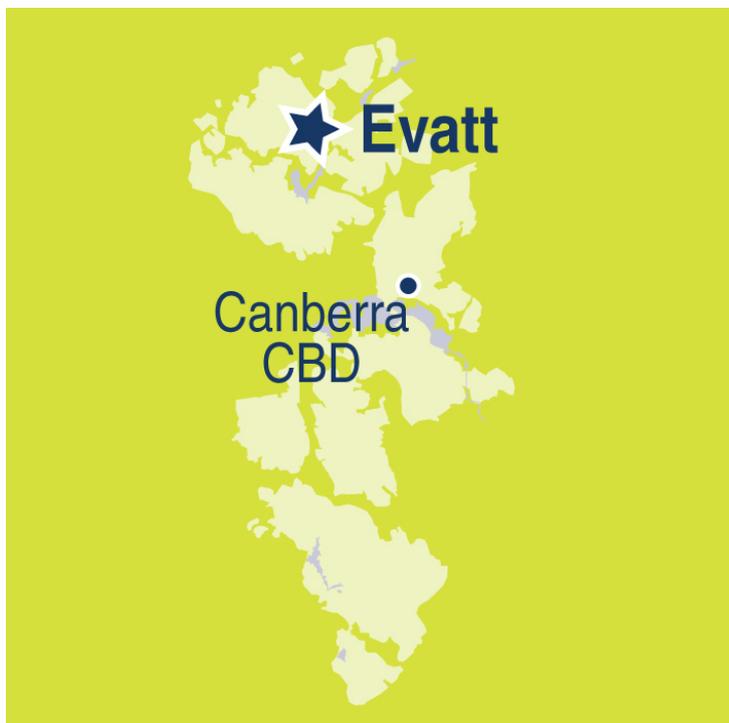




teach
learn
share

Using visual tools to assist low achievers with mental computation

- > [Summary](#)
- > [Target student group](#)
- > [Method](#)
- > [Results](#)
- > [Lessons learned](#)
- > [Next steps](#)
- > [Research base](#)
- > [Further reading and links](#)
- > [Contacts](#)





teach
learn
share

Summary

To what extent does student choice about visual tools improve students' strategies for mental computation?

Student outcomes are affected by the choice of visual tools made by the teacher. Children achieve greater accuracy when they can make their own selections. The focus of this strategy was to determine which visual tools assisted low achievers with mental computation. The strategy also identified the tools that students relied on to assist them with mental computation.

The strategy provided feedback to staff and aimed to encourage teachers to incorporate similar methods of teaching and learning into their mathematics lessons.

Feedback from teachers who implemented the strategy indicated that the use of visual tools (open number lines, ten-frames, story boards and tactile equipment) enhanced student understandings of mental computation. The ability to choose visual tools improved student performance as this led to growth of student confidence when performing individual tasks. The teaching tool that most enhanced student performance was the story board. It was also the preferred choice for all the students.

While this is a small case study, the outcomes of the initiative provide impetus for replication with other children whose NAPLAN results are below the national minimum standard.

Target student group

St Monica's Primary School is among the larger Catholic primary schools in Canberra, enrolling more than 460 boys and girls, with two or more classes in each year from kindergarten to year 6.

The strategy targeted year 4 students and their teachers in the metropolitan area of Canberra. Students were selected because their NAPLAN results were at or below the national minimum standard.



Method

In 2011, testing and teacher observations indicated that the children were struggling with the application of mental computations throughout all aspects of their mathematics. Two teachers had indicated an interest in implementing a program to enhance the mental computational ability and engagement of the students during class. Of particular concern were the children who struggled to understand the concepts of Number. It was also felt that teachers often move away from visual tools to pen and paper before all students are ready for this change.

