



MINISTRY OF EDUCATION

Te Tāhuhu o te Mātauranga

NUMERACY IN NEW ZEALAND: LOOKING TO THE FUTURE

THE 2006 RESEARCH FINDINGS



Tēnā koutou katoa.

The overarching outcome of the Ministry of Education is the building of a world-leading education system that equips all New Zealanders with the knowledge, skills, and values to be successful citizens in the 21st century. Since 2000, the Numeracy Development Projects (NDP) have successfully contributed to this by improving the capability and knowledge of New Zealand teachers, leading to improving student achievement in mathematics.

This pamphlet summarises the fourteen research and evaluation papers from researchers who considered various aspects of the NDP, including the Secondary Numeracy Project (SNP). These papers add to the impressive body of research informing and guiding mathematics education in New Zealand. It is encouraging to see the continuing progress in raising student achievement in mathematics. Although the findings show that some groups of students still have progress to make, the gaps are not growing and there are indications that they are closing. The findings from the longitudinal study of schools who continue to focus on numeracy achievement after the initial professional development phase are particularly impressive. The growth in teachers' effectiveness and professional leadership in primary, intermediate, and secondary schools, within both English- and Māori-medium settings, is very satisfying.

Almost all New Zealand primary schools have taken the opportunity to be part of this successful professional development initiative, so it is time to look ahead to build on the gains we have made. Leaving behind the idea that success is for a select few only, we need to make sure **all** students are successful mathematics learners with the ability and inclination to use mathematics effectively – at home, at work, and in the community.

Research such as this highlights our successes; it also identifies areas where development is still needed. Understanding of fractions and proportional thinking are areas needing more work, along with work in statistics, algebra, geometry, and measurement.

Congratulations on the pleasing results seen in these papers. Together, let's look ahead to face the challenges and to continue to build the foundation and knowledge needed by **all** our students as they become successful citizens.

Nāku noa, nā

Karen Sewell
Secretary for Education



2006 NDP RESEARCH AND EVALUATION

Researchers focused on:

- student achievement
- lead teachers and sustaining numeracy in schools
- professional practice.

SNP EVALUATIONS

Researchers focused on:

- student performance and progress on the Number Framework
- professional knowledge and practice
- facilitation.

The compendium and report are available from Learning Media or online from www.minedu.govt.nz, www.tki.org.nz, and www.nzmaths.co.nz



Student Achievement

By year 6, longitudinal students had mean stages on the strategy domains almost half a stage higher than students in schools new to the NDP.

The proportion of year 6 longitudinal students who reach the higher stages of the Number Framework has increased over the last five years.

Longitudinal students consistently perform better than their peers nationally on tests that include items from all strands of the mathematics curriculum.

At the end of their first year on the NDP, just under half of the year 6 and 7 students reached NDP stage 6, while about 40% of year 8 and 9 students reached stage 7.

In comparisons using effect sizes, Pasifika students had the largest average effect size (0.40), followed by students from low-decile schools (0.38) and Māori students (0.35).

Students' performance on basic facts was strongly related to their performance on strategy domains.

The students who were tested in each of the three years of the study showed a significant improvement in algebraic thinking.

There was a significant correlation between stages in the NDP and the algebraic thinking test used in the study.

There appears to be a lack of continuity between the algebraic thinking fostered in the NDP and questions in the NCEA Level I algebra examination.

Only 13% of the 238 year 7 and 8 students interviewed were able to correctly add $\frac{3}{4} + \frac{7}{8}$.

Many students used an algorithmic procedure rather than making sense of the quantities being combined.

Almost one-third of the students "added across" the numerators and denominators to get an answer of $\frac{10}{12}$.

Analyses of patterns of performance and progress from 2003 to 2006 show there have been positive longitudinal trends in most areas of the Number Framework (Te Mahere Tau).

The additional focus by facilitators and teachers on areas of concern from research in previous years has improved performance.

Performance on the addition, subtraction, and proportion domains needs additional focus for 2007, particularly at years 3 and 4.

Māori children in Te Poutama Tau schools acknowledge the role of support at school and at home for learning mathematics.

They place emphasis on teacher-taught strategies and are aware that there can be more than one way to solve a mathematics problem.

