Exploring the Impact of Numicon: An Australian Context

Summary of a Numicon Pilot Project conducted in an Australian primary school in 2012/13

Project summary compiled by Oxford University Press Australia in association with Stradbroke School, South Australia

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Purpose

The focus of this pilot project was to collect student achievement data in mathematics, particularly in the areas of number and algebra. This was the culmination of an intensive implementation of the Numicon Approach to support educators working with students in their first year of school. This project was conducted in a mainstream Australian primary school over the course of one school year. On completion of the 12-month period, data was gathered and analysed to determine the effectiveness of the Numicon Approach on student achievement in mathematics in an Australian context.

Background

The Numicon Approach was developed as a result of a Teacher Training Agency (TTA) Teacher Research Project carried out in a UK school from 1996–7. The project was led by Dr. Tony Wing from Brighton University, in collaboration with the school's maths coordinator and headteacher. The key finding was that children whose arithmetic had been supported using structured imagery showed dramatic improvement in their attainment levels in national tests in comparison to previous cohorts. The results of this project can be more fully explored in the report: *Learning about numbers with patterns using structured visual imagery (Numicon) to teach arithmetic*[1].

An effective program of multi-sensory arithmetic activities for UK students in Reception and Year 1[2] was developed as a result of the TTA project. The program of activities was published as a series of comprehensive teaching guides, along with a set of structured apparatus that was produced to support the program. Assessment Signposts are included in the teaching guides and are designed to help teachers identify where to start on the program as well as identify gaps in student understanding. The Signposts also provide direction for educators on where to go next depending on the student's response. This entire suite of resources is available to teachers as Numicon.

Numicon is a progressive teaching program that uses a series of structured patterns – Numicon Shapes and Rods – to represent numbers and to develop understanding of number ideas and relationships. The Numicon Shapes and Rods help teachers and students to communicate their ideas. Students are able to visually communicate their mathematical thinking to teachers. This in turn helps teachers 'see' a student's understanding.

By following the teaching program, students secure the essential building blocks of mathematical understanding that is so important to success in mathematics through and beyond the primary years.

Fig 1. Numicon Shapes were developed to support the development of visual imagery and relational understanding of number.

Oxford University Press Australia & New Zealand's (OUPANZ) exploration of Numicon for the Australian market coincided with the early development of the Australian Curriculum: Mathematics[3]. It was imperative that Numicon clearly support the content and proficiencies of mathematics as outlined in the curriculum. It was also important for Numicon to have a synergy with pedagogy currently considered best practice in the teaching and learning of mathematics in the early years. OUPANZ correlated the Numicon teaching program to the F–2 Australian Mathematics Curriculum and determined that it would support the Proficiency Strands and Achievement Standards of the curriculum in the first three years of schooling.

Professional development is integral to the successful implementation of the Numicon Approach. The comprehensive professional development program includes direct experiences of Numicon activities and explorations of the underpinning theory that allow educators to reflect on their current pedagogy. All Numicon trainers are experienced educators, have used Numicon in classrooms, and are fully trained and accredited.

1 Tacon, R., Atkinson, R. & Wing, T. (2004). *Learning about numbers with patterns using structured visual imagery (Numicon) to teach arithmetic – Summary of a research project carried out at an infant school in England.* London: BEAM Education.

2 The UK schooling levels of Reception and Year 1 are equivalent to the first and second years of schooling in South Australia, which are also called Reception and Year 1. Reception in South Australia is equivalent to the Foundation Year level in the Australian Curriculum.

3 Australian Curriculum, Assessment and Reporting Authority. (2012). *Foundation to Year 10 Curriculum.* Retrieved 1 July, 2013 from http://www.australiancurriculum.edu.au/Mathematics/Curriculum/F-10

Pilot School Context

Stradbroke School is a metropolitan primary school located in the north-eastern suburbs of Adelaide, South Australia. The school has a stable population of 750 students from Reception to Year 7 (aged from 5 to 13 years old).

Of the total student population, 45% are from language backgrounds other than English, 1.5% are of Aboriginal or Torres Strait Islander descent, 4.6% of students are verified under the Students with Disabilities Policy and 18% receive financial assistance under the South Australian School Card scheme.