Two teachers and four students from year 4 and were involved in the implementation of the strategy. Students were selected from an analysis of their local assessments in mathematics and the results of NAPLAN testing (Numeracy) during year 3 at school. Pre-interviews were conducted to ascertain children's prior understanding in Number and number facts. Interview items were obtained from the Schedule for Early Number Assessment (SENA 2) (NSW Department of Education and Training 2003). Included were items on early arithmetical strategies, numeral identification, counting (by tens and hundreds), combining and partitioning, and place value.

The post-interviews and testing were designed to measure how successfully the structured program was implemented and the effectiveness of the use of visual tools, and to correlate more closely the purpose of each lesson. At the post-interviews, the oral SENA items were presented to each student individually in the same time frame as that used in the pre-test. In support of the oral test, a written test was also administered as some children perform better on a written test than an oral test.

The four visual tools (number line, ten-frames, think boards and Unifix cubes) selected to enhance student outcomes in mental computation were well chosen. Both teachers agreed that these particular visual tools would be effective in helping them to understand what the children were thinking and how the children employed the mental computation strategies. The children were very familiar with the four visual tools selected as they were tools used to teach Number. The children in each focus group chose their visual tools to show their thinking when engaging in mental computation. Funding of \$500 was spent on photocopying materials used during the program.



teach
learn
share

Alastair McIntosh's strategies approach (2005) provided an excellent guide for the sequence and structure of the lessons. Both teachers were aware of the excellent resource that was provided through McIntosh's approach and modules but neither had actually adopted his strategy sequence in their teaching.

The program consisted of structured lessons for 15 minutes each day, with a major focus on visual tools, strategy use and recording of children's thinking for five weeks. The structure of the lessons was developed from the pre-test in conjunction with teacher observations of the students made during the year. New learning was based on prior knowledge to promote confidence as well as a high level of success. The sequence of the lessons reflected students' existing knowledge, scaffolded with more complex strategies. The preparation and planning of the lessons, while time consuming, had an enormous impact on the success of the program.

Table 1: Lesson structure and focus

Months	Week 1	Week 2	Week 3	Week 4	Week 5
August / September	<p>Lesson duration: 15 minutes</p> <p>Focus: 2-digit addition: bridging multiples of ten</p> <p>Visual tool: IWB* – number-line worksheet – number line</p>	<p>Lesson duration: 15 minutes</p> <p>Focus: 2-digit addition: working from the left</p> <p>Visual tool: IWB – ten-frames worksheet – ten frames</p>	<p>Lesson duration: 15 minutes</p> <p>Focus: 2-digit addition: working from the right</p> <p>Visual tool: IWB – story boards worksheet – story boards</p>	<p>Lesson duration: 15 minutes</p> <p>Focus: 2-digit subtraction: bridging multiples of ten</p> <p>Visual tool: Unifix cubes blank worksheet for recording</p>	<p>Lesson duration: 15 minutes</p> <p>Focus: revision consolidation / assessment of concepts taught</p> <p>Visual tool: student choice of visual tool</p>

*IWB = interactive whiteboard



The teachers organised the lesson structure on the gradual release of responsibility model of teaching. This method was proving to be an effective teaching model in the classroom. Each day the lesson commenced with a brief revision of the previous day's lesson and new learning was constructed on that prior learning. Throughout the lessons the children engaged in dialogue with each other about their learning. Children's conversations were recorded and have been pivotal to an internal evaluation of the strategy.

Results

All students progressed from medium levels of achievement to high levels of achievement in most aspects of the SENA 2 oral test.

Overall the children demonstrated:

- significant progress with numeral identification working from 2-digit to 4-digit numbers
- substantial improvement in the use of number-facts strategies, including counting by tens off the decade
- substantial improvement in their application of multiplication and division facts, even though multiplication and division were not the focus of the strategies employed
- less reliance on using fingers to count, and more tasks completed mentally with some tasks answered spontaneously.

Feedback from both teachers indicated that the use of visual tools (open number line, ten-frames, story boards and tactile equipment) certainly enhanced student understandings of mental computation. The ability to choose visual tools improved student performance as this led to a growth in student confidence when performing individual tasks. Both teachers agreed that the student preference for visual tools gave them insight into how individual students can enhance their performance.

