Findings from the New Zealand Secondary Numeracy Project 2007

Foreword

The Secondary Numeracy Project (SNP) was introduced in selected secondary schools in 2005 with the aim of providing teachers with two years of professional development that would improve the effectiveness of their teaching and enable students to develop a deeper understanding of mathematics. This compendium is a collection of the research undertaken alongside the SNP in the third year of its implementation.

The papers in this compendium reflect the continuing development of the SNP as more schools engage. Some papers follow on from earlier reports that analysed the impact on years 9 and 10, while other papers explore previously uncharted waters. Facilitation and professional development in wharekura (Māori-medium secondary schools) within the context of Te Poutama Tau features for the first time, while there is also a progress report on attempts to construct a written diagnostic assessment to complement the Numeracy Development Project (NDP) diagnostic interview. Research into the connection between number and algebra gets more exposure, and cautionary attempts are made to detect differences in NCEA student performance in year 11 as a result of the SNP and to identify what impact the SNP may have on teaching and learning in year 11 mathematics.

The SNP continues to grow. The development of a mathematical pedagogy has opened opportunities for more students to understand mathematics. As students show improved understanding of mathematics, so teachers continue to explore and develop their pedagogy. And the cycle continues. There will always be more work to do. What has been achieved so far can be applauded.

Student Performance and Progress

In "Performance of SNP students on the Number Framework" (p. 5), Andrew Tagg and Gill Thomas present their third year of analysis of the progress of students in SNP, measured against the Number Framework. With SNP in its third year of implementation, comparisons could be made on the effects of the project for students from 2005 to 2007.

Tagg and Thomas's analysis indicates that the SNP continues to have a consistently positive impact on student achievement in year 9. For schools new to the project in 2007, significant shifts in performance between the beginning and the end of the year were achieved in the proportion of the student population that could perform in the top three stages of the additive domain and the top two stages of the multiplicative domain, and in the proportional domain. These figures are remarkably similar to the gains achieved in the first two years of the SNP for these domains. Consistent with previous findings, New Zealand European students performed better than Māori or Pasifika students, and students from high-decile schools performed better as a group than students from medium- or low-decile schools. Male students performed slightly better than female students in the multiplicative domain, while female students performed better on the basic facts domain.

Schools that entered the project in 2005 and 2006 were also expected to assess their students at the end of their year 10 courses. The results for 2007 followed the pattern of 2006 and indicate that, while these year 10 students performed better than the year 9 students in all aspects except the proportional domain, the differences in performance were small. Further investigation may reveal reasons for these differences. It may be related to schools consolidating their efforts in year 9 during the second year so it may be too soon to detect change in year 10 performance. Tagg and Thomas also allude to the possibility that the sample of year 10 students may not have the same characteristics as the initial year 9 cohort.

Tagg and Thomas draw attention to the proportion of students who still perform at stage 5 or lower on the Number Framework for both the strategies that they bring to bear and the knowledge that they can recall quickly to help solve a problem. As an example, 50% of year 9 students start the year at or below stage 5 in the fractions and place value knowledge domains. While these reduce to 31% and 28% by the end of year 9, the future learning for these students in mathematics is in jeopardy.

Impact of the SNP on Teaching and Learning of Year 11 Mathematics

In "An investigation into the impact of the Secondary Numeracy Project on student performance in two NCEA Level 1 mathematics achievement standards" (p. 17), Roger Harvey focused on two NCEA Level 1 achievement standards, AS90147: Use straightforward algebraic methods and solve equations, and AS90151: Solve straightforward number problems in context. These achievement standards were chosen because their content has the most direct connection to the content of the SNP.

In view of the comments from teachers in Harvey and Smith's other paper (see below) that the greatest impact of the SNP on their teaching occurred in courses that do not generally use achievement standards as their assessment tool, it would seem fair to assume no discernable effect would be detected in the achievement standards results. In fact, Harvey has detected some differences in performance, with a modest improvement for SNP students in the algebra standard and no significant difference in the number standard. He cautions against jumping to any conclusions, noting many factors that could be affecting the data. Further study is suggested to collect a comprehensive picture of student attainment in mathematics.

In "Teachers' views on the impact of the Secondary Numeracy Project on the teaching of year 11 classes" (p. 27), Roger Harvey and Derek Smith investigate whether the professional development within the SNP has had an effect on teaching practice in year 11 classrooms. A group of 17 teachers from five schools were selected to participate in the study. They completed a written survey that allowed them to express their views on the impact of the SNP on their teaching practice. The teachers surveyed taught courses focused on achievement standards and courses focused on unit standards. Most of these courses were assessed across the range of achievement standards and unit standards available for year 11 qualifications.

An extended use of discussion in developing mathematical ideas with students was noted by a number of the teachers. Many teachers reported a more judicious use of calculators. The majority of teachers noted a positive influence on student engagement in learning mathematics. Comments indicate a greater willingness on the part of students to ask questions and develop an understanding of mathematics. The effect is not, however, universal.

The study also found that teachers of year 11 mathematics courses focused on unit standards tended to report greater changes in their practice, perhaps because they see benefits in adopting different pedagogical practices to ensure they meet the needs of individual students who have historically found mathematics demanding.

