Findings from the New Zealand Numeracy Development Project 2004

Kathryn C. Irwin and Murray Britt

Numeracy Project Longitudinal Study

Gill Thomas and Andrew Tagg

Solution Strategies of Communicating their Mathematical Thinking and Going Public: Students' Views about the Importance

Ngarewa Hawera

Jenny Young-Loveridge, Merilyn Taylor, and Gill Thomas

Evaluators and Titles

...  It's such an excellent model in its own way...  I feel that this numeracy programme has come...  You can really see the advantage...  The children have been open...  Experts and mentors...  What they're doing...  The Numeracy...  The children...  They're very confident...  We've always...  It's such a positive thing...  It's not just one team...  There are...  I would say...  We've had...  It has been wonderful seeing...  It's quite hard to...  It's been an excellent experience...  We've had...  What we've learnt...  It's such an excellent model...  It’s such a positive thing...  What we’ve done...  We’ve had...  We can see...  It has been wonderful seeing...  It’s been an excellent experience...  We’ve had...  What we’ve learnt...  It’s such an excellent model...  It’s such a positive thing...  What we’ve done...  We’ve had...  We can see...  It has been wonderful seeing...  It’s been an excellent experience...  We’ve had...  What we’ve learnt...  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The Numeracy Story continued
What is the evidence telling us?

Findings from the New Zealand Numeracy Development Project 2004

Student Achievement

Research from the New Zealand Numeracy Development Project (NDP) has revealed that students in the NDP have made improvements in all aspects of proficiency in mathematics. This includes improvements in understanding of mathematical concepts, skills, and strategies; fluency with numbers; and problem-solving skills.

Professional Practice

The NDP has helped teachers to clarify their thinking and consolidate their understanding of mathematical concepts. The research findings show that teachers who have participated in the NDP have a better understanding of the mathematical concepts they teach and are able to apply these concepts more effectively in their teaching.

Some of the key findings of the research include:

- The NDP has helped teachers to improve their understanding of the mathematical concepts they teach.
- Teachers who have participated in the NDP have a better understanding of the mathematical concepts they teach and are able to apply these concepts more effectively in their teaching.
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Findings from the New Zealand Numeracy Development Project 2004

**Student Achievement**

- There is a positive shift in achievement in decimals, proportion, and ratio.
- Year 7 students in NDP schools performed significantly better than non-NDP students on the mathematics test (taken from TIMSS 1995) covering all strands of the mathematics curriculum.
- Students from schools in the NDP show more positive dispositions towards mathematics.
- Improvements are evident in the achievement of Maori and Pasifika students, proportion and ratio (0.43).
- Significant average-effect size in multiplication and division (0.40) and in student achievement across years 1–8. This picture has confirmed clear evidence of sustainability.
- Improvements in the Number Framework stages are of equal size.
- Students at higher stages in the Number Framework are more likely to progress in the knowledge domains.
- Higher stages appear to be larger steps for students.
- The Number Framework stages are not of equal size.

**Key points from the evaluation reports are:**

- The Number Framework and the diagnostic interview have been important in providing insights into student achievement.
- The use of appropriate language is significant in improving mathematical communication.
- The facilitator was amazing. She modelled effective practices. They need to be enthusiastic, supportive, and involved.
- The facilitator is central to the mentoring and coaching and feedback model.
- The facilitator must be provided for observing and giving critical feedback to colleagues.
- Support must be provided for observing and giving feedback to colleagues.
- Teachers have increased confidence and enthusiasm for teaching mathematics.
- Students have increased confidence and enthusiasm for learning mathematics.
- The facilitator has numeracy leaders to clearly think and consider the content.
- The NDP has helped leaders to clearly think and consider student data.