It is evident that by using a structured program of strategies the students were able to develop their understandings and application of number sense, which also improved their performance and overall achievement. The emphasis on students being able to visualise their answers before they were introduced to symbolic strategies proved invaluable to their learning.



‘This project could be successfully conducted anywhere from kindergarten to year 6. The case studies mentioned above and others cited in the research project clearly indicate the success of similar projects. Alistair McIntosh’s mental calculation strategies are well researched and relevant to all primary students.’

Lessons learned

Results of this research project highlight the importance of students having an input into which visual tools are used in the classroom to assist with their learning. Importantly, teachers need to tailor instruction to the individual needs of learners and provide students with exposure to a repertoire of options when teaching mental computation strategies. Student performance was enhanced when students were given choice of the visual tool and flexibility with strategy choice. The teaching tool that most enhanced student performance was the story board. It was also the preferred choice for all students. One student commented that it was the only device he could use in mathematics that utilised his love of literacy to help improve his mathematics.

For all students, modelling and visualising strategies with each visual tool was useful as it provided them with the confidence to be able to complete the tasks, experiment with each visual tool and make decisions about their preferred choice of visual tool. Of significance was the reluctance of the children to use tactile equipment because they didn’t want to become dependent on such equipment as they are unable to use it in formal test situations such as NAPLAN.

McIntosh’s strategies approach to teaching mental computation, which was used in the structured program and during interviews, benefitted the students. The strategies approach helped teachers to plan activities sequentially for specific areas and to develop students’ understanding of their application of number sense. McIntosh’s (2005) suggestion that the introduction of written algorithms be delayed was certainly beneficial to the students.

Next steps

These findings have great implications for future teaching. Teachers would benefit from the provision of professional learning time to read relevant literature, and to prepare and structure lessons based on student need in this area of numeracy.

‘One teacher recognised the over emphasis she had placed on teaching algorithms and realised that the students did not need to know how to do these to be able to solve a mental calculation.’



teach
learn
share

‘The think boards help me because I can’t really make any errors with them because if you do, you have three other ways of doing the mental calculation in each of the sections. So if you make a mistake you can see straight away because your answers are not the same.’ (Student)

‘I still find the story the best because when I make up a crazy story to go with the mental computation that I am doing it is a good way of bringing the mental computation to life. So as you are working out an answer you can think about it by relating it to objects.’ (Student)

Research base

Lewis (2004) suggested teachers should be encouraged to use a range of manipulatives and visual models such as open number lines, ten-frames and hundred charts to develop students’ numeracy skills, concepts and understandings. By listening to others, children can reflect on alternative solutions to a problem and the teacher has the opportunity to introduce strategies that may not have been raised spontaneously. In terms of this project, a range of visual tools to support the learning were scrutinised and participating teachers decided that number line, ten-frames, story boards and tactile equipment would be used throughout the project.

Yang (2005) mentions that using writing in mathematics assists students to support their thinking as they reflect on their work and explain their thinking about the ideas developed in the session. Not all children find mathematics easy. For children who are more literate, the story board is an excellent device when solving mental computations as it is an exceptional medium for scaffolding children into mathematical thinking.

Heirdsfield (2003) and Klein and Beishuzen discovered that children who used their own mental computation strategies and had greater flexibility in the use of their mental computation strategies, were more able to understand how numbers work, acquire a deeper knowledge in dealing with numbers, develop number sense, have a higher rate of success and were more confident in their ability to make sense of number calculations.

Heirdsfield (2005) highlighted the benefits of developing students’ mental computation with a group of year 3 students. Teaching was focused on developing mental strategies for 30 to 45 minutes, once a week, for ten weeks.



Ross and Frey (2009) described a gradual release of a responsibility model of instruction as a framework for effective instruction. In this model, explicit teaching in demonstrated and shared learning is followed by guided learning in which the teacher supports the student to use the strategies until they become independent and take the lead in their learning. The teachers at St Monica's Primary School adopted this model of instruction to teach the children in mathematics.

