41%	39%
8	N/A	N/A	14%	12%	23%	27%	5%	3%
N =	5093	2355	5093	2355	5093	2355	5093	2355

The pattern of performance on the knowledge domains mirrors that of performance on the strategy domains, with similar proportions of year 9 and year 10 students reaching the higher stages of each domain. The proportions of students still rated at stage 4 or below were also similar for the two year groups on all four domains. The effect sizes for the differences between the two years levels were again small (less than 0.2), with the largest being on the fractions (–0.12) and basic facts (–0.13) domains, where year 9 students outperformed year 10 students.

Impacts of Demographic Factors

This section analyses the impacts of demographic factors (gender, decile, and ethnicity) on the performance and progress of all students.

The results from the SNP in 2005 and 2006 showed that the comparative performances of demographic subgroups of students in the SNP were similar to those found in previous NDP research (Tagg & Thomas, 2006, 2007; Young-Loveridge, 2006). The 2007 results show a similar pattern to previous findings (see appendices A and B (pp. 59–65) for a detailed breakdown of the performance of students from each demographic subgroup). This section describes the results on the multiplicative and basic facts domains by demographic subgroups. These domains were chosen by the researchers because they consider these domains to be central to numeracy at years 9 and 10. Appendix C (p. 66) provides details of effect sizes between the demographic subgroups of SNP students for all seven domains. Table 9 shows the mean initial and final stages of the demographic subgroups of year 9 students on the multiplicative domain as well as the mean final stages of the year 10 students.

Table 9
Mean Stages on the Multiplicative Domain of Demographic Subgroups

	Year 9 Initial	Year 9 Final	Year 10 Final
Male	5.86	6.41	6.55
Female	5.68	6.29	6.26
Low decile	5.50	5.92	5.94
Medium decile	5.68	6.31	6.37
High decile	5.92	6.47	6.65
NZ European	5.86	6.44	6.49
Māori	5.50	6.04	6.22
Pasifika	5.35	5.89	5.81
Total	5.76	6.34	6.41

The pattern of comparative performance of demographic subgroups on the multiplicative domain continues to reflect that found in previous years. Male students had a higher mean stage than females, the mean stage of New Zealand European students was higher than that of either Māori or Pasifika students, and the mean stage of students from high-decile schools was higher than that of students from medium-decile schools, with both being higher than that of students from low-decile schools. It should be noted that the multiplicative domain was the only domain on which the mean final stage of year 9 males was significantly higher than that of year 9 females. Year 9 females had a higher mean final stage on the basic facts domain than males, while on all other domains, there was no significant difference between genders. The subgroup of year 9 students with the lowest mean final stage was Pasifika students (5.89), while the highest was students from high-decile schools (6.47). This finding is consistent with the results for year 10 students, where Pasifika students had the lowest mean stage (5.81) and students from high-decile schools had the highest mean stage (6.65). The mean final multiplicative stages of year 9 and year 10 students were similar, with the difference less than 0.2 of a stage in all instances.

To investigate the significance of the impact of demographic factors on students' performance on the Number Framework further, effect sizes were calculated for comparisons between males and females; between students from low-, medium-, and high-decile schools; and between New Zealand European, Māori, and Pasifika students. The results of this analysis for all seven domains are included in full in Appendix C (p. 66). Table 10 shows the effect sizes for demographic factors on the multiplicative domain. The shaded cells represent comparisons where the difference was not statistically significant at the 1% significance level.

Table 10
Effect Sizes for Comparisons of Demographic Subgroups on the Multiplicative Domain

	Year 9 Initial	Year 9 Final	Year 10 Final
Male/Female	0.15	0.11	0.27
High/Medium decile	0.21	0.16	0.26
High/Low decile	0.38	0.53	0.66
Medium/Low decile	0.16	0.35	0.40
NZ European/Māori	0.31	0.38	0.26
NZ European/Pasifika	0.45	0.52	0.64
Māori/Pasifika	0.14	0.14	0.36

Table 10 shows that the effect sizes for comparisons of final results for individual year levels varied from 0.11, for the difference between year 9 male and female students, to 0.66, for the difference between year 10 students from high- and low-decile schools.

Table 11 shows the mean gains and effect sizes for the impact of the SNP on year 9 students on the multiplicative domain, analysed by demographic subgroup. The results of this analysis for all seven domains are included in full in Appendix C (p. 66).