Evaluators and Papers

Andrew Tagg and Gill Thomas

Do they continue to improve? Tracking the progress of a cohort of longitudinal students

Jenny Young-Loveridge

Patterns of performance and progress on the Numeracy Development Projects: Findings from 2006 for year 5–9 students

Kay Irwin and Murray Britt

The development of algebraic thinking: Results of a three-year study

Jenny Young-Loveridge, Marilyn Taylor, Ngārewa Hāwera, and Sashi Sharma

Year 7–8 students' solution strategies for a task involving addition of unlike fractions

Tony Trinick and Brendan Stevenson

Te Poutama Tau 2006: Trends and patterns

Ngārewa Hāwera, Marilyn Taylor, Jenny Young-Loveridge, and Sashi Sharma

"Who helps me learn mathematics, and how?": Māori children's perspectives

RESEARCH FOCUS FOR 2007

Researchers are evaluating the effectiveness of numeracy initiatives supporting:

- pāngarau teachers in wharekura;
- beginning teachers;
- teachers new to numeracy schools;
- teachers who are improving their knowledge and understanding of mathematics through receiving fee-funding support to complete university papers.

Researchers are developing:

- a tool for assessing teachers' pedagogical content knowledge;
- an algebra framework extending on from the Number Framework;
- student profile sheets and diagnostic interview items for statistics.



Lead Teachers and Sustaining Numeracy in Schools

About one-third of lead teachers believed that numeracy practices in their school had strengthened as a result of 2006 professional support.

More than half felt that their learning needs were either "met" or "fully met" by the lead teacher professional development initiatives in 2006.

Lead teachers and facilitators did not always agree on which factors were most helpful in sustaining and developing numeracy practices.

The four domains of knowledge perceived to be important for lead teachers were: knowledge of, and attitude towards, mathematics; knowledge of students as learners; knowledge of teachers as learners; and knowledge of communities as learners.

Principals and teachers regarded knowledge of mathematics and knowledge of students as learners as most important for lead teachers, whereas the lead teachers themselves perceived knowledge of communities as learners as most important.

As the teachers learned more about the children's mathematics needs, they found they needed to put more time into planning in order to meet these needs.

The teachers used NDP teaching approaches to teach other mathematics strands.

The teachers were becoming less reliant on the NDP books and more able to adapt and invent within their mathematics programmes.

Evaluators and Papers

Jenny Ward, Gill Thomas, and Andrew Tagg

Numeracy sustainability: Current initiatives and future professional development needs

Joanna Higgins, Brenda Sherley, and Sandi Tait-McCutcheon

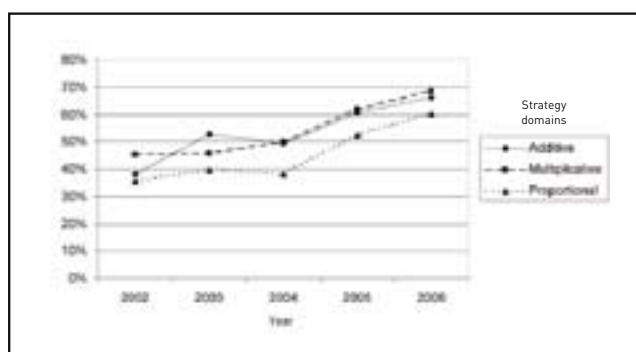
Leading a curriculum reform from inside a school

Fiona Ell

Keeping going at Country School: Sustaining Numeracy Project practices

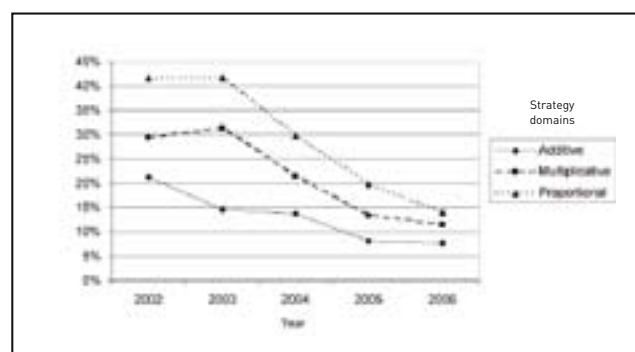
Percentage of year 6 students at or above the expected level of achievement

This graph shows the percentage of year 6 students from longitudinal schools who are rated at NDP stage 6, advanced additive, i.e., curriculum level 3, or above, on the strategy domains at the end of each year.