The students participating in the pilot were from four Reception classes and the school's Speech & Language class[4].

In line with the enrolment policy of the South Australian Department of Education and Child Development, the students started school between July 2011 and April 2012 and spent between three and six terms in a Reception class before moving to Year 1 in January 2013. The seven students in the Speech & Language class were Reception, Year 1 and Year 2 students. The five teachers involved were all experienced junior primary teachers with ten or more years of teaching experience. In addition to the teaching staff, the School Services Officers who provided assistance in each class also participated in the professional learning component of the pilot project.

Pilot Project Overview

After meeting with Anne Lamont, the principal of Stradbroke Junior Primary School[5] in October 2011, it was agreed that OUPANZ would offer a full-day Numicon introductory session to Stradbroke Junior Primary Reception staff to gauge and confirm interest in participating in the Numicon Pilot Project. Following the positive response to this session it was agreed that the Numicon Approach would be fully implemented in Reception classrooms beginning in 2012.

OUPANZ would provide the four Reception classes and the Speech & Language class with the appropriate Numicon resources, materials and training. The project would continue for the duration of 2012 and be reviewed in Term 4 of that year.

Target year level/ group

- Four Reception classes with an average of 26 students per class
- One Speech & Language class with 7 students from Reception, Year 1 and Year 2

Participating educators

- All teachers with a Reception cohort in their class
- Speech & Language Class teacher
- School Services Officers (SSOs): classroom-based school support officers who work in Reception classes and the Speech & Language class

Additional educators

Educators from neighbouring 'cluster' schools also took part in the training sessions to facilitate wider discussion and participation. This group of educators attended all training days and cluster meetings but were not considered part of the pilot project, nor were their students included in the data set.

4 Stradbroke School hosts a regional Speech & Language class that is part of a statewide facility catering to students who experience significant language delays and/or speech difficulties. The class size is kept small, with a maximum of eight R–2 students aged between 5 to 8 years old. Students develop their speech and language skills with the support of the teacher, School Services Officer and speech pathologist.

5 In 2013 the junior primary and primary school amalgamated to become Stradbroke School. Ms Anne Lamont (formally principal of Stradbroke Junior Primary School) was appointed principal of Stradbroke School (R-7) as part of the amalgamation process.

Resourcing

The diagram below shows the Australian schooling levels that each Numicon kit is appropriate for.

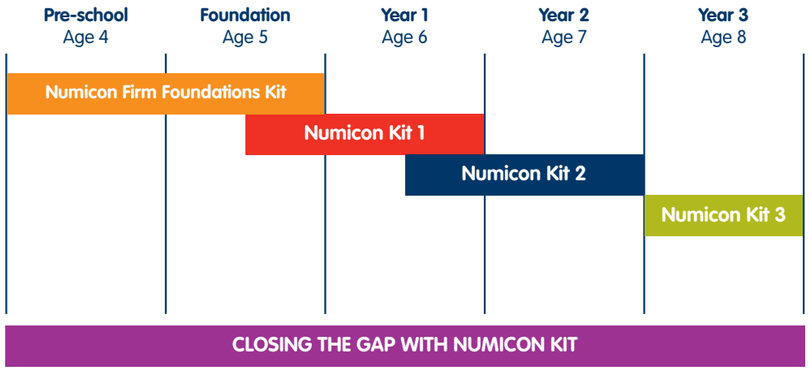

Fig 2. Diagram showing Numicon kits and how they correlate at year level to the Australian Mathematics Curriculum.

- The Reception classes would begin with the Firm Foundations teaching program, with materials taken from the Numicon Firm Foundations Class Kit. The Speech & Language class used the Closing the Gap teaching program, based on the Numicon Closing the Gap Class Kit.
- Reception teachers were also supplied with Closing the Gap Teaching Guides and Kit 1 Teaching Guides and supplementary resources, including IWB software site licensed for use across all classes.
- All classes were resourced accordingly by OUPANZ. Careful consideration was given to the storage of the equipment to ensure it was easily accessible in the classroom. All print materials were prepared and class sets distributed.

