



Making Maths Real with Numicon





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What is Maths?

"Mathematics is the exploration and use of patterns and relationships in quantities, space, and time. Statistics is the exploration and use of patterns and relationships in data.

These two disciplines are related, but different ways of thinking and of solving problems. Both equip students with effective means for investigating, interpreting, explaining, and making sense of the world in which they live". *NZ Curriculum*

- An abstract concept, with numerals assigned to represent the concept
- Rules and methods to follow
- It is an axiom (a statement regarded as true)

It is made up of different components:

- Problem solving
- o Patterns
- Relationships
- Calculations and counting
- Reasoning and generalizing & communicating

How does Numicon help?

- It makes numbers real
- It provides a structured learning process that follows the CPA sequence, using appropriate manipulatives.
- · Children enjoy learning about maths which has a direct purpose and real-life context
- Reduces anxiety
- Supports all types of learners, AVK, as well as those with learning difficulties
- Reduces auditory processing and working memory load
- The teacher is supported with on-line and face to face support by a Numicon trained NZ teacher.
- · Focuses on key aspects of mathematics: Communicating, Generalizing, Exploring Relationships



Mathematics and Statistics are interconnected. All strands should be taught together where relationships fall naturally

What does this mean for our students?

Visual prompts Hands-on activities One small step at a time, repeated Working alongside others Opportunity to say what they want to learn

Connections with real life experience

What does this mean for our teaching?

Open ended tasks and challenges Effective questioning strategies *Making Skills and Capabilities explicit* Opportunities to work collaboratively More self-directed learning Making connections

Numicon Manipulatives

Numicon is essentially a whole school approach to mathematics that uses manipulatives to explore patterns and relationships in mathematics.

It uses number shapes and number rods, Along with other manipulatives.



The Shapes

- Any group of objects can be arranged into a pattern that can be 'read'.
- A group then does not have to be counted
- The concept of 'number' or 'how many' is built
- Ready to explore relationships with groups
- Shapes and rods are tools for conversations about numbers
- and their relationships
- Generalisations about anything!
- Numeral symbols have meaning
- Mathematical thinking and communication grows
- Components or units in groups make up the whole encourages part – whole thinking
- The 'whole idea' thinking is generalising
- Problem-solving, investigating, interpreting explaining and making sense of the world around them, follows readily





Part - Whole

Bar Model



Foundations: Making Connections Haylock and Cockburn (2008)

Abstraction of Manipulatives: No magic in the plastic

With any tool that you use in your teaching, you need to think about its purpose and if it is the best tool for the job. Each manipulative encourages certain thinking, for example, counters can be manipulated greatly as they can be counted separately and split into groups. Cuisenaire rods cannot be broken up but encourage thinking of numbers as a whole. Numicon shapes are extremely flexible in its abstraction – you can count the holes individually or think of the number as whole by looking at the shape. Once you remove the colour and physicality of the holes (perhaps by just using a cut out shape), you scaffold the thinking further.

Set up your shapes like this

Set up your counters/buttons... like this

Set up your numeral cards like this







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STARTING PLACE SUGGESTION - ALL SETTINGS								
NZC Levels	1		2		3		4	
	MAINSTREAM EDUCATION							
Year Levels	0/1	2	3	4	5	6	7	8
Numicon Books	Firm Foundations	Numicon 1	Numicon 2	Numicon 3	Numicon 4	Numicon 5	Numicon 5	Numicon 5/6
Apparatus Packs	Firm Foundations	А	А	В	В	С	С	С
Numeracy Stages	0-3	1-4	5		6		7-8	
RECOVERY, INTERVENTION, TUTORING								
Years 2-5 10-15 wks	Numicon Intervention Programme (NIP)							
Years 5-10	Numicon Intervention Programme (NIP)			Numicon 3	Numicon 4	Numicon 5	Numi	con 6
Years 5-10	Big Ideas (BI) - Catchup							
IN CLASS SUPPORT (ICS), SPECIAL SCHOOLS/UNITS								
No age limit	Breaking Barriers (BB)			Numicon 3 Number	Numicon 4 Number	Numicon 5 Number	Numi Nun	con 6 nber
Strand Books to accompany	Firm Foundations	Numicon 1 - GMS	Numicon 2- GMS	GMS	GMS	GMS	GI	MS

Key features for teaching:

- Long-term, medium-term and short-term planning AND Assessment is provided. It's all done for you!
- Lesson structure is based on explorative activities (play), language, problem-solving, then recording.
- Real life contexts are the opportunity to apply the generalisations to solve problems.
- One lesson, planned well for the whole class, or groups provides more time for teacher participation and enjoyment.
- Focus activities during the week sequenced providing conceptual development. These include direct teaching, demonstration, problem-solving and investigations written by and trialled by teachers over many years and settings. This enables easy differentiation for mixed ability and targeted teaching.
- Formative Assessment is supported with 'look and listen for' prompts in the activities. Learning is recorded weekly along with Explorer Progress Booklets to show concrete evidence of learning. Summaries of learning is provided at each Milestone at 4 - 6 week intervals. This can be shared via Linc-ED, eTAP, or Kamar.
- Pupil Books are provided for collaboration, deeper investigations and problem solving for Numicon 3 - 6

vity groups through approp the long- and medium-ter	ssion chart gives an overview of the expected coverage over the school year and the ing the activity groups. [Statistics work has been included within the Geometry and Measurem viriate contexts.] m planning documents for Number, Pattern and Calculating 5 and Geometry, Measurement a	Numbers and the Number System 2-2 & 2-3		
istics 5 for references to as Strand and Activity Group Number	eessment milestone statements, a fantastic tool for measuring children's progress.	Exploring equivalence with fractions		
Settina Started	Getting started with apparatus and imagery	an numerais.		
Numbers and the	1 Working with numbers up to a million	Practice		
Number System Numbers and the 2 Exploring equivalence with fractions		Can you find three different ways to describe the amount of these tiles that is coloured blue? Can you find:		
Number system	3 Understanding decimals	a an improper fraction		
umber System		b a mixed number		
ometry	1 Measuring angles	c a proper fraction?		
culating	 Developing fluency with adding and subtracting calculations and understanding inverse relationships 	2.9 Can you draw an illustration that shows the fraction $\frac{18}{2}$?		
culating	2 Strategies for bridging when adding and subtracting mentally	b Can you write $\frac{18}{18}$ in another way?		
mbers and the mber System	4 Estimating and rounding	c Can you explain how you worked this out?		
culating	3 Further strategies for adding and subtracting	3 Can you write these numbers in other ways?		
ttern and Algebra	1 Exploring sequences and number patterns	a $\frac{23}{2}$ b $12\frac{1}{2}$ c $\frac{38}{2}$ d $25\frac{1}{2}$		
netry	2 Transformations			
mbers and the mber System	5 Working with negative numbers	Going deeper		
culating	4 Developing fluency with multiplying and dividing	L Can you draw tiles to show these fractions? You can use any design		
nbers and the nber System	6 Comparing and ordering fractions	the tiles you choose.		
rn and Algebra	2 Using inverse relationships to solve problems	$a \frac{1}{4}$ $b \frac{3}{4}$ $c 2\frac{1}{2}$ must even be use		
ulating	5 Written methods of adding			
ulating	6 Written methods of subtracting	2 Can you make an illustration that shows the fraction $\frac{1}{4}$?		
culating	7 Multiplying and dividing by 10, 100 and 1000	3 a Can you explain how you did question 2 above?		
surement	1 Metric and imperial units	b Can you use your method to make an illustration that shows $4\frac{3}{4}$?		
ern and Algebra	3 Properties of number	4 a Which Numicon Shape would be most useful for illustrating quarter		
culating	8 Using mental methods for multiplying and dividing	b Can you explain why, and use some of the Shapes to illustrate $\frac{15}{4}$		
culating	9 Division with remainders	5 a Which number red would be most useful for illustrating quarters?		
eometry	3 Exploring angles	a which humber fou would be most useful for hustrating quarters:		

The Numicon Approach

Numicon is a distinctive approach to children's mathematical learning that emphasises three key aspects of doing mathematics:

This demands children to:

- Think and communicate with and about abstract objects
- Look for patterns in abstract objects
- Generalise and use these patterns



But it's hard to **generalise** in the abstract at first... Which is why Numicon is founded on the CPA approach: Concrete - Pictorial - Abstract



Numicon acknowledges the difficulties and teaches how to generalise to solve problems

Action and imagery activities to give experience to understand symbols, necessary for communicating a generalisation.

To aid this, a strong focus is placed upon the use of structured materials that will lead children into *doing* mathematics.



Activities

Focus Activity – Direct Teaching

To provide students with a model representing the relationship and action LOOK FOR ASSESSMENT CUES



Activity 2: Connecting grouping in tens with place value

Have ready: Numicon 0–100 cm Number Line, Numicon Coloured Pegs or counters, Tens and Units Frame (photocopy master 47), sheets of wrapping paper with between 21 and 99 pictures, *Numicon Software for the Interactive Whiteboard* (optional)

Step 1

Show children the wrapping paper; discuss and agree which pictures to count. Look and listen for children who talk about tagging each picture with an object and then arranging the objects into groups of 10 (see Numbers and the Number System 1, Activities 4 and 5).