Table 11
Effect Sizes for Gains Made on the Multiplicative Domain by Demographic Subgroups of Year 9 Students

	Mean Initial Stage	Mean Final Stage	Mean Gain	Effect Size
Male	5.86	6.41	0.55	0.48
Female	5.68	6.29	0.61	0.56
Low decile	5.50	5.92	0.42	0.38
Medium decile	5.68	6.31	0.63	0.55
High decile	5.92	6.47	0.55	0.52
NZ European	5.86	6.44	0.58	0.53
Māori	5.50	6.04	0.54	0.49
Pasifika	5.35	5.89	0.54	0.52
Total	5.76	6.34	0.58	0.52

The overall effect size for the impact of the SNP on year 9 students' performance on the multiplicative domain was 0.52. The largest mean gain (0.63) was for students from medium-decile schools, while the highest effect size (0.56) was for female students. In an interesting contrast to previous results, both the smallest mean gain (0.42) and the lowest effect size (0.38) were for students from low-decile schools. Previous findings had indicated that subgroups with lower mean initial stages tended to make greater gains (Tagg & Thomas, 2007; Thomas, Tagg, & Ward, 2003). However, despite the fact that only Pasifika students had a lower mean initial stage, the gains made by students from low-decile schools in 2007 were 0.12 of a stage smaller than those of any other subgroup.

Table 12 shows the effect sizes for demographic factors on the basic facts domain. The effect sizes on this domain tended to be smaller than those on the other six domains. The shaded cells represent comparisons where the difference was not statistically significant at the 1% significance level.

Table 12
Effect Sizes for Comparisons of Demographic Subgroups on the Basic Facts Domain

	Year 9 Initial	Year 9 Final	Year 10 Final
Male/Female	–0.24	–0.17	0.15
High/Medium decile	0.44	0.33	0.14
High/Low decile	0.61	0.59	0.47
Medium/Low decile	0.11	0.21	0.32
NZ European/Māori	0.34	0.36	0.11
NZ European/Pasifika	0.44	0.34	0.44
Māori/Pasifika	0.09	–0.03	0.33

The three largest effect sizes calculated on the basic facts domain were for the differences between high- and low-decile students. The largest effect size calculated for final assessment results was 0.59, for the difference between year 9 students in high- and low-decile schools. The fact that the effect sizes for the differences in final results tended to be smaller than those for initial results would seem to indicate that the differences between subgroups are reduced over the course of the SNP. Overall, year 9 students performed better on the basic facts domain than year 10 students, though the effect size was small (–0.13).

Concluding Comment and Key Findings

Year 9 students in schools participating in the SNP for the first time made progress, by the final assessment, on all three strategy domains. Specific results are as follows:

- The percentages of year 9 students rated at stage 7 or 8 on the additive, multiplicative, and proportional domains increased from 10% to 26%, 25% to 45%, and 37% to 54% respectively.
- The percentages of students still rated stage 4 or lower on the additive, multiplicative, and proportional domains decreased from 12% to 4%, 13% to 5%, and 15% to 6% respectively.

These year 9 students also made progress on the four knowledge domains. By the final assessment, the percentage of students at the top two stages of the domain had increased from 25% to 45% for fractions, from 22% to 43% for place value, and from 27% to 46% for basic facts. The percentage of students at the top stage of the FNWS domain increased from 63% to 77%. The percentages of students rated at stage 5 or below of the domain decreased from 37% to 24% for FNWS, from 51% to 32% for fractions, from 50% to 28% for place value, and from 24% to 15% for basic facts.

While year 10 students performed better than year 9 students on the multiplicative domain, year 9 students performed better on the basic facts domain. The effect sizes of the differences between year levels were small in all instances. The lack of progress in year 10 requires further investigation because previous studies (for example, Higgins, 2004; Thomas & Tagg, 2004; Young Loveridge, 2006) have shown that, in all other year levels, students build on previous achievement.

Demographic factors continue to impact on the performance of students in 2007. Specific factors are as follows:

- New Zealand European students performed better than Māori or Pasifika students; the performance of year 9 Māori students was slightly better than that of year 9 Pasifika students.
- Year 10 male students performed better than year 10 female students. Year 9 male and female students performed similarly, with males performing better on the multiplicative domain and females performing better on the basic facts domain.
- Students from high-decile schools performed better than students from medium-decile schools, who in turn performed better than students from low-decile schools.

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