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Changing the culture: a numeracy tutorial program

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Summary

Students with persistent difficulties led to whole-school change in the teaching of Maths.

Carey Baptist College, Perth, is a metropolitan coeducational college catering for K–12 students. At the start of 2008, mathematics was a major priority for the college. Despite support programs for both underachieving and gifted students, NAPLAN results indicated that there was a need to improve student learning. A target was set: an 80 per cent class average understanding of critical concepts in Measurement and Number strands across the school.

By the end of Semester 2 2008, it became clear that the target was not being met. A different strategy was needed; one that would address individual student needs, raise teacher understanding of specific maths concepts and how best to teach them, and provide ongoing support for and development of teachers' professional learning. This was the basis for the development of the Numeracy Tutorial Program, with funding initially provided through the National Partnership for Literacy and Numeracy.

The Numeracy Tutorial Program was built on data made available through a Numeracy Assessment Tool developed by Wendy Devlin, Carey's Maths Curriculum Coordinator, to identify students who needed to improve their understanding of specific concepts in preparation for class Maths lessons. The data revealed students who were below, at or above the standard each semester, for each year level, enabling all students' needs to be identified.

The Maths Tutor planned collaboratively with teachers to ensure students were given appropriate in-class support or guidance to achieve – or to advance beyond – the standard indicated by the data. A withdrawal tutorial program was implemented to replace previously held weekly support classes for low-achieving students. The withdrawal program provided one or two tutoring sessions for these students to ensure they understand the required concepts before they return to the class lesson.

As well as the withdrawal–tutoring component, teachers are provided with a range of ongoing professional learning focusing on content pedagogical knowledge, such as the 'specificity of teacher learning as it applies to the concepts, ideas, topics, and skills required of students' (Sykes 1999).

Through the Numeracy Tutorial Program, teachers have become aware of the specific mathematical conceptual needs of their students; are able to make professional judgements about students' performances; and become strategic in their implementation of the Australian Curriculum in Mathematics.



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Target student group

The program was implemented with K–6 students at Carey Baptist College in Harrisdale, a suburb of Perth, Western Australia.

Method

The need for a new numeracy program

'Students do misunderstand ... it's not because they cannot understand, it's because they understand something else.' (David Tripp 1993)

At the start of 2008, mathematics was a major priority for the Primary School at Carey Baptist College. The Mathematics Curriculum Coordinator (MCC), a co-author and professional trainer in *First Steps in Mathematics (FSiM)*, had delivered the FSiM Number Professional Development Course in 2007 to K–6 class teachers. She was familiar with the field of 'misconception research', which revealed that students fell behind because they had various misconceptions, *not* because they were incapable of understanding the mathematics. While FSiM had helped teachers to diagnose these misconceptions and guide students to rebuild concepts, the time required made it difficult for teachers to complete the curriculum. Even with additional support, the MCC tutoring underachieving students, and programs for gifted and talented students, the 2008 NAPLAN results did not show improvement.

So the MCC developed a new assessment tool that would guide teachers to the critical concepts underpinning the Western Australian Statements of Learning for Number and Measurement. The results from the new assessment tool supported the FSiM findings: that students at all levels have misconceptions that hinder future progress. However, the results led to the replacement of some teacher judgements – which often meant incorrectly assuming that a student with the right answer understood the underlying concept – with the ability to identify misconceptions and better plan for strategic conceptual development for all students. This was formalised through the Carey Baptist College WA Numeracy Implementation Planning Cycle.



The Numeracy Implementation Planning Cycle

Teachers implement the following cycle at the end of Semester 1 each year.

1. **Assess:** class is assessed using the Diagnostic Resource for Assessing Mathematics (DRAM).
2. **Record:** Teachers enter assessment data on an Excel spreadsheet.
3. **Analyse:** Teachers use data for reporting to parents; year-level teachers collaborate to identify gaps in curriculum, gaps in individual student's conceptual knowledge, students working above the class level, continuity from each student's previous year's results.
4. **Plan:** Year-level teachers and the Maths Tutor plan programs to identify students who need tutoring in underlying concepts; identify students working above year-level concepts; select a sequence of conceptual learning; and identify gaps in resources and professional learning.
5. **Teach:** Class Teachers teach and develop concepts. The Maths Tutor works with students to construct or reconstruct concepts until they are understood, and works with students who are above class level to extend their understanding of the concepts covered in the class program. The tutor also works in class with teacher or withdraws students who request further tutoring.
6. **Practise and evaluate:** Students practise and apply concepts using teacher-designed examples and a range of resources; teachers apply concepts in cross-curriculum areas; tutors assess progress.
7. **Select next focus:** Teachers and the Maths Tutor select the next conceptual focus and maintain fluency in this concept and those previously addressed.
8. **Analyse:** Repeat Step 3.

At the end of Semester 2, teachers again administer whole-class assessment, mark and record data on Excel, analyse and use data for reporting to parents and the following year's teachers. They also compare data for Semesters 1 and 2 and evaluate 'value added' for each student; compare data with the last NAPLAN results; and liaise with next-year's teachers in a formal F-7 handover of data and work samples. (Years 6-7 is middle-school transition.)