Training

Training was on-going and led by Julie Baillie, Primary Education & Professional Development Manager at OUPANZ. Julie is an accredited trainer and the manager of the Numicon program in Australia.

A full-day session was provided once every term (Terms 1–4, 2012). Each session was followed up approximately two weeks later with a teacher-led cluster meeting to facilitate the sharing of progress and ideas. The schools funded the teacher release time required for all educators to attend each session.

Further support and advice was provided by the trainer via email and school visits.

The main focus of the training centred on the Firm Foundations teaching program and covered the following areas:

- understanding the theory underpinning Numicon
- structuring the program and using the equipment
- creating a visually rich mathematics classroom environment
- building teacher capacity and understanding key mathematical ideas
- exploring the activities to build firm foundations in mathematics
- using the Numicon Assessment Signposts to monitor progress and determine when students can move to the next stage
- managing the classroom and organising instruction time
- addressing issues and responding to questions
- sharing lessons and activities.

Teachers were also given support to conduct in-school Numicon sessions for colleagues and parents.

Project participants completed a questionnaire at the end of the project and their comments and observations are included in the findings.

Pilot Project Implementation

- All classes in the project incorporated Numicon into their daily maths lessons. Numicon was used for whole-class instruction, small-group work and by students individually.
- Numicon materials were made easily accessible and Numicon Shapes and Number Lines were displayed in all classrooms.
- When working with groups, all tasks, challenges and equipment required were prepared by the educator prior to the session. This allowed the teacher to move between groups and to observe, question and assess students during the actual session.
- Students were initially given the opportunity to explore the Numicon Shapes. Familiarisation with the Numicon Shapes, their features and order remained a consistent focus in all sessions. In whole-class or group teaching situations, the focus was on working through practical activities using Numicon materials.
- Educators generally progressed through the cards in the Activity Groups section of the teaching guides in the suggested order, to ensure that the firm foundations of the Numicon Approach were laid and developed.
- Most educators developed a weekly cycle, with the first day used to introduce and demonstrate concepts and tasks. This was followed by pair or independent work by students to reinforce the task. On the second and subsequent days, the students who had demonstrated understanding of the activities were set a further challenge or investigation task. The students whose understanding still required consolidation were rotated in small groups and assigned a range of activities or games for further practice. The teacher moved between groups to promote conversation and encourage students to explain their thinking and understanding.
- As all classrooms had an IWB, the Numicon software was available to all classes. Classroom teachers indicated that the software allowed them to introduce activities, demonstrate the use of equipment and check for understanding. This helped teachers determine which students required greater assistance with tasks or 1:1 instruction with the class teacher or the SSOs. The IWB software was also used at the conclusion of the lesson to check for misconceptions and to share learning.
- SSOs supported students and small groups requiring further assistance with the tasks.
- Teachers were encouraged to access support resources already developed and provided by Numicon through the OUPANZ website www.oup.com.au/numicon.

Data Collection

Student achievement data for all Year 1 students was collected *using I Can Do Maths (ICDM) – Test A*. This orally administered test was selected because it provides an overview of maths achievement referenced with Australian norm samples. Stradbroke School Students in Years 2–7 complete the *Progressive Achievement Test in Mathematics (PAT Maths)* in March each year. Scale scores for *ICDM* and *PAT Maths* allow for achievement to be compared as students progress through school.

The test is administered in March each year following the test conditions described in the *I Can Do Maths* manual. This data set is used to identify students who require additional support. In 2013, a maths group intervention program was introduced and students were identified for this program based on their *I Can Do Maths* results and the Numicon Assessment Signposts data.

Data Set

A comparison was made between the results of the *I Can Do Maths – Test A* for Cohort 1 and Cohort 2 students.

Cohort 1 (Year 1 students in 2012) had no prior use of Numicon and were used as the control group for this project.

Cohort 2 (Year 1 students in 2013) had been supported by the use of the Numicon teaching program for one school year. This cohort included the four Reception classes in the Numicon Pilot Project in 2012.

