Findings from the New Zealand Numeracy Development Project 2004

Foreword

There are at least two ways that reforms can be undertaken in education. One way is to provide set lessons for the teacher and set work for the students. The second is empowering the teacher through professional development. In implementing the Numeracy Development Project (NDP), New Zealand took the second of these options.

The motivation for the New Zealand reforms was undoubtedly the relatively poor showing of New Zealand students in the 1995 Third International Mathematics and Science Study (TIMSS). In that year, New Zealand and about 50 other countries participated in TIMSS. The published results identified the poor performance of New Zealand students in number (place value, fractions, and computation), measurement, and algebra concepts. These results were of sufficient concern that steps were taken that would ultimately lead to the NDP.

The NDP was first implemented in 2001, following a pilot project in 2000. The Number Framework, developed as the basis of the NDP, outlines the progress that most students follow in their development of number knowledge. Teachers are able to assess students' performances by using a diagnostic test in a one-to-one situation. Facilitators provide professional development for the teachers, using a pedagogy that is based around the individual contribution of students.

The NDP has developed rapidly and now includes the Early Numeracy Project (ENP) for children in years 1 to 3; the Advanced Numeracy Project (ANP) for years 4 to 6; the Intermediate Numeracy Project (INP) for years 7 and 8; the Secondary Numeracy Project (SNP) for years 9 to10; and Te Poutama Tau for students in years 1 to 8 in Māori-medium settings.

All the teachers involved in any aspect of the NDP return the results of each student's diagnostic test to a central data bank. This is done early in each year and at the end of each year. Consequently, a growing set of statistics is available to help monitor progress and suggest what might be expected by students at all levels. For further details of the numeracy projects, see www.nzmaths.co.nz/numeracy.

The success of the NDP is due to the soundness of its Number Framework, the strength of the teaching model, and the ability of the facilitators. Through the facilitators' work, teachers have been able to see and understand number in greater depth than before and are able to encourage students to use more open approaches to calculation than the traditional algorithm. But more than this, the teachers who are now confidently using the pedagogy of the NDP are doing so because of the progress that their students are making and the greater enjoyment that those students are exhibiting.

The eleven papers and an extract in this compendium look at a variety of aspects of the NDP. They can be roughly grouped under the categories of student achievement, effective teaching, and students' perspectives. A summary of these papers follows.

Jenny Young-Loveridge's analysis of the 2004 NDP data (p. 5) used results from approximately 70 000 students overall from ENP, ANP, and INP. As in 2002 and 2003, all groups benefited from their participation in the projects. While Asian students made greater gains than Pākehā/European students, followed by Māori and then Pasifika students, all ethnic groups moved to higher stages than they had in 2003. The results also showed a narrowing of the gap between most groups.

The evaluation showed that students from low-decile schools who started the NDP at stage 3 or lower on the Number Framework did better than corresponding students in medium-decile schools. This may be partly due to the additional resources that were provided for some of these low-decile schools through School Improvement initiatives.

One of the many ways that NDP data has been analysed is with respect to schools that have been involved over a period of time. The Longitudinal Study began in 2002 and aims to track the progress of students in schools involved in the NDP. In 2004, 31 schools were involved in this study, some of which had been in the NDP since 2000. Gill Thomas and Andrew Tagg's paper (p. 21) reports on aspects of this study.

They compared the data from 6099 students in the longitudinal schools with data from 70 000 students in the national database for achievement in additive, multiplicative, and proportional strategies. This was done in two ways: first, directly between peers, and secondly, between students at one year level in the longitudinal schools with students at the initial stage of the next year level. Students from the schools that had been in the NDP for some time were rarely outscored by the national cohort, and in many cases, their performances were significantly better.

Thomas and Tagg's data also provides evidence for the expected Number Framework achievement levels of students in the NDP. So, for instance, virtually all year 3 students might be expected to be at least at stage 4 (advanced counting), with 40 percent at stage 5 (early additive) or even higher.

One way to test overall productivity of the NDP is to compare the students against a known standard. This comparison is of much more interest and value if the standard is a recognised international one, such as the 1995 TIMSS. In their second paper (p. 35) Thomas and Tagg compare the performance of students who had been in the NDP for two years or more with both local and international TIMSS results from 1995 to test how well the NDP is succeeding.

A test was devised for year 4, 5, and 8 students in 31 longitudinal schools, using questions from the 1995 Grade 4 and Grade 8 TIMSS tests respectively. Of the 24 questions on Thomas and Tagg's test, the year 4 students performed better on 16 and equally well on six, compared with their compatriots in TIMSS 1995. In the case of the year 5 students, they did better on 19 questions and the same on two, while the year 8 students did significantly better on six questions and significantly worse on three. The outcomes of the year 4 and 5 students provide strong evidence for the success of the NDP.

Kay Irwin and Murray Britt's paper (p. 47) reports on the first year of a three-year study that is looking at students' development of algebraic thinking. In 2004, students from years 7 to 10 in four intermediate schools and four secondary schools were given the same tests on each of the four basic arithmetic operations. Some of the secondary school students had come from primary or intermediate schools that had not been involved in the NDP.

On the questions involving letters as algebraic symbols, the year 7 students outperformed all other students, with year 10 students being next best and the year 9 students the weakest. These results may be due to the fact that the year 8 and 9 students were being taught algebra in the conventional way. This is a study that will be worth following, as it will be of interest to see if the new SNP will help students at secondary level develop algebraic thinking skills.