**Te Poutama Tau**

- It’s such an excellent model in its own way alongside us; it hasn’t directed us from the top. (Primary teacher)
- The facilitator is amazing. She modelled expert lessons and gave us something to aim for. (Primary principal)
- The facilitator really focuses on their achievement data. (Primary principal)
- Support coaches and feedback colleagues are all essential to sustaining effective numeracy practices.
- 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. (Primary principal)
- Student achievement is a key component. (Primary principal)
- Teachers should consider emphasising the effective communication of mathematics in pāngarau.
- The facilitator was amazing. She modelled effective practices.
- They’ve made and, as a teacher, feeling successful around what you’re teaching the children in terms of numeracy. (Primary principal)
- Next year, one of our major focuses is the use of the video – teachers can describe in terms of sustaining the change. (Primary principal)
- Support coaches and feedback colleagues are all essential to sustaining effective numeracy practices.
- 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.
- We’re not asking do something different - we’re asking to change the way we assess achievement and be more responsive to the achievement information. (Primary principal)

**Sustainability and School Capacity**

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**Findings from the 2001–2004 Numeracy Development Project**

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- Next year, one of our major focuses is the use of the video – teachers can describe in terms of sustaining the change.
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Findings from the New Zealand Numeracy Development Project 2004

The Numeracy Story continued

What is the evidence telling us?

Evaluation and research findings clearly show that the Numeracy Development Project (NDP) is helping students achieve and understand the mathematics they need for learning across the curriculum and for life.

NDP Research Findings from 2001—2004

Student Achievement

• Improved achievement in student achievement, with statistically significant improvements across all achievement indicators, with the largest gains in Number and Probability.
• Reporting of student achievement in the 2003 Mathematics Achievement Test shows that the NDP has had a significant impact on student achievement.
• Students in NDP schools are more likely to progress in the Number Framework stages.
• The Number Framework stages are not of equal size.
• Higher stages appear to be larger steps for students.

Key points from the evaluation reports are:

- The Broad framework and the diagnostic interview continues to provide a consistent picture of students' mathematical strengths and needs.
- The large database of student results relating to the aspects of number assessed through the diagnostic interview continues to provide a consistent picture of students' mathematical strengths and needs.
- The use of appropriate language is significant in improving mathematical understanding.
- The teacher's orientation to the use of equipment influences the quality of the appropriate use of equipment within the teaching model.
- The use of appropriate language is significant in improving mathematical understanding.
- Students from schools in the NDP show more positive dispositions towards mathematics ideas in their teaching programmes.

Earlier research findings

• Earlier research findings on raising student achievement in mathematics by encouraging self-responsibility in students seems to have played a major role in encouraging self-responsibility in students.
• This school's emphasis on strengthening teacher–student relationships and the facilitators' effective facilitation practice, and educational change. Each phase of the research has contributed to the development of evidence-based teaching and learning models.
• Principles of effective teaching and learning identified in earlier research have been incorporated into the teaching and learning models of the NDP.
• Students in schools in the NDP show more positive dispositions towards mathematics ideas in their teaching programmes.

Current research findings

• Strategies to maintain progress must be developed.
• Support must be provided for observing and giving feedback to colleagues.
• Mentoring within the programme and seeing the development that has been made is a key feature.
• 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 have enjoyed it – it is hands-on, fun, and I can see the results. (Primary teacher)
• It has been excellent professional development for staff in looking at what, why, and how they teach. (Secondary principal)
• I feel that this numeracy programme has come alongside us; it hasn't directed us from the top or even told us what to do. She was very good at moving children on ... (Primary teacher)
• The facilitator was amazing. She modelled effective practices. They need to be enthusiastic, supportive, and involved. (Teacher)

Earlier Research Findings

The NDP has been successful in raising student achievement in mathematics through its focus on professional practice and educational change. Each phase of the research has contributed to the development of evidence-based teaching and learning models.

NDP Facilitation

The value of the NDP is its ability to support teachers in diagnosing and addressing students' mathematical needs.

• The facilitator can diagnose...
The Number Framework shows stages of students’ mathematical thinking about number, and its structure helps teachers to identify, plan, and teach effectively to improve student achievement in mathematics. The Number Framework is a diagnostic interview and teaching model that helps teachers to determine where their students sit on the framework. They help teachers to plan lessons, analyse the children’s thinking, and pose relevant questions to students. In addition, the diagnostic interview has become the benchmark for grouping and tracking progress. (Primary teacher)

The Number Framework encourages greater ownership and involvement of students and helps to improve student achievement in mathematics. The Number Framework is integral to the teaching and learning strategies of the Numeracy Teaching Model.