'Diagnostic Resource for Assessing Mathematics (DRAM) and the tutorial program focus on the abilities of each individual child and give me the exact entry point to plan my lessons, review concepts and identify which children need some small-group work to enhance their understanding and build automatic responses. I am now more confident that the children have the necessary knowledge base and I now extend them further in their maths than I have done in past years. I've now got the data and I can see they are really ready to move on. I know what the data means and I am confident that it is valid.'

(Julie Crichton, year 2 Classroom Teacher)



Withdrawal tutorial sessions

All K–6 students were assessed and monitored according to the process outlined above. The model for students requiring short-term withdrawal tutorial sessions varied according to the year level and the student.

For students in years 3–6, this usually meant one or two tutorial sessions during which any misconceptions were identified and students worked with the tutor to rebuild their understanding of those concepts. Students were then ‘fed back’ into the classroom, where teachers monitored their understanding.

At years 1–2, it was found that each student’s current conceptual phase of learning – according to the FSiM Number Continuum – determined their ability to understand the concepts. Students who were identified as functioning at a phase behind the class were withdrawn for 30 minutes each day. This resulted in all students in these year levels reaching the same phase as their peers after one or two years.

Teachers also developed classroom strategies to identify students with misconceptions. They would ask questions such as: Who doesn’t get this idea? Who needs more time or help? This worked for most students, although occasionally one or two students didn’t realise that they needed help; they were so used to not understanding that they didn’t know it was possible.

‘The feedback I get from the DRAM gives me starting and continuing points for planning my lessons and for going over concepts and skills that the students need to have. The tutoring sessions have helped students who have ‘misconceptions’ understand concepts that have been taught in the classroom and bring them up to the level needed to move on. I have seen myself grow as teacher, as I’m now able to plan my lessons according to students’ needs.’

(Dolly Onamade, year 4 Classroom Teacher)

Professional learning

In keeping with the program’s principles, teachers are provided with a range of ongoing professional learning strategies from the Mathematics Curriculum Coordinator. The strategies focus on specific curriculum content and how students learn, linking teacher and student learning to maximise student outcomes. Professional learning support varies depending on the individual teacher, and includes:

- demonstration of strategies
- in-class collaboration
- using an extra teacher to guide individuals or small groups during the independent-learning phase of a lesson



- planning work programs
- collaborative analysis of student responses
- provision of professional reading
- training Educational Assistants to support students with special needs

Results

Student outcomes were judged by a range of local assessments, including the school-designed DRAM, interviews and NAPLAN results. Performance was also judged and recorded by teachers using in-lesson observations, students' work samples and post-lesson assessments. Teachers also observed changes in students' attitudes to mathematics.

'General comments about the maths 'climate' at the school:

- Peer tutoring is now occurring naturally among teachers and students.
- A large number of students now say Maths is their favourite subject.
- At the school Christmas concert, Foundation students were interviewed on stage about what they wanted for Christmas. Two out of five students wanted maths books! That's a good sign for the future of Mathematics.
- There is a buzz in the class when students realise a maths-tutoring session is next.'

Overall results

The Excel longitudinal data show whole-class and individual student progress and conceptual development in the school for every student from 2009 to the present. The table below shows the K–6 year level data for 2008–2011.

Table 1: Carey Baptist College Primary School data 2008–2011

Year	PP (Foundation)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
2008	68%	74%	56%	57%	59%	55%	57%
2009	75%	72%	66%	59%	64%	60%	62%
2010	75%	73%	51%	62%	56%	56%	74%
2011	79%	66%	84%	78%	77%	73%	67%



Before-and-after comparisons were made between subsequent cohorts of students over three consecutive years (2009–2011). Comparisons were also made between individual student's results over the three years.

Different teachers, same cohort of students: class averages over 3 years

End of K 2009 = 75%

End of year 1 2010 = 73%

End of year 2 2011 = 84%

Year 2 class, same teacher's data: class averages over 3 years

End of 2009 = 66%

End of 2010 = 51%

End of 2011 = 84%

The data show that year 2 teachers moved their class average results up nearly 20 per cent, from 66 per cent in 2009 to around 84 per cent in 2011, while other year levels gained around 10 per cent. At the end of 2011, the school's Foundation teachers had achieved their goal of 80 per cent of the Australian Standards in Number, Geometry, Measurement and Statistics and Probability strands.

The school has almost reached its goal of an 80 per cent average understanding of critical concepts underpinning the WA Statements of Learning. At the time of writing this document (end of Semester 1 2012), some year levels have already achieved a 60 per cent average towards achieving the National Standards, even though some of these standards are 12 months ahead of the previous Statements of Learning. The school has made a small shift: it is now above the state average, and above national averages in NAPLAN.

