MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

The Numeracy Story *continued*

What is the evidence telling us?

Evaluation and research findings clearly show that the Ministry of Education's Numeracy Development Project (NDP) is improving student achievement and the quality of teaching and learning in mathematics in New Zealand schools.

The NDP's approach to mathematics education is dynamic and evidence-based. All aspects of the policy process – development, implementation, evaluation, and research – are interdependent and interconnected.

The way the project has developed is underpinned by research evidence about mathematics education, effective teaching, teacher learning, effective facilitation practice, and educational change. Each phase of the project has involved exploratory studies, pilots, and investigative case studies. The project's strategic objectives have been evaluated each year. New Zealand mathematics academics, teacher educators, and teachers have all contributed significantly to the NDP.

By the end of this year, 17 000 teachers and 460 000 students will have been involved in the English-medium and Māori-medium components of the project. By the end of 2007, most primary and intermediate teachers will have had the opportunity to participate. Funding for the Secondary Numeracy Project has been approved to 2008. As well as the numeracy facilitators assigned to schools, the NDP has an online facilitation option and is supported by the mathematics website www.nzmaths.co.nz and an extensive publishing programme.

Findings from 2004 Numeracy Evaluation and Research

The 2004 NDP evaluation and research findings have been compiled into a compendium. The 2004 numeracy researchers and their associates focused on three strategic themes:

- student achievement
- professional practice
- sustainability.

Copies are available from Learning Media or online from TKI and NZ Maths.

Student Achievement

	Evaluators and Titles of Papers
There is continued positive impact on student achievement, with statistically significant average-effect size in multiplication and division (0.40) and in proportion and ratio (0.43). Improvements are evident in the achievement of Māori and Pasifika students, with the "disparity" reducing in comparison to 2003. Manurewa Enhancement Initiative schools are performing better than low-decile schools generally. Boys are achieving better than girls at higher levels of the Number Framework. This result is consistent for Māori and Pasifika boys too.	**Jenny Young-Loveridge** *Patterns of Performance and Progress: Analysis of 2004 Data*
Students from schools in the NDP show more positive dispositions towards working with, and learning from, other students in mathematics classes and towards sharing their mathematical thinking.	**Jenny Young-Loveridge, Merilyn Taylor, and Ngarewa Hawera** *Going Public: Students' Views about the Importance of Communicating their Mathematical Thinking and Solution Strategies*
There was significant improvement in the achievement of students in a 24-item mathematics test (taken from TIMSS 1995) covering all strands of the mathematics curriculum.	**Gill Thomas and Andrew Tagg** *The Impact of the Numeracy Development Project on Mathematics Achievement*
The large database of student results relating to the aspects of number assessed through the diagnostic interview continues to provide a consistent picture of student achievement across years 1–8. This picture has confirmed clear expectations of achievement in number.	**Gill Thomas and Andrew Tagg** *Evidence for Expectations: Findings from the Numeracy Project Longitudinal Study*
Year 7 students in NDP schools performed significantly better than non-NDP students on a test of generalisation as a precedent to algebraic thinking.	**Kathryn C. Irwin and Murray Britt** *Algebraic Thinking in the Numeracy Project: Year One of a Three-year Study*
There is a positive shift in achievement in decimals, proportion, and ratio. 53% of students show gains in achievement stages.	**Tony Trinick and Brendan Stephenson** *An Evaluation of Te Poutama Tau 2004*

Overall NDP Research Findings from 2001–2004

Research over the first four years of the NDP has shown that all students in the NDP have made improvements greater than would be expected naturally over time. It is also clear that students at higher stages in the knowledge domains are more likely to progress in the strategy domains.

Key points from the evaluation reports are:

- The Number Framework stages are not of equal size.
- The size of students' gains is strongly linked to their starting points on the Number Framework.
- Higher stages appear to be larger steps for students to make.

