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Moving on from Count Me In Too: Evidence-based teaching and learning in numeracy in the early and middle years of schooling



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Her day-to-day facilitation work is focused on the numeracy professional development of practicing teachers, is student-centred and predominantly classroom-based.



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Marilyn Holmes is an Adviser in Mathematics at the Dunedin College of Education. Mrs Holmes holds a Masters in Science from Curtin University of Technology and is currently working on her doctoral studies.

She is a highly experienced primary teacher, having taught children aged from 5 to 13 years in many different types of schools in every decade since the 1960s.

Mrs Holmes has been a Senior Lecturer in Mathematics Education at Auckland College of Education, 1997–2001 and has also lectured in several curriculum areas at the Dunedin College of Education, 1994–1996.

She is one of the original group of lecturers, mathematics advisers and Ministry personnel who developed the idea that grew into the Numeracy Project as it is today. Mrs Holmes has contributed further as a facilitator for the project pilots since 2000: Count Me In Too Project, Early Numeracy Project, Advanced Numeracy Project, and Intermediate Numeracy Project.

She continues to inform the development of the project through her involvement in teacher professional development as well as contributing to teacher resources: Ministry of Education numeracy booklets, 'Figure It Out' booklets and the New Zealand Mathematics web site.

New Zealand developed the Early Numeracy Project for Years 1–3 in 2000–2001, based on the New South Wales' Count Me In Too, and much has happened in mathematics education since. Change is inevitable and numeracy has moved on. Today the New Zealand Number Framework, the Diagnostic Interview and Teaching Model now underpin numeracy teaching practice in over 14,000 classrooms from Year 1–9.

Important developments to date have included a flexible national database and web site, well-developed supporting materials and data-rich annual evaluation reports which inform future direction and expectation of achievement. Because the Numeracy Project is evolving, further development and consolidation will continue.

This paper gives a brief background to the Numeracy Project and outlines, through a story, how evidence-based teaching is an integral part of classroom practice.

Introduction

Change is inevitable in education. As New Zealand pushes towards its goal of a knowledge based economy the impact is on a teaching community where change is not carefully drip fed but is geared towards an accelerated pace. Managing change becomes an issue that is imposed on teachers who generally regard it with trepidation or uncertainty. Mesnik (2004) writes that "practically all forms of human behaviour involve decision making under the supervision of a mysterious guide – uncertainty".

How can teachers then be certain that they are making the best decisions for

children's learning in mathematics? It is especially hard when their professionalism appears to be undermined by statements such as "...transition to evidence based practice has yet to occur in education...this is despite there being millions of studies that move education beyond craft and opinion" and "many of those outside education find it hard to believe, after a century of scientific and technological progress... that the primary aim of teacher education is to reproduce rather than to improve existing teaching practice" (Hattie, 2003, p12). Shulman (1989) gives credence to teachers by acknowledging "their accumulated wisdom of practice which in many cases is as important a source of guidance for practice as the theory or empirical principles".

Experienced teachers are not to be underestimated; they have a wealth of knowledge. The sample they draw their evidence from is the hours, the months and the years they spend with several hundreds of children. The New Zealand Numeracy Project helps teachers to manage the inevitable changes, allay their uncertainties, challenge their beliefs and at the same time create an environment where teachers feel a certainty about their professional judgments for children's learning (Higgins, 2001, 2002, 2003; Irwin, 2002, 2003; Thomas & Tagg, 2004; Thomas, Tagg & Ward, 2003; Thomas & Ward, 2001, 2002).

Background

The New South Wales Department of Education and Training initiative Count Me In Too (Years 1-3 children) provided a well researched base from which to develop the New Zealand Numeracy Project. Following a successful pilot of Count Me In Too in 2000, the Early

Numeracy Project, was implemented into New Zealand schools in 2001. Milestone Reports and Evaluations have annually documented evidence from teachers, facilitators, researchers and policy analysts and have continued to inform further development of the Numeracy Project. It must be stressed that this is not a static project; it is an evolving discipline. Today the project includes work in schools for Years 1-8 children; a growing secondary component for Years 9-10; Te Poutama Tau an initiative in Maori; and supporting material (refer www.nzmaths.co.nz for further information).

Facilitators, principals, and teachers are interdependent in effectuating the successful implementation of the Numeracy Project. Schools are encouraged to either work in the project by syndicates or as whole school professional development. Having several teachers involved at once means the commitment is easier to maintain, through the support they give each other. Built into the contract between the Ministry and the school is an obligation from the principal to participate in initial workshops, with a moral responsibility to lessen the workload of teachers by engaging in one major professional development; the Numeracy Project.