The Number Framework provides a common language and understanding of teaching and learning that helps to improve student achievement in mathematics. The Number Framework is used to guide classroom discussion.

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.

Diagnosis interviews

The diagnostic interview encourages greater ownership and involvement of students and helps to improve student achievement in mathematics. The interview has been developed for grouping and tracking progress. (Primary teacher)

The diagnostic interview is used to determine where students are focused on appropriate work of five places, we had taken for granted. Students had a veneer of understanding, but not necessarily a deep understanding of the concept. (Intermediate teacher)

Materials

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. (Primary teacher)

The Numeracy Teaching Model

The teaching model is designed to move students from using materials to help them understand why calculations work, through to using number properties to help them tackle problems. (Peter Hughes, Principal Lecturer, University of Auckland, Faculty of Education)

The Teaching Model

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student achievement in mathematics.

The Number Framework, the diagnostic interview, and the teaching model are all integral to teaching mathematics. The Number Framework, for example, is used to help identify students' current stage of understanding and to plan lessons accordingly. Diagnostic interviews provide a more in-depth look at a student's understanding, allowing teachers to identify specific areas for improvement. The teaching model is designed to help teachers become more effective in their teaching practices.

Existing Knowledge

Materials

Using Imaging

& Strategies

Using Imaging

The teaching model is designed to move students from a concrete understanding of mathematical concepts to a more abstract understanding. It includes the following stages:

- One-to-one Counting
- Counting from One on
- Early Additive
- Advanced Additive
- Advanced Proportional

The starting point for teachers is considering the existing knowledge of their students. They must then plan lessons that will build on this knowledge, using a variety of teaching strategies to ensure that all students are engaged and challenged.

The Numeracy Teaching Model

Students' thinking is encouraged by providing group work opportunities, as well as individualized instruction. The framework includes four stages of thinking:

1. Surface
2. Deeper
3. Transfer
4. Deep

Each stage of thinking requires a different approach from the teacher. Surface thinking involves students engaging with basic concepts and procedures. Deeper thinking requires students to apply these concepts in new contexts. Transfer thinking involves students relating new concepts to their existing knowledge. Deep thinking involves students engaging in complex problem-solving tasks.

Language and Learning

The importance of the links between language and learning has been emphasized throughout this project. Students who have been given the opportunity to use language in their thinking and writing tend to perform better in mathematics. Key terms such as 'ratio', 'proportion', and 'fraction' must be clearly defined and used consistently throughout the curriculum.

Computers in Schools

The project has highlighted the importance of using technology in the classroom. Students who have access to computers are more likely to engage with mathematical concepts and to develop a deeper understanding of the subject.

The Numeracy Development Project's publishing programme

This pamphlet is available in a number of formats, including digital and printed copies. It includes a range of resources for teachers, including teacher booklets, online facilitation workshops, and a set of materials masters. The pamphlet is designed to help teachers improve their teaching practices and to support student achievement in mathematics.
The Number Framework

The Number Framework When the students are ready, they can use it to plan and assess. This is important to ensure that the students are confident in their learning. This can be done by using the framework to assess their progress and identify areas for improvement.

The Number Framework is designed to help teachers understand students' progress in key areas of mathematics. It provides a clear sequence of learning stages that can be used to plan and assess students' understanding. This helps teachers to identify areas where students may need additional support, and to plan activities that are appropriate for their needs.

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The Number Framework helps teachers to identify, plan, and teach effectively to mathematical thinking about number, and its structure and impact on student achievement in mathematics.

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.

**Diagnosing**

The individual diagnostic interviews give teachers insightful data to guide their teaching. The Framework provides a structured approach to understanding student thinking and identifying areas for development.