Professional Practice

	Evaluators and Titles of Papers
Using class groups as a pedagogical strategy is effective in addressing the learning needs of Māori children.	**Joanna Higgins** *Effective Teaching Strategies for Māori Students in an English-medium Numeracy Classroom*
The teacher's orientation to the use of equipment influences the quality of learning experiences provided for students. The quality of learning experiences can be described in terms of a continuum that ranges from a rule-based approach to a problem-focused discussion approach. The report confirms the importance of the appropriate use of equipment within the teaching model.	**Joanna Higgins** *Equipment-in-use in the Numeracy Development Project: Its Importance to the Introduction of Mathematical Ideas*
The use of appropriate language is significant in improving mathematical thinking.	**Kathryn C. Irwin and Joanna Woodward** *A Snapshot of the Discourse Used in Mathematics where Students Are Mostly Pasifika (a Case Study in Two Classrooms)*
Principals' experience and involvement, the strength of lead teachers, collaborative environments, and language proficiency are the key features of kura kaupapa Māori that have consistent student achievement on the Number Framework in pāngarau.	**Tony Trinick** *Te Poutama Tau: A Case Study of Two Schools*
This school's emphasis on strengthening teacher–student relationships and encouraging self-responsibility in students seems to have played a major role in helping the students appreciate the importance of reciprocal communication in mathematics learning as they participated in the NDP. Teachers should consider emphasising the effective communication of mathematics ideas in their teaching programmes.	**Jenny Young-Loveridge** *Students' Views about Mathematics Learning: A Case Study of One School Involved in the Great Expectations Project*

Earlier Research Findings

Earlier research findings on raising student achievement in mathematics by improving the professional capability of teachers include the following:

- The Number Framework and the diagnostic interview have been important in enhancing teachers' knowledge of content and pedagogy.

  [My] content knowledge has not just developed, it has been a reawakening. (Primary teacher)

- Teachers have increased confidence and enthusiasm for teaching maths.

  Maths was previously not a favoured subject to teach (especially number), but I am now really enjoying it – it is hands-on, fun, and I can see the results. (Primary teacher)

- The NDP has helped teachers to clarify their thinking and consolidate their existing ideas.

  It has been excellent professional development for staff in looking at what, why, and how they teach. (Secondary principal)

  There's a real shared knowledge and there's a shared language in the staffroom, too, and teachers have often observed one another and they really focus on their achievement data. (Primary principal)

Effective Facilitation

The role of the facilitator is critical in improving professional practice.

[The facilitator] was amazing. She modelled expert lessons and gave us something to aim for. She was very good at moving children on ... (Primary teacher)

I feel that this numeracy programme has come alongside us; it hasn't directed us from the top ... It's such an excellent model in its own way of helping teachers change. (Primary principal)

Building on the gains made ... *The NDP is moving into a phase in which the emphasis is not only on improving the teaching and learning of mathematics in New Zealand schools but also on enhancing the capacity of schools to sustain and build on that learning. The real success of the project will be reflected in ownership for ongoing development in mathematics education being shifted to schools, teachers, and the mathematics education community.*

Sustainability and School Capacity

Principals' experience and involvement, the strength of lead teachers, collaborative environments, and language proficiency are the key features of kura kaupapa Māori where the Te Poutama Tau influence is being sustained.

A school-wide focus on the use of achievement information is a necessary condition for sustaining the development of teaching practice and raising student achievement.

The majority of schools reported that they had developed targets for student achievement, but few reported having numeracy meetings focused on raising student achievement.

School leaders (including numeracy lead teachers) are central to developing and sustaining effective numeracy practices.

Deprivatisation of teaching practice, openness to reflective critique, and support in observing and giving critical feedback to colleagues are all essential to sustainability.

Evaluators and Titles of Papers

Tony Trinick
Te Poutama Tau: A Case Study of Two Schools

Gill Thomas and Andrew Tagg
Evidence for Expectations: Findings from the Numeracy Project Longitudinal Study

Earlier Research Findings

- Principals and numeracy lead teachers are central to sustaining and developing effective practices. They need to be enthusiastic, supportive, and involved.

  Because we've embraced it as a whole staff, it's far more powerful than just one team or just a few teachers doing it. (Primary principal)

- Support must be provided for observing and giving feedback to colleagues.

  Next year, one of our major focuses is the use of the video – teachers seeing themselves and being very much a part of the mentoring and coaching and feedback model ... (Primary principal)

- Strategies to maintain progress must be developed.

  [There are] three key characteristics in terms of sustaining the change ... support [for teachers] ... challenge ... and success: it's seeing the success of the children within the programme and seeing the development that they've made and, as a teacher, feeling successful around what you're teaching the children in terms of numeracy. (Primary principal)

Quality Mathematics Teaching

The Number Framework, the diagnostic interview, and the teaching model are all integral components of the NDP's approach to enhancing the quality of teaching and improving student achievement in mathematics.