Fig 3. Cohort numbers for 2012 and 2013

Cohort	Level	Year	Test	No. of students	Boys	Girls	NEP*
Cohort 1 (without Numicon)	Year 1	2012	*I Can Do Maths –Test A*	93	51	42	3
Cohort 2 (with Numicon)	Year 1	2013	*I Can Do Maths –Test A*	78	35	43	3

** NEP – Negotiated Education Plan, students identified under the Students with Disabilities Policy (2006)*

A comparison was made between the results of the *I Can Do Maths – Test A* for Cohort 1 and Cohort 2 students. The students were assigned *ICDM* stanine scores based on their results. A table with *ICDM* stanine descriptors and their average distribution rates can be found below.

Fig 4. *ICDM* Stanine table with descriptors and average distribution rates

Stanine	Descriptor	Distribution (Bell curve)
9	Very High	4%
8	High	8%
7	Above Average	12%
6	Average	16%
5	Average	20%
4	Average	16%
3	Below Average	12%
2	Low	8%
1	Very Low	4%

Findings

The key findings from the data and teacher questionnaires are as follows:

1. Students who had been supported using the Numicon Approach teaching program during the period of the pilot project (Cohort 2) showed a dramatic improvement in attainment in the *I Can Do Maths – Test A* in comparison with the results of the previous cohort whose learning had not been supported by Numicon (Cohort 1).

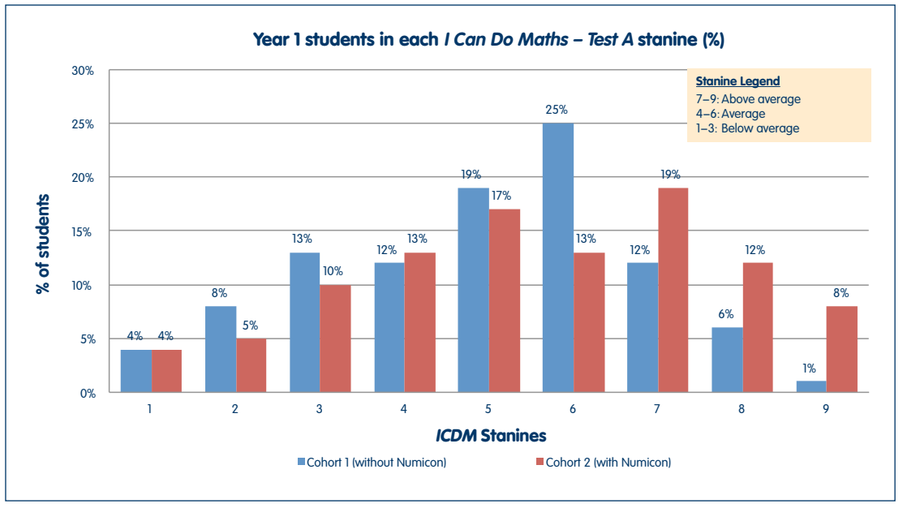

Fig 5. Percentage of Cohort 1 and Cohort 2 students in each stanine of the *I Can Do Maths – Test A*.

Comments:

a) 39% of students in Cohort 2 achieved above average, high or very high scores in comparison to 19% of Cohort 1.

b) Only 19% of Cohort 2 achieved below average to very low scores in comparison to 25% of Cohort 1.

c) 82% of Cohort 2 were considered to be average or above in comparison to 75% of Cohort 1.

d) 20% of Cohort 2 had high or very high scores in comparison to only 7% of Cohort 1.