Key aspects

Three aspects have been named as pivotal to the Numeracy Project; the teacher development programme, framework and diagnostic interview (Young-Loveridge, 2004). However, it could be argued that the teacher development programme is the cocoon around the framework, diagnostic interview and the teaching model (Holmes & Tozer, 2004). The triangulation of these three, form a strong core for the teaching learning process. The interview provides the teacher with the child's

existing knowledge and strategies 'what do they know', the framework gives the direction 'where am I taking them' and the teaching model gives the vehicle to make connections between the process of teaching and the child's process of learning 'how will I get there'.

The New Zealand Number Framework has two main sections: knowledge and strategy. The dichotomy is for teaching purposes and to focus teachers on teaching strategic thinking through the teaching model. It is the strategy framework that requires teachers to reflect on their beliefs about how children learn and what children know about number concepts. The *Strategy* section describes the mental processes children use to solve operational problems with numbers. It consists of a sequence of nine global strategy stages (see Figure 1) with three operational domains: addition and subtraction, multiplication and division and proportions and ratios.

Counting strategies

0. Emergent

1. One to one counting
2. Counting from one on Materials
3. Counting from one by Imaging
4. Advanced Counting

Part-whole strategies

5. Early Additive
6. Advanced Additive
7. Advanced Multiplicative
8. Advanced Proportional

Source: Ministry of Education, 2004

Figure 1 The number framework

The *Knowledge* section describes the key items of knowledge that students need to learn to provide the foundation for strategy development and consists of five aspects; numeral identification, number sequence and order, grouping/place value, basic facts and written recording.

Data collection

The gathering of data and subsequent analysis are 'part and parcel' of the Numeracy Project. The assessment tool is an individual task-based oral interview in which carefully sequenced questions are couched to elicit a variety of responses. Teachers are supported with their first diagnostic interviews by their facilitators who coach teachers in the use of the tool and in clarifying their understandings of children's thinking about number. Ongoing formative assessments can be complex but for an empowered teacher who knows, understands and applies the detail of the number framework to daily interaction and observation these are made simpler.

A characteristic of good data is its potential to help teachers make good decisions about children's learning. Data tell a story. Each Diagnostic Interview provides the classroom teacher with immediate and detailed information about the child's number knowledge and mental strategies and allows behavioural observations to be made in response to the oral questions.

Understanding data and actions for improvement

The two questions uppermost in teachers' minds should be: What does it all mean and; how can we use it to improve children's achievements?

A cameo involving one child is used to show how data could be understood and acted upon. Joanne is representative of many Stage 4 (Advanced Counting) children and it is through her data that we trace her journey and what it means for her.

Joanne's story

Joanne has transferred to Kapai School at the beginning of her fifth year at school. In her interview, her teacher notes that although Joanne is normally outgoing and confident, she is now tentative in her responses and has difficulty explaining her thinking. Her interview data show:

Strategies knowledge

Add/Sub Mult/Div. Prop/Ratios FNWS BNWS
Frac. Grouping/PV Basic Facts
Stage 4 4 2-4 4 4 2-3 4 4

Data interpretation gives a simple clear profile statement. With reference to the Number Framework, what strategies in the three domains did Joanne show that placed her at Stage 4? To solve the single digit addition problem $8+5$, Joanne counts on from 8, saying 9, 10, 11, 12, 13. She keeps track on her fingers. The problem $37-9$ is solved by counting back on her fingers, however in crossing the decade, 30 is omitted and her answer is 27. Counting on or back from the biggest number is her most advanced addition and subtraction strategy. Her response to a multiplication problem presented as an array, brings out fingers again as she skip counts the rows in 5s. To solve the simple problem $_$ of 12, she shares out the beans one by one into three piles, and answers 4, voiced as a question. Joanne looks to the teacher for confirmation for many of her responses.

Knowledge data show that Joanne can read and sequence numbers both forwards and backwards up to 100. Numbers bigger than this prove challenging. She has already shown that her backward counting over the decade is not secure. She is unable to recognize common unit fractions. Her place value knowledge is limited to knowing how many tens there are in numbers to 100 only. She appears to know basic facts to 10, her doubles to 20 and teen numbers.

The teacher looks to the Number Framework to provide specific identifiable learning steps when planning for Joanne's needs. The analysis of one short line of data show that, for Joanne, as a Year 5 child, these results are cause for concern because at Kapai School 80% of the children, at the beginning of Year 3, are Stage 4 in addition and subtraction. Behavioural observations show Joanne's hesitancy, the use of fingers, her need for reassurance, slow responses and the absence of mathematical language to explain her thinking. It would suggest that the power of the face to face interview cannot be overstated when compared with a silent pen and paper test.

Joanne's class

At a class level the results of individual interviews provide substantial diagnostic assessment information. There are 28 children in Joanne's class. Each set of individual's data contributes to a detailed class profile, part of which is in Figure 2.