Lessons learned

There was a significant shift in the way teachers taught Maths. Initially, as teachers sought to develop their understanding, results for the first two years of the program were low. At the end of the second year, they were even lower than the first year in some classes (see **results in Table 1); this showed that students had understood less than 60 per cent of the year's course, and meant that the following year, teachers not only had that year's content to teach, but much of the previous year's content as well. It made the first three years very demanding.



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However, the involvement of the MCC in tutoring at-risk students created an environment where teachers work more collaboratively across year levels; this improves all student outcomes and enhances teachers' own learning. As well as teachers planning their teaching practice more strategically, peer tutoring is occurring naturally among teachers and students.

Students' enthusiasm towards Maths lessons also demonstrates the change in culture at Carey. As confidence grew during the program they became 'hungry to learn', even requesting tutoring at times. Over time, teachers and year 5 students suggested changes and rewrites to assessment items.

'A sample of questions and comments from low-achieving students:

- Hey, I'm quite good at this, aren't I?
- Why did I think fractions were hard? Is that all they are?
- I need more help, because I know the answers but I don't know why I know them.
- I can work out the answers, but I want to know without spending so much time working them out.
- Ask me another question! P-L-E-A-S-E!

Advice for other schools

Schools and individuals interested in implementing the program would need to contact Steps Professional Development to purchase the assessment tool. Use of the assessment tool requires very little introduction, enabling individual teachers and parents who have no FSiM background to easily use the tool, as the rubrics are very specific about the level of conceptual understanding evident in students' responses.

The assessment sets of the tool underpin the Australian Mathematics Curriculum Achievement Standards, and are available for individual, class and whole-school use. Trialling has included ESL and Special Education students, including students with 90 per cent sight impairment and dyspraxia. The Excel data record masters are part of the package.

Next steps

Initial funding was provided under the Smarter Schools National Partnership for Literacy and Numeracy. Total costs for the program came to \$15,740. The school administration reallocated funds so that the tutorial program continued after the National Partnership funds ceased. The costs of materials (assessment papers for each student) came to \$1500, which was covered by curriculum budget funds as part of normal expenses. The Maths Tutor is a vital component of the program and needs to be budgeted for.



Sustainability depends on the Administration supporting teachers to advance the students as high as they are able to go. At present, signs are good. Many teachers wanted to outline next year's curriculum in the last two days of non-contact time, based on the 2011 data they had during handover of student's files and data from 2011 to 2012.

The teachers and the MCC have continued to reflect on issues holding students at certain levels. New learning suggests that the curriculum and the tutorial program developed the concepts in all students, but it was not shifting the concepts from short-term memory to long-term memory for some students. This affected their ability to problem-solve, as they used up short-term memory on concepts rather than solving the problem. Teachers are currently trialling an explicit-teaching model – the Fleming Effective Teaching Model – as explained by John Fleming, at a seminar in May 2012. The school is also using a daily warm-up program from *Junior Elementary Maths Mastery and Elementary Maths Mastery* (Farkota 2010).

The MCC has worked together with classroom teachers to prepare a rewrite of the assessment tool aligned to the Australian Curriculum Mathematics Content Descriptors.

Research base

The Mathematics Curriculum Coordinator recognised the need for a new, more efficient approach that would help teachers develop 'a specific kind of knowledge of how to teach a subject and how to tap students' thinking about subject matter as the basis for continued teaching' (Shulman 1986). The MCC was influenced by growing evidence for an approach that simultaneously engages teachers in learning about the subject matter *and* how students learn it – the concepts, ideas, topics and skills required by students – and doing so at relatively specific levels of concentration (see [Sykes](#) 1999). This type of thinking influenced the development of the assessment tool. The tool was based on FSIM professional development modules. The modules are founded on national and international numeracy educational research and designed to provide teachers with a conceptual development continuum, as well as a new way to access what students think and understand.

'I have found the assessment tool a valuable addition to my program. The diagnostic tool has been thoughtfully crafted to pinpoint exactly what the child does and does not know and to highlight any misconception cemented over the years. The additional tutorial program (Leading Explicit Instruction) guaranteed personal attention to those children who needed clarification, further explanation, or their misconceptions challenged and rectified. Now that I have discovered this method, I can't see myself teaching any other way.' (Kark Najjar, year 5 teacher)



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Further reading and links

Carey Baptist College WA 2012, *Diagnostic resource for assessing mathematics F–6*, Carey Baptist College, Perth, Western Australia.

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Shulman, L 1986, 'Paradigms and research programs in the study of teaching: a contemporary perspective', in M Wittrock (ed) *Handbook of research on teaching* (3), Macmillan, New York.

Sykes, G 1999, '[Make subject matter count](#)' , *Journal of Staff Development*, Spring 1999, vol 20, no 2.

Tripp, D 1993, *Critical incidents in teaching: developing professional judgement*, Routledge. London.

Willis, S 2004, *First steps in mathematics*, Rigby, Port Melbourne, Victoria.

Contacts

For more information about the strategy, contact [Carey Baptist College](#)  via email: info@carey.wa.edu.au .