Step 2

When children have tagged the pictures with Pegs or counters and arranged them into Numicon 10-patterns, ask them to say how many they have in total, and how many tens and how many units they have. Look and listen for children who can say how many tens and units from the Numicon Shape patterns.

Focus Activity – Problem-solving in real life context – SET THE SCENE

To provide students with a setting or reason for the maths they are learning.



Learning Journal – Explorer Progress To provide students the opportunities to share their thoughts and their learning

Activity 1: Introducing the word 'times' with repeated adding

Have ready: Numicon Shapes, Numicon 10s Number Line, Numicon Software for the Interactive Whiteboard (optional)

Step 1

Set the scene by telling children about preparing for a school play about space travel. Four children will be dressed up as aliens, each wearing one mask, two silver sleeves, three wobbly antennae and five shiny badges. Ask children how many of each item are needed. Remind them about organizing work when working on problems and write a list of the different costume parts.

a can write a number stor	
	y.
	Date / /
I know these facts.	



Key Mathematical ideas in Numicon 1-4

Teaching Progressions can be found under Supporting Resources on <u>www.numicon.co.nz</u>. These show when to connect NPC and GMS into your programme during the year.

	Number, Pattern and Calculating	Geometry, Measure and Statistics		
Numicon 1 NZC Level 1	 Counting objects to at least 30 Ordering numbers to 20 Counting in two's, five's, and ten's Understanding place value of 2-digit numbers Reading, writing and understanding +, -, <, > Adding and subtracting facts to 10 Recognising halves and quarters of wholes 	 Making tiling, repeating and growing patterns Making, naming and sorting 2D and 3D shapes Exploring properties of 2D and 3D shapes Giving directions, describing, turns and rotations Comparing and ordering mass, capacity and length Understanding time duration Telling the time to the hour and half hour Understanding money 		
Numicon 2	 Patterns and sequences of 2s, 5s, and 10s Counting to 100 and beyond Comparing and ordering numbers to 100 Recognise the place value of 2-digit number When/how to add/subtract to solve problems Adding and subtracting facts to 20 Working with multiplying and dividing Recognising halves, quarters and thirds of wholes Understanding fractions as numbers 	 Making and classifying polygons Identifying/describing faces, edges, vertices of 3D Symmetrical patterns, identifying lines of symmetry Identifying and naming prisms Exploring fractions of rotations Creating block graphs and bar graphs Telling the time to five minutes, including quarter past/to the hour 		
Numicon 3 N7C1.e	 Developing fluency - + - in 2- and 3-digit numbers Exploring multiplying and dividing Partitioning 2- and 3-digit numbers Comparing and ordering numbers to 1000 Using apparatus and imagery in + - x ÷ Understanding fractions of a wholes & numbers Using fraction notation 	 Building skeleton 2D and 3D shapes Identifying regular and irregular polygons Making and identifying right angles and types of lines Sorting 2D and 3D shapes using sorting diagrams Describing position and movement on a grid Telling the time (analogue and digital) 12-hour clocks Measuring mass, capacity, length using standard units Understanding discrete and continuous scales 		
Numicon 4 NZC I avial 3	 Understanding place value in 4-digit numbers Ordering and comparing numbers to 1000+ Developing fluency with mental and written methods for adding and subtracting Developing fluency with multiplying and dividing facts to 12 x 12 Developing fluency with mental and written methods for multiplying and dividing Exploring negative numbers Exploring decimal fractions Exploring equivalent fractions 	 Sorting/classifying triangles and quadrilaterals Making/identifying symmetrical figures Making/identifying types of angles in polygons Plotting /reading co-ordinates in the first quadrant Describing/drawing translations on a co-ordinate grid Measuring mass, capacity and length using decimals Calculating area and perimeter of rectilinear shapes Collating, comparing, presenting monetary data Reading/creating tables and graphs Telling the time (analogue/digital 24-hour clocks) Time duration 		

Breaking Barriers covers a summary of the concepts in Numicon 1, 2 and 3 at a pace to enable students with high Learning Needs to participate in the same class environment as their peers. Numicon supports inclusive education practice.

Numicon Intervention Programme covers the key mathematical ideas in Numicon 1, 2, and 3 in a 12-15 week intervention either as part of the classroom environment or in a separate environment. A Diagnostic Assessment in mathematics determines the starting point and teaching programme for each student to close the gap between the students who are struggling and their average-achieving peers.

'**Investigations with Numicon'** teaching book contains ten open-ended investigations with a low threshold and high ceiling, with the potential to stretch children to Level 3 and beyond of the NZ Curriculum. Suitable for bright children in maths, including bright children who are not succeeding in mathematics known as 'twice exceptional'.