The diverse range of children's numeracy needs as evidenced by the data cannot be ignored. The challenge is for the classroom teacher to plan a classroom programme in response to the highlighted strengths and weaknesses in student knowledge and strategies. To effectively manage a

Biographies					Strategies					Knowledge				Edit	
Name	DOB (dd/mm/yyyy)	Year	Ethnicity	Gender	Add Sub	Mult Div	Proport	FNW S	BNW S	Num ID	Fraction	Place Value	Basic Facts	Status	Action
Tom	10/05/1996	5	Maori	m	4	4	2-4	5	4	na	2-3	4	4	Active	Edit 186825 Room 5
Tara	1/10/1995	5	NZ European	f	6	6	5	6	6	na	5	5	5	Active	Edit 186829 Room 5
Tim	21/03/1996	5	Maori	m	5	5	5	6	6	na	5	5	5	Active	Edit 186830 Room 5
Tania	18/12/1995	5	NZ European	f	5	6	5	5	5	na	5	5	6	Active	Edit 186833 Room 5
Tina	3/02/1996	5	NZ European	f	5	5	4	5	5	na	4	5	4	Active	Edit 186837 Room 5
Travis	18/05/1996	5	NZ European	m	4	4	2-4	5	2	na	2-3	4	2-3	Active	Edit 186840 Room 5

Figure 2

response to this data, children are grouped according to their strategy stage. Joanne joins five others from her class for accelerated learning of part-whole thinking strategies taught through the numeracy teaching model; using materials, using imaging and using number properties. Research indicates the importance of including children in their learning (Alton-Lee, 2003; Askew, Brown, Rhodes, Johnson & Wiliam, 2002). Joanne's teacher does this by:

- discussing the learning intention of the lesson
- using open and high order questions
- allowing wait time for considered responses
- actively listening
- encouraging student to student conversations

- providing immediate scaffolding and feedback
- making connections to existing concepts
- stimulating metacognition and self assessment
- shared identification of next learning steps.

These teaching techniques are all part of the synchronicity of quality responsiveness to Joanne and what her data tell us. Intuitive and informally collected evidence informs the next teaching step for the experienced teacher. However, "the intuitive and implicit" must be "made explicit" to the children (Timperley & Parr, 2004, p69). Therefore, the teacher concludes the strategy lesson with Joanne's group in an informal and immediate student self

assessment. The teacher shares her observations, and a clear direction for the next lesson is openly discussed and understood by all parties.

Joanne's school

Management at Kapai School has made it clear that teachers will gather valid and consistent diagnostic and formative data throughout the year so that a detailed school-wide numeracy picture emerges. Problem-solving discussions can now focus on the story told by data. From a close analysis of trends, achievement targets will be set and these are critical to informing the direction for future staff professional development. Alton-Lee (2003), in her best evidence synthesis of quality teaching states that "the gathering and

analysis of high quality student achievement data and the use of externally referenced benchmarks have been found to be powerful tools in bringing about changes in teacher practice that facilitates higher achievement for students" (p19). Timperley's research in 2004 also found that significantly higher achievement was accomplished when syndicate and school staff meetings were focused on data analysis and discussing implementation issues arising from the evidence. In their study, Thomas and Tagg (in press) found that thirteen longitudinal schools, which set school-wide targets for numeracy and collected achievement information to rate performance, outperformed the six longitudinal study schools which did not.

Joanne's country

Kapai School results are entered into the national database located on-line. This database has been contributed to by all schools involved in the Numeracy Project since 2000. By the end of 2005 data on over 400 000 students will have been entered. The annual analysis of this data has provided a rich statistical source upon which Kapai School can base its numeracy achievement comparisons with a national picture. The database provides, by norm referencing, the capacity for Kapai School to compare, by year level and domain, the performance of its children with other schools of similar decile and with children of similar ethnicity or gender. The facility also allows Kapai to make in-school comparisons of its own progress from the beginning of the year, between years and over time. A strength of the database is the facility to transfer both group and individual student data from class to class and, in the near future

from school to school. This ensures the continuity of student information for successive classroom teachers.

A national numeracy story is the last which the data tell. The national trends and patterns revealed in the data (Christensen, 2003; Higgins, 2003; Irwin, 2003; Thomas, Tagg and Ward, 2003) continue to confirm that the Numeracy Project is having a significant positive impact on children's achievement and to inform expectations and practice for the school, in the classroom and ultimately, for the child.

Conclusion

It is clear that data tell stories for all; the child, the teacher; the school, the parents and the nation. Without informed analysis or in fact "interrogation" of data and a precise understanding of the story it tells, little or moderate impact will be made on children's achievement. The data provides the base for constructive management of the implicit complexities of teaching in a dynamic classroom. "There is impartiality about achievement data if it is handled legitimately and that, unlike a person expressing an opinion, data is an objective messenger that is hard to shoot" (www.nzmaths.co.nz/numeracy/Lead_Teacher).

Never before have we had such a complete picture of a child's mathematical understandings of number (A. Robertson, personal communication, May 26, 2005). Nor have teachers had the opportunity to be certain and confident that they can and are, making a significant impact on children's achievement.

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