The Number Framework

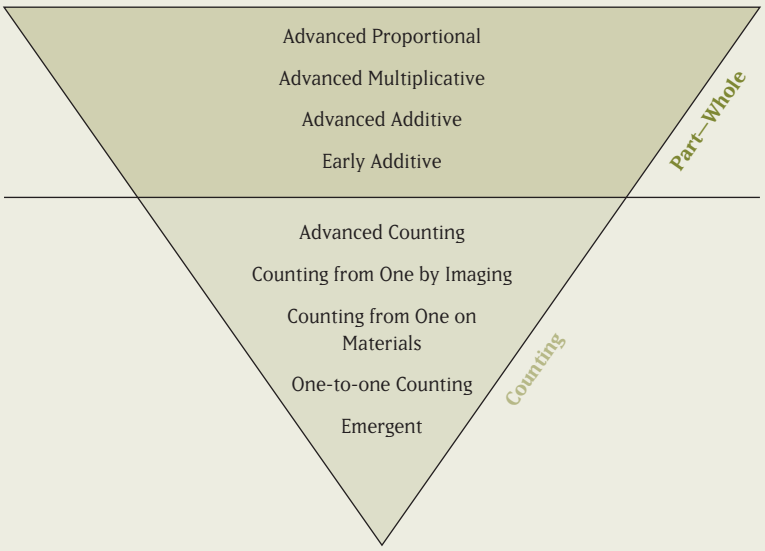
The Number Framework shows stages of students' mathematical thinking about number, and its structure helps teachers to identify, plan, and teach effectively to their students' learning needs.

[The project] has helped me see/identify stages and steps to push students along ... (Primary teacher)

Part–whole, that is the prize. If you can get them to advance to that, then they are going to make it. (Primary teacher)

It gave me a very clear sequence of learning. (Primary teacher)

Stages of the Number Framework



Diagnostic Interviews

The individual diagnostic interviews give teachers more detailed knowledge about where their students sit on the Number Framework. They help teachers to more clearly define their lesson objectives, focus learning, select appropriate learning activities, and pose relevant questions to students. In addition, the interviews provide principals with hard data for setting expectations of student achievement and teachers' self-review, and they help to make communication to parents about mathematics and mathematics teaching more specific.

[The assessment is] really fantastic. It allowed me to sit, listen to, and analyse the children's thinking. I could tell how easily they picked up a concept. (Intermediate teacher)

The individual assessment has become the benchmark for grouping and tracking progress. (Primary teacher)

Some of the findings blew me out of the water. Place value, keeping track of five places, we had taken for granted. Students had a veneer of knowledge ... Schools have to respond to kids wherever they are. (Secondary principal)

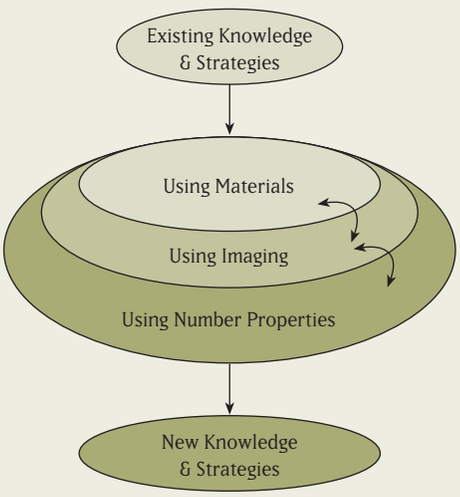
Grouping of children is much more accurate and better able to cater for their needs. (Primary teacher)

The Numeracy Teaching Model

The teaching model is designed to move students forward: from using materials to help them understand why calculations work, through to calculating mentally with understanding, speed, and accuracy. (Peter Hughes, Principal Lecturer, The University of Auckland, Faculty of Education)

The starting point for teachers is considering the NumPA [Numeracy Project Assessment tool] achievement data each time they plan a lesson or teaching unit. (Vince Wright, Numeracy Co-ordinator, University of Waikato)

The Teaching Model



The Effective Numeracy Teacher

Some characteristics:

- develops strong working relationships with their students
- creates a classroom environment that fosters independent work habits and self-monitoring
- values and celebrates their students' varied thinking strategies
  ... I'm quite sold on strategy work now, and I'm using it with my fourth form as well. (Secondary teacher)
- values risk-taking
- is clear about the intended outcomes for each lesson and shares these with their students
- uses materials to present new concepts
  There has been an emphasis on equipment throughout this project, and I could understand the reasons for using it and see the benefits for my students. (Intermediate teacher)
- links physical, symbolic, and oral representations deliberately and effectively
  Kids have to physically manipulate and understand a concept first before they can go to the number properties, and I think the big difference with the ANP ... is the imaging part ... (Primary teacher)
- recognises the importance of language and classroom dialogue in progressing mathematical thinking
  ... There is a language within maths that we have to identify ... especially a section like [fractions], which is heavily weighted on language ... (Primary teacher)
- works from a strong evidence base
- makes extensive use of group teaching based on the strategy stages of their students
  I use materials a lot more. I'm aware of imaging. I plan for more groups than I used to. (Primary teacher)
- ensures that the students who are not in a group working with the teacher are focused on appropriate work
- gives their students clear feedback on their learning
- makes good use of Figure It Out, NZ Maths, and other resources.

Te Poutama Tau

Te Poutama Tau, the Māori-medium component of the NDP, has highlighted the links between language and learning. Both the 2003 and the 2004 evaluations of Te Poutama Tau identified language proficiency as a significant factor that impacts on student progress in the higher stages of the Number Framework.

Ka taea ngā tauira ki te whai rautaki, engari he uaua te whai kupu.
(The students can follow a strategy but find it difficult to explain.)
(Māori-medium teacher)

He pai kia hoatu taonga hei āwhina, hei kōrerotanga mā ngā tamariki.
(It is helpful to give children equipment to help in their explanations.)
(Māori-medium teacher)

English-medium schools

The importance of the links between language and learning has been reinforced through English-medium case studies that show high-quality teaching practice – eliciting, supporting, and extending students' thinking and developing rich classroom discussion.

Getting them to share and discuss … what they have learnt and how they have done it and then … share with the group … they bounce ideas off one another and, I mean, that's how I learn, too. (Primary teacher)

… the correct use of advanced mathematical terms helped the development of mathematical thinking in a group of students who had English as an additional language and had not been doing well at school.
(Khisty and Chval, 2002)

Our one suggestion for improving the use of the NDP with Pasifika students would be to put more emphasis on the use of the mathematics register, both terms and the discourse of premise and consequence, rather than colloquial terms and conversational conventions.
(Irwin and Woodward, 2005)

Ministry of Education Publishing Programme

The Numeracy Development Project publishing programme for 2005 includes:

- ten NDP teachers' booklets (also available on CD-ROM)
- a set of material masters
- web-based material available through the NZ Maths website
- DVDs containing examples of effective teaching and showing children at each stage of the Number Framework
- the last two of four parent information pamphlets
- this pamphlet for teachers
- a compendium of the 2004 evaluation and research papers.

Other resources include:

- the Ministry-funded mathematics website www.nzmaths.co.nz
- the Figure It Out series and its Māori equivalent, He Tau Ano Te Tau
- printed, web-based, and DVD materials to support teachers in Māori-medium settings involved in Te Poutama Tau
- online facilitation workshops, available through NZ Maths
- 2001–2003 evaluation and research reports
- the online planning tool on NZ Maths.

Mathematics activities include:

- Maths Week, 15–19 August 2005
- CensusAtSchool, 15 August to 15 September 2005.

Website link to evaluation and research reports:

Go to: www.tki.org.nz/e/community/maths/, then click on "Pedagogy and professional support" and then on "research".

For further information relating to the contents of this pamphlet, contact the Curriculum, Teaching and Learning Group, Ministry of Education, PO Box 1666, Wellington.

Published 2005 for the Ministry of Education
by Learning Media Limited,
Box 3293, Wellington, New Zealand.
www.learningmedia.co.nz

Photographs by Adrian Heke
Design by Bunkhouse graphic design

Thanks to Tui Glen Primary School, Fergusson Intermediate, and Upper Hutt College, all of whom were involved in photographic sessions for this pamphlet.

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

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

Item number: 31048
ISBN: 0 7903 1048 1
Online ISBN: 0 7903 1258 1