2. Boys in Cohort 2 showed the biggest improvement in attainment in comparison with the boys in Cohort 1.

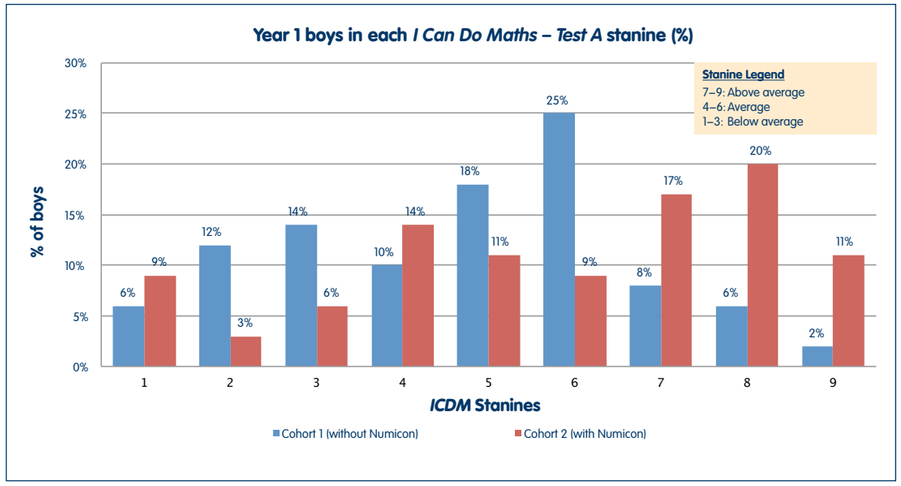

Fig 6. Percentage of Cohort 1 and Cohort 2 boys in each stanine of the *I Can Do Maths – Test A*.

Comments:

a) 48% of boys in Cohort 2 achieved above average to very high scores in comparison to 16% of boys in Cohort 1.

b) Only 18% of boys in Cohort 2 achieved below average to very low scores in comparison to 30% of boys in Cohort 1.

3. Educators noted improvement in the progress of all Cohort 2 students in comparison to the Cohort 1 students. In particular, Cohort 2 students relied less on using their fingers for adding on, and began to use, make and write numbers earlier than Cohort 1 students. On the whole, Cohort 2 students developed greater speed in 1:1 correspondence and in adding and subtracting using whole numbers. Cohort 2 students were also more willing to trust the count and had stronger understanding of place value than Cohort 1 students.

4. All students enjoyed using the equipment and educators commented that the hands-on, multi-sensory approach supported the boys in particular in gaining greater confidence as their understanding grew.

5. All educators agreed that the teaching guides, Numicon Shapes, Numicon Number Lines and other equipment that assisted students to develop visual imagery and patterns, such as the Feely Bags, Numicon Baseboards and Pegs, were a key component to student improvement.

6. The Numicon Assessment Signposts were useful for on-going assessment to show gaps in learning and identify those students requiring individual support.

7. The Numicon professional development program was seen as a valued and integral component of the project. It provided educators with the theory underpinning Numicon, along with its practical application – both of which were considered vital for the successful implementation of the program. Educators felt supported and confident to start using Numicon in the classroom.

Moving Forward

The success of the pilot project has resulted in Stradbroke School committing to training and resourcing the implementation of the Numicon Approach into all Year 1 classes from 2013. In addition to this, a group intervention program based on the Numicon Approach began in 2013 and will run for four mornings each week. This program will be reviewed and improved each year. The training of SSOs within the pilot project provides the school with opportunities to incorporate the Numicon Approach when supporting older students, especially those with misunderstandings of place value and difficulties with automaticity of number facts.

References

ACER Press (2005). *Progressive Achievement Tests in Mathematics (PAT MATHS) 3rd Edition.* Melbourne: ACER Press.

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Doig, B., & de Lemos, M. (2000). *I Can Do Maths. Teacher's Guide and Test Booklets Level A.* Melbourne: ACER Press.

For further information about Numicon resources or to register your interest to attend a Numicon Professional Development session go to:

oup.com.au/numicon

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About the author

Julie Baillie is the Education and Professional Development Manager for the Primary Division of Oxford University Press, Australia. Julie was trained by members of the team involved in the original Numicon research in the UK and subsequently accredited as the Australian Numicon Trainer. She manages the Numicon program Australia-wide.

Prior to joining Oxford University Press, Julie was an early years educator with the South Australian Department for Education and Child Development. With over 20 years of experience in classrooms and schools, Julie has worked at school, district and state levels. She has written curriculum support documents and led curriculum projects with school leaders to implement strategies to improve literacy and numeracy in schools.

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Published in Australia by
Oxford University Press
253 Normanby Road, South Melbourne, Victoria 3205, Australia