2005 Secondary Mathematics Pilots: Secondary Numeracy Project and CAS

Foreword

In 2005, two pilot projects in secondary school mathematics were implemented by the Ministry of Education. The 2005 Secondary Numeracy Pilot Project (SNP) emphasised the use of mental computational strategies to solve numeric problems, while the 2005 Computer Algebraic Systems (CAS) Pilot Project integrated calculators into classrooms to assist in the teaching of mathematics. The theme that is common to these projects is that they both aim to help students develop a deeper understanding of mathematics. This report is a collection of the research undertaken alongside the introduction of these projects.

The Numeracy Development Projects (NDP) were first implemented by the Ministry of Education in 2001, following a pilot project in 2000. This was developed as a response to the relatively poor performance of New Zealand students in the 1995 Third International Mathematics and Science Study (TIMSS). The early years of the NDP focused on the Early Numeracy Project (ENP) for students in years 1–3 and the Advanced Numeracy Project (ANP) for students in years 4–6. In 2001 and 2002, a smaller number of teachers took part in NDP exploratory studies aimed at students in years 7–10. As a result of this exploratory work and the findings of the evaluations, the Ministry of Education expanded the intermediate and secondary components of the project. In 2005, 43 secondary schools chose to participate in the SNP pilot.

The SNP shares features with the other parts of the NDP. Teachers are introduced to a Number Framework, which describes strategies and knowledge that students have been observed to use to solve numerical problems. The Number Framework contains broad stages of increasingly sophisticated strategies, with progress through the earlier stages tending to occur more readily than with later stages. The teachers conduct a diagnostic interview to assess students' performance against the Framework and use this information as a starting point for teaching. Facilitators introduce and model a teaching approach for developing mathematical understanding that progresses, for most topics, through physical representations, imaging, and on to abstract mathematical concepts and algebraic thinking.

The goal of the SNP is to develop students' capacity to work efficiently with numbers by developing their computational strategies. This structural thinking can then be exploited to develop their understanding of algebra.

However, it all takes time. Time was identified as a pressure by teachers and facilitators both at the start and the end of the SNP pilot. Teaching is an intensely busy profession, and the act of significant teaching is a mentally draining occupation. Patience is needed, and the pace of change needs to be realistic if the project is to successfully build on the significant gains that have already been achieved.

Three chapters in this report examine aspects of the implementation of the SNP: the content of the number knowledge assessment; student performance and progress; and the impact of the SNP on teachers and facilitators. The final chapter reports on the CAS Pilot Project.

Number Knowledge Assessment

The diagnostic interview is an integral part of the NDP. In the SNP, this interview differs in two aspects from the interview that is used in primary and intermediate schools. Both modifications have been introduced in response to trialling in secondary schools in an effort to reduce the time needed to assess students against the Framework.

While primary and intermediate teachers can choose one of three increasingly difficult forms of the strategy interview to use with students, only one set of strategy questions is used in the SNP. This composite of appropriate questions for secondary students is extracted from the two more advanced forms of the interview used in primary and intermediate schools.

The second aspect that differs is the form of the knowledge assessment. This is no longer part of the individual interview with students, as occurs in primary and intermediate schools; rather, it is a pen and paper whole-class assessment. Again, the questions are based on those used in the primary knowledge interview. This knowledge assessment was initially adapted by Peter Hughes and Carol Mayers as part of the Manurewa Enhancement Initiative in 2004; a secondary working party further adapted this when introducing it to SNP schools in 2005.

Given such a change to the form of the knowledge assessment, it seemed sensible to determine whether in fact students found the items within each domain increasingly difficult and whether items across domains but identified as being at the same stage of the Framework were of similar difficulty. In other words, did the student data match the expected progressions of difficulty described in the Number Knowledge Framework? Tagg and Thomas ("Secondary Numeracy Project Knowledge Test Analysis", p. 5) undertook this piece of research, using 1000 scripts from a random sample of schools stratified by decile grouping. The research indicated that the items were generally ordered from easiest to most difficult within each domain. Six changes were subsequently made to the 2006 version to fine-tune this assessment.

Student Performance and Progress

Tagg and Thomas ("Performance on the Number Framework", p. 12) also provide an analysis of the progress of students in the SNP, measured against the Number Framework. Each student was assessed through a diagnostic interview against the Framework at the start of year 9 and reassessed towards the end of the year to ascertain the progress they had made. Tagg and Thomas looked for evidence of progress by the students, compared this with the progress of year 8 students in NDP schools, analysed demographic factors, and investigated the relationship between number knowledge and progress in multiplicative thinking.

Their analysis used data from 3975 students across 31 schools and showed that progress was made in all strategy and knowledge domains. Significant shifts occurred in the proportion of the student population that could perform in the top two stages of the additive (45% to 69%), multiplicative (25% to 46%), and proportional (36% to 53%) domains. Although the final performance of New Zealand European students was better than that of Māori and Pasifika students and the performance and progress of Pasifika students was overall slightly better than that of Māori, all ethnic groups progressed to higher stages in the Framework. Male students generally performed better than female students. Students from high-decile schools as a group performed better than students from medium-decile schools, who in turn performed better as a

group than students from low-decile schools. Having said that, there still exist in all decile bands students who experience significant difficulties making sense of their mathematics. There just aren't as many of them in higher decile schools.

While the project appears to have done much to shift students beyond counting strategies, it is a matter for concern that there were still 5% to 6% of students who, at the end of that year, still used counting strategies as their best available strategy for solving additive, multiplicative, and proportional problems. Their ability to understand more sophisticated mathematics in the future is very limited.

Impact of the SNP on Teachers and Facilitators

While Tagg and Thomas researched the impact that the SNP was having on student achievement, Harvey and Higgins, with Jackson, (p. 36) delved into the impact of the SNP on teachers and facilitators. Surveys seeking feedback from SNP teachers and facilitators were conducted at the start and towards the end of the year. In addition, a small sample of in-school facilitators and regional facilitators were interviewed.

The SNP model differs significantly from the primary version, in which facilitators are not based in a school and tend to work full time in a number of schools. In the SNP, most facilitators are practising teachers who are released from some of their teaching to facilitate the project with approximately 12 teachers. Generally, in 2005, these teachers were all at the same school, although there were several instances of facilitators working with up to three smaller schools.

The SNP facilitation model was received positively by schools. It allowed for substantive discussion to occur with the facilitator within mathematics departments throughout the duration of the project on a very regular basis, encouraging professional dialogue about mathematics teaching. Adapting the intentions of the project to local circumstances was more readily achieved. Additionally, teachers reported more willingness to take risks in adopting new practices when the support of the facilitator was readily available.

The diagnostic assessment was significant in influencing teachers' understanding of students' knowledge and thinking. While there was little reported change to teachers' personal mathematical knowledge, both teachers and facilitators reported growth in knowledge of how students learn mathematics.

There has been a need identified by teachers and facilitators for continuing development of secondary specific resources, and the Ministry has taken action on this for 2006.