- The **Number Framework** consists of five places: One-to-one Counting, Materials, Existing Knowledge, New Knowledge & Strategies, and Advanced Proportional Thinking.
- The **Diagnostic Interviews** are designed to assess students' understanding of number concepts and their ability to apply these concepts in problem-solving situations.
- The **Teaching Model** is a comprehensive approach to teaching mathematics, focusing on student engagement and understanding.

- **Materials** provide concrete objects to help students visualize and manipulate mathematical ideas.
- **Existing Knowledge** involves understanding what students already know and building on that knowledge.
- **New Knowledge & Strategies** focus on developing students’ understanding of new mathematical concepts and strategies.
- **Advanced Proportional Thinking** involves understanding and applying advanced mathematical concepts.

**Engaging students**

The Number Framework supports teachers in engaging students through various strategies, including the use of visual representations, real-world problem-solving, and collaborative learning.

- Teachers use the Framework to identify students’ strengths and areas for improvement, allowing for tailored instruction.
- Students are encouraged to explore mathematical concepts through hands-on activities and discussions.
- **Teaching Model** includes several components:
  - **Using Number Properties** to support students' understanding of number relationships.
  - **Existing Knowledge & New Knowledge** to build on students’ existing understanding.
  - **Materials** and **Materials: Advanced Proportional Thinking** to provide concrete and abstract representations of mathematical concepts.

**Accompanying resources**

- **Printed, web-based, and DVD materials** to support teachers in their implementation of the Number Framework.
- **Online planning tool on NZ Maths** to assist with lesson preparation.
- **Other resources include:**
  - this pamphlet for teachers
  - a set of material masters
  - a set of material masters
  - **2001–2003 evaluation and research reports**
  - **2005–2006 evaluation and research reports**
  - **CensusAtSchool, 15 August to 15 September 2005.**
  - **Maths Week, 15–19 August 2005**
  - **Mathematics activities include:**
    - the online planning tool on NZ Maths
    - **the Ministry-funded mathematics website www.nzmaths.co.nz**
    - **2001–2003 evaluation and research reports**
    - **2005–2006 evaluation and research reports**

**Teaching model**

The teaching model is designed to move students systematically through five stages of learning: One-to-one Counting, Materials, Existing Knowledge, New Knowledge & Strategies, and Advanced Proportional Thinking.

- The starting point for teachers is considering the student’s current understanding of number concepts.
- The **Teaching Model** is designed to move students forward: from using materials to help them understand why calculations work, through to understanding and applying advanced mathematical concepts.

**The Effective Numeracy Teacher**

The Effective Numeracy Teacher focuses on appropriate work for the group, considering the students’ current understanding and ability to apply mathematical concepts.

- The teacher makes good use of **Figure It Out**, NZ Maths, and other resources.
- The teacher works from a strong evidence base.
- The teacher recognises the importance of **language and classroom dialogue** in progressing students’ understanding.
- The teacher links physical, symbolic, and oral representations deliberately and explicitly.
- The teacher values **risk-taking**.
- The teacher values and celebrates **their students’ varied thinking strategies**.

**Fluency**

**Fluency** is an essential component of effective numeracy teaching. It involves students’ ability to recall mathematical facts and procedures automatically and accurately.

- **Fluency** helps students to apply mathematical concepts in new and unfamiliar situations.
- **Fluency** enables students to focus on more complex problem-solving and reasoning processes.

**Language and Learning**

The importance of the links between language and learning has been reinforced by research and practice in the field of mathematics education.

- **High level of evidence** supports the importance of language in mathematics learning.
- **Literacy strategies** are used to enhance mathematical understanding.
- **Language and classroom dialogue** play a crucial role in student learning.

**Te Poutama Tau**

Te Poutama Tau, the Māori-medium component of the NDP, has highlighted the importance of language proficiency as a significant factor in student achievement.

- The Ministry of Education’s **Te Poutama TAU** identified language proficiency as a significant factor that impacts on student progress in the higher stages of the Number Framework.

- The Ministry of Education is committed to ensuring that all students have equal access to quality education, regardless of their language proficiency.