Downton (2006, p 21) emphasised that the choice of task is crucial and teachers 'need to consider the "level" of understanding that children are at and choose tasks that are going to extend them beyond this level'.

Irons (2001, p 25) identified that 'discussion and novel thinking are easily generated when situations are used that are of interest to children. Contexts such as money or food encourage children to describe strategies and explain thinking ... children see their personal experiences are important and valued by others'.

Hodge et al (2007, p 393) reiterate that Dewey's ideas have been of assistance as they explain interests as something that individuals can nurture rather than qualities that are innate features of people: 'Students' current interests act as leverages from which students' content-related interests could be developed'.

Further reading and links

Downton, A 2006, 'Making mathematics exciting for reluctant learners', *Prime number*, vol 21, no 1, pp 20–6.

Heirdsfield, A 2001, *Integration and compensation in accurate mental computation*, MERGA, pp 292–99.

Heirdsfield, A 2002, 'Mental methods moving along', *Australian primary mathematics classroom*, vol 7, no 1, pp 4–8.

Heirdsfield, A 2003, 'Spontaneous mental computation strategies', in N Pateman, B Dougherty & J Zilloux (eds), *International group for psychology of mathematics education*, Honolulu, pp 55–62.

Heirdsfield, A 2005, 'One teacher's role in promoting understanding in mental computation', *Psychology of mathematics education*, vol 3, pp 113–20.



Heirdsfield, A, Dole, S & Beswick, K 2007, 'Instruction to support mental computation development in young children of diverse ability', in Peter L Jeffery (ed), *Australian association for research in education conference*, 26 November – 30 November 2006, Adelaide.

Hodge, LL, Visnovska, J, Zhao, Q & Cobb, P 2007, 'What does it mean for an instructional task to be effective?' in J Watson & K Beswick (eds), *Mathematics: essential research, essential practice* (Proceedings of the 30th annual meeting of the Mathematics Education Research Group of Australasia, vol 1, pp 392–401) MERGA, Hobart.

Irons, CJ 2001, 'Mental computation: how can we do more?' *Teaching mathematics*, vol 26, no 1, 22–6.

Klein, T & Beishuizen, M 1994, 'Assessment of flexibility in mental arithmetic', in JEH Van Luit (ed), *Research on learning and instruction of mathematics in kindergarten and primary schools*, pp 125–52.

Lewis, E 2004, 'Mental computation: getting the right balance', *Square one*, vol 4, no 4, pp 2–12.

McIntosh, A 1998, 'Teaching mental algorithms constructively', in LJ Morrow & MJ Kenney (eds), *The teaching and learning of algorithms in school mathematics, 1998 yearbook*, NCTM, Reston, VA, pp 44–8.

McIntosh, A 2004, 'Developing computation', *Australian primary mathematics classroom*, vol 9, no 4, pp 4–9.

McIntosh, A 2005, *Mental computation: a strategies approach. Module 1 – introduction*. Department of Education, Hobart.

NSW Department of Education and Training 2003, *Count Me in Too, Professional Development Package*, Professional Support and Curriculum Directorate, Sydney.

NSW Department of Education and Training, 2003, 'Quality teaching in NSW schools: A discussion paper', (20 May 2007).

NSW Department of Education and Training, 2012, '[Number sense and mental computation](#)', (21 May 2012).



teach
learn
share

Ross, D & Frey, N 2009, 'Learners need purposeful and systematic instruction', *Journal of adolescent & adult literacy*, vol 53, no 1, pp 75–8.

Sousa, D 2008, *How the brain learns mathematics*, Sage, California.

Yang, D 2005, 'Developing number sense through mathematical diary writing', *Australian primary mathematics classroom*, vol 10, no 4.

Contacts

St Monica's Primary School, Evatt, ACT

Email: office@stmonicas.act.edu.au 