Tony Trinick and Brendan Stephenson (p. 56) evaluated all the available data from the 33 Māori-medium schools that participated in Te Poutama Tau in 2004 and compared it to the corresponding results from 2002 and 2003. Apart from assessing overall performance and how it compared to previous years, the authors were interested in where students performed well and

where their performance was weaker. It should be noted that there was very little difference between the proficiency in te reo Māori of students in 2003 and those in 2004.

Minimal student gains were made in the areas of numeral identification, multiplication, fractions, and proportion, while significant gains were found in the area of decimal knowledge. As with students in the NDP, advancement was more difficult at the higher year levels, probably because the difference between levels is greater at the upper end of the framework. However, there was still a slightly higher performance overall for the 2004 students.

Kay Irwin and Joanne Woodward (p. 66) analysed the mathematical discourse used by two teachers in upper primary classrooms.

In one class, there was particular emphasis on the use of enquiring discourse, where students were encouraged to explain their thinking and were given sufficient time to gather their thoughts. There is evidence that these aspects of discourse continued into discussions held between students when they were involved in their group work. The students in this class were Pasifika, and the gains they made on the Number Framework were significant when compared to the national average for Pasifika students. It is suggested that this improvement may be related to both the emphasis on language and to the mode of teaching.

Joanna Higgins's paper (p. 74) looks specifically at effective teaching in a particular Māori classroom, but the principles there would seem to apply equally to students of any ethnicity. In this classroom, the teacher uses the metaphor of the waka to describe the class: they are all heading in the same direction, but different members have different talents and are able to do different things. She also uses the koru as a metaphor to describe how all the students are growing with mathematics, emerge in different ways, and help others to emerge better than they would by themselves.

So the students know that it is all right for the groups of the mathematics classroom to have different levels of ability. In fact, the teacher of this classroom uses the abilities, particularly of the lead group, to help teach the less able students. It's something that she says is part of Māori culture. But she is sensitive to students' needs and will take care when pairing up a peer teacher to a student.

In the extract from her paper on the pedagogy of facilitation (p. 79)[1], Higgins considers two facilitating approaches: one following the guidelines of the teacher manual and the other from a standpoint that is more responsive to students. The teacher's manual, materials/activities, teaching method, and modelling practice are examined from the viewpoint of the two approaches. As a result of this analysis and of facilitator interviews, Higgins concludes that teachers are more likely to gain confidence and numeracy development is more likely to be sustained if facilitators introduce teachers to a framework of ideas rather than adhere to the design features of the NDP guide books.

Tony Trinick's paper (p. 80) reports on a study of two schools that had been in the Te Poutama Tau project in 2003 and whose student achievement data had shown positive mean stage gains. These schools were studied in order to identify key factors that might promote student achievement in Māori-medium schools generally. Data was collected using questionnaires and follow-up interviews that covered such things as socio-cultural features of

[1] Higgins, J. (2005). Pedagogy of facilitation: How do we best help teachers of mathematics with new practices? In H. L. Chick & J. L. Vincent (Eds), *Proceedings of the 29th annual conference of the International Group for the Psychology of Mathematics Education*, 3, 137–144. Melbourne: PME.

the school; relationships with the local community; the experience and attitudes of its management and teachers; and teachers' reflections on the Te Poutama Tau project.

Although the two schools were successful in the teaching of the Te Poutama Tau approach to pāngarau (mathematics), they differed significantly in a number of areas. However, they did exhibit a number of features in common that Trinick feels combine to promote successful achievement in pāngarau. These include the participation by both principals in the teacher professional development project, the setting of clear goals for the teachers, individual support for teachers where needed, and a focus on student learning.

Equipment has an important role to play in the NDP, and this is Joanna Higgins' focus in her paper on page 89. The teaching model of the NDP uses equipment to introduce new concepts, invokes imaging for students to visualise the concept, and then moves to internalising the idea and independently solving problems using the understanding of number properties. This reinforces the importance of equipment as the basis of a teaching model.

Equipment, especially in middle and senior primary school, may be used in mathematics to demonstrate the working form of an algorithm. However, Higgins shows how the use of equipment in the NDP should develop from a concrete manipulative reference point, to a representation of the thinking needed in the solution of a problem, and finally to a means to mediate discussion.

Higgins' paper amplifies the use and place of equipment through these three stages by referring to the tool itself and its use by teachers and by students. These comments are supported by teachers' quotes.

The paper by Jenny Young-Loveridge, Merilyn Taylor, and Ngarewa Hawera (p. 97) looks at how students feel about the importance of communicating their mathematical thinking and listening to the strategies of their peers. Despite a range of differences between the schools involved, most students saw an advantage in explaining their strategies to others, and both NDP and non-NDP schools were agreed on this. However, there was less agreement as to the importance of knowing other students' strategies, with more students in NDP schools seeing an advantage for this.

It is worth noting that the school in Young-Loveridge's other paper (p. 107) was much more positive in both areas than any of the other five schools in the paper above. Around three-quarters of the class in this school thought that these were important issues and were able to articulate their reasons for their responses. This reflects the fact that this school placed a strong emphasis on involving the students in their own assessment and making them aware of their learning.

As a result of the research that has been undertaken by the authors in 2004, it is clear that there are areas where progress is being made and there are areas of concern. Two points in this latter category are the progress of certain subgroups of students and how the overall progress to date can be sustained. These issues are already under consideration and are being focused on by the Ministry of Education and facilitators in 2005.

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