Percentage of year 6 students classified as "at risk"

This graph shows the percentage of year 6 students from longitudinal schools who are rated at NDP stage 4, advanced counting, or below, i.e., curriculum level 1, on the strategy domains at the end of each year.



From: *Do they continue to improve? Tracking the progress of a cohort of longitudinal students*
by Andrew Tagg and Gill Thomas



FINDINGS FROM THE NUMERACY DEVELOPMENT PROJECTS 2006

(PRIMARY AND INTERMEDIATE)

Professional Practice

The NDP have become an important national schooling improvement strategy for raising achievement among disadvantaged students.

Strategic and operational collaboration among interested parties has been central to the successful development and implementation of the NDP.

Teaching fractions with conceptual understanding is complex, particularly operating with fractions and using proportional reasoning.

Teachers can answer content questions about fractions better than they can describe the key concepts involved in the question.

Teachers had most difficulty describing the actions they would next take with students to teach fractions.

Parents found the community sessions helped them to understand the mathematics their children were doing at school.

Parents were able to share their ideas and experiences at the community sessions.

The role of the lead team (lead parents and lead teacher) is vital for the success of the Home-School Partnership.

Evaluators and Papers

Brian Annan

*The Numeracy Development Projects:
A successful policy-research-practice
collaboration*

Jenny Ward and Gill Thomas

What do teachers know about fractions?

Jonathan Fisher and Alex Neill

*Exploratory study of Home-School
Partnership: Numeracy*

RESEARCH FOCUS FOR 2007

Researchers are investigating:

- the achievement of year 6 students who have been in NDP classrooms since year 1 of their schooling;
- patterns of performance and progress in students of different gender, ethnicity, and socio-economic status, with a particular focus on students in years 5–11 and Māori and Pasifika students;
- the patterns of achievement in pāngarau of students involved in Te Poutama Tau, including their achievement over time;
- the performance of Te Poutama Tau students in geometry (te āhuahanga), measurement (te ine), and statistics (te tauanga);
- students' perceptions and attitudes towards learning mathematics (pāngarau) in te reo Māori and in English-medium classrooms;
- effective classroom teaching for Māori students in English-medium classrooms;
- links between teachers' pedagogical content knowledge and student achievement;
- the relationship between basic facts in numeracy and sight words in literacy;
- the relationship between student achievement in number and student achievement in geometry, measurement, and statistics;
- the practices that facilitate positive transitions between early childhood centres and primary schools;
- the impact of the SNP on student achievement in mathematics as students involved in the project in years 9 and 10 move to year 11;
- the benefits for teachers' professional development of being part of both ICT initiatives and the NDP.



EVALUATIONS OF THE 2006 SECONDARY NUMERACY PROJECT

Impact on Teachers and Facilitators

The SNP has had a positive impact on teachers' knowledge and practice of teaching mathematics.

Having an in-school numeracy facilitator is an effective way to foster and sustain change within a mathematics department.

Teachers want more support materials to help them teach year 9 and year 10 students.

Student Performance and Progress

Overall, year 9 students in SNP schools made progress on all domains, with demographic factors impacting on student performance. Students from higher decile schools, NZ European students, and male students generally outperformed others.

The overall effect sizes of the difference between year 9 and 10 levels were small.

Evaluators and Papers

Roger Harvey and Joanna Higgins

Evaluation of the 2006 Secondary Numeracy Project

Andrew Tagg and Gill Thomas

Performance of SNP students on the Number Framework

NDP PROFESSIONAL DEVELOPMENT FOCUS FOR 2007

The NDP aim to improve student achievement in mathematics through improving the professional capability of teachers. Quality teachers have a thorough understanding of the mathematics they teach, of how students are likely to learn it, and of misunderstandings that students are likely to encounter.

The initial phase of the NDP is drawing to an end, with almost all primary and intermediate schools in New Zealand having had the opportunity to take part. The focus now is on:

- sustaining and improving on the gains made in student achievement during the initial phase of the NDP;
- supporting students who are not achieving as expected, e.g., "at risk" and "cause for concern" students;
- extending NDP into the other strands of the mathematics curriculum, i.e., geometry and measurement, and statistics;
- developing the capability of principals and lead teachers to support beginning teachers and those new to their school in their mathematics professional development needs with minimal facilitator help;
- supporting schools' senior management in continuing the mathematics development in their school, including presenting, interpreting, and communicating assessment information to set and monitor student achievement targets;
- improving teachers' understanding and ability to teach the higher stages of the Number Framework, e.g., multiplicative and proportional thinking, fractions, decimals, and percentages;
- supporting specialist mathematics coaches as they mentor and support teachers of year 6–8 students;
- supporting the teaching and learning of the multiplication and division strategy domain, especially the use of the revised NDP *Book 6: Teaching Multiplication and Division*;
- the learning needs of pāngarau teachers of year 9 students in wharekura;
- the importance of knowledge, particularly basic facts and place value knowledge, for mathematics learning at stages 5–8 of the Number Framework;
- initiating support for the new mathematics and statistics curriculum in term four;
- promoting the use of Digital Learning Objects.



2007 Ministry of Education resources include:

New **Figure It Out** student books, together with *Answers and Teachers' Notes*:

Financial Literacy (late October 2007).

Levels 2–3: *The Real Cost of Pets*; Level 3: *Saving for a Holiday*;

Levels 3–4: *Granny's Gift*; Levels 4–4+: *Young Entrepreneurs*

NDP Book 6: Teaching Multiplication and Division: Revised Edition 2007: Draft

Book 6 has been revised to provide more support for the effective teaching and learning of the multiplication and division strategy domain. The key mathematical ideas and key knowledge needed are provided at the beginning of each activity to provide more clarity and support for teachers.



Numeracy Project resources

www.nzmaths.co.nz/numeracy/index.aspx

www.nzmaths.co.nz/maori/index.aspx



Mathematics/Pāngarau learning objects

www.nzmaths.co.nz/LearningObjects

www.nzmaths.co.nz/maori/Lo/default.aspx



Family section

This new section on the NZ Maths website provides information and activities for parents and whānau to help them support their children's learning. It includes activities to work on together at home.

www.nzmaths.co.nz/families/index.aspx

Expectations of student achievement

These show the numeracy stages and curriculum levels expected by the end of each year level, including an indication of when students are "at risk", "cause for concern", or "high achievers", to assist school leaders and teachers.

www.nzmaths.co.nz/numeracy/lead_teacher/plc/expectations/index.aspx

Mathematics/Pāngarau units of work

www.nzmaths.co.nz/units.aspx

TKI

Literacy and Numeracy community:

www.tki.org.nz/r/literacy_numeracy

Mathematics community:

www.tki.org.nz/e/community/maths

Research and evaluation reports: go to

www.tki.org.nz/e/community/maths and enter "research" into search box. Alternatively, go to www.nzmaths.co.nz/numeracy/References/reports.aspx

The *Effective Pedagogy in Mathematics/Pāngarau: Best Evidence Synthesis Iteration (BES)* by G. Anthony and M. Walshaw

draws together research evidence about what pedagogical approaches work to improve student outcomes in pāngarau and mathematics. It identifies, evaluates, analyses, and synthesises what the New Zealand evidence and international research tell us about quality mathematics teaching. The BES illuminates the findings with vignettes in early childhood settings and primary and secondary classrooms to bring the findings to life for teachers. Importantly, it illuminates what the evidence suggests can make a bigger difference to outcomes for diverse mathematics learners. The BES is available electronically from <http://educationcounts.edcentre.govt.nz/goto/BES>. Free hard copies can be ordered through the website from August 2007.



Further information relating to the contents of this pamphlet can be obtained from your nearest Numeracy Project co-ordinator. For names and email addresses, go to

www.tki.org.nz/r/governance/prof_learn/numeracy_e.php

Published 2007 for the Ministry of Education

by Learning Media Limited,

Box 3293, Wellington, New Zealand.

www.learningmedia.co.nz

Photographs by Adrian Heke

Copyright © Crown 2007

All rights reserved.

Enquiries should be made to the publisher.

Thanks to the Wellington facilitators and to the students and teachers from Te Kura Kaupapa Māori O Te Ara Whanui, Kelson Primary School, Avalon Intermediate School, and Tawa College who took part in the photoshoot for this pamphlet.

Additional copies of this pamphlet are available free on request. Call Customer Services on freephone 0800 800 565. Send orders to freefax 0800 800 570 or email orders@learningmedia.co.nz

This pamphlet is also available online at www.minedu.govt.nz, www.tki.org.nz, and www.nzmaths.co.nz

Item number 32594

ISBN 978 0 7903 2594 1

Online ISBN 978 0 7903 2597 2