Written and Oral Assessments of Secondary Students' Number Strategies

A key component of the assessment tools used in the SNP is the diagnostic interview with students that teachers use to establish a student's strategy stage on the Number Framework. In "Written and oral assessment of secondary students' number strategies: developing a written assessment tool" (p. 32), Gregor Lomas and Peter Hughes describe the first stage of an attempt to develop a written strategy Number Framework stage assessment tool (WSSAT) that is designed to give teachers the same information about students' stages from a pencil-and-paper assessment as they would get from the oral interview. The WSSAT has been designed to closely align with the SNP strategy section of the Number Framework, but it also draws on several other research sources for diagnostic questions on place value, decimals, and number sense. It was envisaged that it would primarily be used in the secondary school environment, so the WSSAT attempted to accurately assess for only stages 5–8 of the Framework. If students did not meet stage 5 criteria, they were assigned a category covering stages 1–4. An oral assessment tool closely aligned to the SNP and NDP Global Strategy Stage (GloSS) assessment tool was also used for comparison purposes in this research.

The written assessment was given to 278 year 9 SNP students, and on the following day, the oral assessment was given to 27 of these students. A comparison of the results of the oral assessment with nationally available data indicated that the oral assessment used could be regarded as a reliable indicator of the students' strategy stages. However, no such claim could be made of the written assessment. The stages determined by the written assessment were generally lower than those of the oral assessment, and in six of the 27 cases, the variation was by more than 2 stages.

Despite this somewhat disappointing finding, there is still profit in further development of this written tool. The items in the assessment are of broader mathematical interest than those currently being used in the Numeracy Project Assessment (NumPA) diagnostic tool and GloSS, incorporating questions requiring estimation and rounding appropriately in a context. Even in its current form, the WSSAT has commendable internal consistency – students were displaying command of early items before weakening at the later stages. The results from the WSSAT also related well to the Assessment Tools for Teaching and Learning (AsTTle) measure of achievement in mathematics and English that was used by the school to place students in banded classes. But further work on the items in the assessment and the criteria for assigning stages is needed before WSSAT can stand alongside the current assessment tools used in the SNP.

Solving Equations: Students' Algebraic Thinking

In "Solving equations: students' algebraic thinking" (p. 39), Chris Linsell reports on research in progress that investigates linkages between students' numeracy stages and the strategies they use for solving linear equations.

A team of researchers and teachers is developing a diagnostic tool that identifies the strategies that students employ to solve linear equations. The tool has both a knowledge and strategy section, somewhat reminiscent of the NumPA. The algebraic diagnostic tool was used in 2007 with 450 year 7–10 students, and with a further 400 students at the beginning of 2008. Ten strategies for solving linear equations have been identified: using known basic facts; counting techniques; using inverse operations; guess and check; cover up; working backwards; working backwards, then using known facts; working backwards, then using guess and check; formal operations; and using a diagram. While some of the strategies are clearly more sophisticated than others, no definitive hierarchy amongst the strategies has yet been suggested.

Preliminary findings indicate that there is a high correspondence between a student's numeracy stage and the most sophisticated strategy that student uses for solving equations, with multiplicative part–whole thinking required for access to the strategies of working backwards and formal operations. Indeed, numeracy stage is a better predictor of a student's ability to use a strategy than the amount of algebra teaching that has occurred. However, although the numeracy stage is a good predictor, it is not foolproof: some students who have mastered computational algorithms but score low on aspects of the numeracy assessment have been able to use sophisticated equation-solving strategies.

A final point of interest in these findings is that students tend to be able to employ their most sophisticated strategy in both a formal symbolic question and an equivalent question that is described in a context using words or diagrams. The consequence is that it may be unnecessary to present students with symbolic equations to detect their most sophisticated solution strategy.

Support for Pāngarau Teachers Working in Wharekura

In their "Evaluation of support for pāngarau teachers working in wharekura" (p. 45), Pania Te Maro, Robin Averill, and Joanna Higgins have compiled a case study that examines the impact of a pilot project of professional development and support in the wharekura Te Poutama Tau (the Māori-medium version of the SNP) and pāngarau (mathematics) on nine teachers working in wharekura in the Hawkes Bay, Taranaki, Waikato, Wellington, and Whanganui regions.

This pilot project was developed as a consequence of recommendations by Tony Trinick and Makoare Parangi, in their 2006 research report, about the needs of wharekura teachers of pāngarau and a wish to create a professional development initiative that would support and ease the workload of these teachers and reduce their professional isolation. The project used three modes of delivery: hui, facilitator visits to schools, and video conferencing. Although video conferencing was perceived initially by the participants as the least useful aspect of the modes of delivery, participants came to the view that all the delivery modes were important and tended to complement each other. Each aspect contributed to teacher growth and assisted in the development of a supportive social and professional network.

Facilitators play a crucial role in the professional development structure of the NDP (which include the SNP). This Te Poutama Tau case study includes feedback from the wharekura teachers on the essential characteristics for effective facilitation. Amongst others, participants agreed that an effective Te Poutama Tau facilitator is able to give positive and affirming feedback; is inclusive and sharing; displays humour and humility; is accommodating, kind, empathetic, available, and approachable; has perseverance and expects it of others; shares a passion for mathematics and Te Poutama Tau; and is passionate about the importance of the project for Māori students. Such characteristics are not peculiar to the facilitation of Te Poutama Tau in wharekura, but they were highly valued by the participants in this study. The report provides an analysis of the achievement data of 125 students, who showed impressive achievement gains on the Number Framework (Te Mahere Tau).

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