Key Mathematical ideas in Numicon 5 and 6

Teaching Progressions can be found under Supporting Resources on <u>www.numicon.co.nz</u>. These show when to connect NPC and GMS into your programme during the year.

Numicon 5 NZC Level 3 - 4	 Reading/writing -digits & multiples to seven places Interpreting negative numbers in context Recognise/describe linear number sequences, rules + And - numbers 4 plus digits, algorithms reasoning Square numbers (2) and cubed (3) Scaling by simple fractions and simple rates Fractions –multiples, equivalent, tenths and hundredths, mixed, improper fractions + And – fractions, x proper fractions/mixed numbers Decimal -fractions, hundredths, tenths & decimal equivalents, rounding Per cent %, fraction and as a decimal Percentage & decimal equivalents of ½, ¼ 1/10, with a multiple of 10 or 25 	 Convert between different units of metric measure and solve problems involving converting between units of time Measure and calculate the perimeter of composite rectilinear shapes in centimetres and metres Calculate and compare the area of rectangles Estimate volume Use all four operations to solve problems involving measures using decimal notation, including scaling. Angles -drawn, measured in degrees Line graphs, complete, read and interpret information in tables, including timetables
Numicon 6 NZC Level 4	 Read, write, order and compare numbers to 10 million use negative numbers and calculate across 0 long multiplication up to 4 digits long division up to 4 digits, and interpret remainders as whole number remainders, fractions, or by rounding common factors, common multiples and prime numbers Addition and subtraction multi-step problems in contexts common factors to simplify fractions + - fractions with different denominators and mixed numbers, multiply simple pairs of proper fractions, divide proper fractions by whole numbers calculate decimal fraction equivalents for a simple fraction identify the value of each digit in numbers given to 3 decimal places and multiply and divide numbers by 10, 100 and 1,000 multiply one-digit numbers with up to 2 decimal places equivalences between simple fractions, decimals and percentages, including in different contexts use integer multiplication and division facts where missing values can be found calculation and comparison of percentages solve problems involving unequal sharing and grouping using knowledge of fractions and multiples simple formulae and linear number sequences Express missing number problems algebraically Find pairs of numbers that satisfy an equation with 2 unknowns enumerate possibilities of combinations of 2 variables 	 Solve problems involving the calculation and conversion of units of measure, using decimal notation up to 3 decimal places where appropriate Use, read, write and convert between standard units, converting measurements of length, mass, volume and time from a smaller unit of measure to a larger unit, and vice versa, using decimal notation to up to 3 decimal places Convert between miles and kilometres Recognize that shapes with the same areas can have different perimeters and vice versa Recognize when it is possible to use formulae for area and volume of shapes Calculate the area of parallelograms and triangles Calculate, estimate and compare volume of cubes and cuboids using standard units, including cubic centimetres (cm³) and cubic metres (m³), and extending to other units [for example, mm³ and km³] Draw 2-D shapes using given dimensions and angles Recognize, describe and build simple 3-D shapes, including making nets Compare and classify geometric shapes based on their properties and sizes and find unknown angles in any triangles, quadrilaterals, and regular polygons Illustrate and name parts of circles, including radius, diameter and circumference and know that the diameter is twice the radius Recognize angles where they meet at a point, are on a straight line, or are vertically opposite, and find missing angles Describe positions on the full coordinate grid (all 4 quadrants) Draw and translate simple shapes on the coordinate plane, and reflect them in the axes Interpret and construct pie charts and line graphs and use these to solve problems

Early Childhood to NZ Curriculum Level 4



- First Steps with Numicon in the Nursery
- First Steps with Numicon at Home
- Firm Foundations
- Numicon at the Seaside

Teaching Resources Numicon 1-6:

- 1. Teaching Resource Handbook
- 2. Implementation Guide
- 3. Explore More extra activities or for homework
- Pupil Books Problem-solving for deeper learning and investigations (Numicon 3 – 6)
- 5. Explorer Progress Books formative assessment
- Investigations with Numicon
- Breaking Barriers
- Big Ideas
- Numicon Intervention Programme

Apparatus Packs

- Apparatus Packs Starter Class and Starter 1:1
- Apparatus Pack A Supports Numicon 1 and 2
- Apparatus Pack B Supports Numicon 3 and 4
- Apparatus Pack C Supports Numicon 5 and 6
- Breaking Barriers Supports Breaking Barriers Teaching Pack
- Firm Foundations Apparatus Packs



Starter Apparatus Pack B



Starter Apparatus Pack C

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Starter Apparatus Pack A

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Numicon- Apparatus & Resources



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