Maths is better than a Mars Bar

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A friend of mine often recalls her maths teacher from the 1980s, who was fond of saying, "Maths is better than a Mars Bar." While few students may have agreed, the obvious passion of the teacher spread to his students with the result that my friend pursued a career in geology that largely relies on an understanding of mathematics. Many primary teachers lack confidence with and passion for maths, yet being numerate is an important skill in today's society. With interest in maths and science at tertiary level on the wane, it is becoming increasingly important that we engender a love for mathematics in students from the earliest years of their schooling. The evidence suggests, however, that as a nation our competency in maths is declining.

The Programme for International Student Assessment (PISA) is conducted every three years and involves assessing the skills of students in countries across the world. More than 14,000 Australian students participated in the most recent round of testing in 2009 from 353 schools across all education sectors. While still higher than the OECD average, the Australian Council for Educational Research (ACER) summary report on the 2009 results reported that, "the average mathematics score was 514 points, 10 points lower than it was in 2003 – representing a statistically significant decline in mathematical literacy" (Thomson, De Bortoli, Nicholas, Hillman & Buckley, 2010). This is a worrying trend, but one that has not gone unnoticed. Schools, regions and even producers of educational resources are trying a range of initiatives to rekindle interest in maths, and more importantly, to support our students to achieve well in the subject.

One school that has taken maths seriously over the last three years is Holy Trinity Primary School in Melbourne's outer northeast. Mathematics Leader, Alison Hall, has been the driving force behind establishing a network of other leaders in the area who regularly meet to share ideas for Professional Learning Team meetings with staff and for raising the profile of maths in participating schools. Among the successful ideas implemented by the group is the instigation of an annual maths tournament. The competition started with six participating schools in 2010, and 72 students from nine schools took part in 2011. According to Hall's report about the event, "the focus on mental computation for a clearly defined purpose ensured good outcomes in the area."

Hall, who is currently undertaking a P–10 leadership course to enhance her skills as a mathematics leader, is also focusing on one of renowned teaching expert Peter Sullivan's key teaching ideas: identify big ideas that underpin the concepts you are seeking to teach, and communicate to students that these are the goals of your teaching, including explaining how you hope they will learn.

Using WALT (We Are Learning To) and WILF (What I am Looking For), teachers have been expressing their lesson objectives to the students to give them a clear idea of the requirements and direction of the lesson. "I believe that explicit teaching can provide students with specific, guided instruction in the basic understanding of required skills. Students can then build on these through practice, collaboration, repetition and hands on activities. It also assists in focusing on fewer rather than too many things in one lesson," Hall explains. The practice has been successfully applied in Year 2 during a place value unit.

On a broader level, the Australian government's Literacy and Numeracy Pilot program has resulted in a number of successful

larger scale trials aimed at improving maths outcomes using student data to identify opportunities for building school leadership and teacher capacity. One such project is Accelerating Catholic Tasmanian Schools to Improve Outcomes in Numeracy (ACTION). Project Coordinator Louise Hodgson is, in her own words, a passionate advocate for "marginalised and disadvantaged students," and the pilot developed in part in response to a commitment from the Archdiocese of Hobart to improve outcomes for students whose performance in standardised and national tests was consistently poor. As is the case with many primary teachers, the project brief identified that: "Many Tasmanian teachers in Catholic schools saw themselves as lacking confidence to teach mathematics and felt anxiety about the discipline," and Hodgson saw an opportunity to enhance teachers' Pedagogical Content Knowledge (PCK) to enable them to offer differentiated learning experiences that would make a genuine impact on student outcomes.

"I believe a curriculum on its own is insufficient to enable teachers to be precise about instruction, as it generally focuses on outcomes or end points for learning but does not provide a clear picture of the typical learning journey taken to get to the end points,' she says.

The ACTION Project began in 2008 with

The results of ACTION speak for themselves

a total of 11 schools joining the pilot. The first step was to administer an Early Numeracy Assessment Interview, both to measure students' current understandings as a baseline against which to gauge the success of the initiative and as a starting point in identifying student needs. A clinical interview developed by Doug Clarke, Ann Gervasoni and Peter Sullivan as part of the Early Numeracy Research Project (ENRP) was chosen as the assessment tool because it offered a research-based framework of growth points which could then be used to explore individualised learning paths for students.

Importantly, the approach was supported by a comprehensive professional learning program for teachers. This included three full-day workshops with experts from the Australian Catholic University through 2009 and 2010 as well as monthly team meetings and professional reading. In addition, numeracy education officers from the Tasmanian Catholic Education Office were assigned to work with project schools for one day a fortnight, offering a range of support from mentoring and coaching to modelling lessons and leading collaborative planning. A key element of the project was investing in numeracy coordinators who would become 'lead learners' responsible for driving the initiatives in their schools through professional development. Participating numeracy coordinators undertook a Post Graduate Certificate in Mathematics Education which equipped them with both knowledge of maths pedagogy and the leadership skills required to effect sustained change. A website was also established to allow online collaboration between schools.

A final dimension of the project was to involve parents in their children's mathematics studies. Hodgson explains: "Parental participation was really high in some schools with 60 per cent of parents turning up. We found parents are genuinely interested in what their children are learning and want to know how maths is being taught and how they can help at home."

The results of ACTION speak for themselves. The ENRP Early Numeracy Interviews showed particular improvement in the area of counting where, for example, 36 per cent of Year 6 students achieved growth point 6 in 2011 as opposed to 17 per cent in 2009. While these figures compare different cohorts of students, NAPLAN scores were used as another quantitive measure of the impact of the project on groups of students as they move from one year level to another. NAPLAN results were converted to effect sizes

Numicon uses structured imagery to support students' understanding

to show whether students had achieved the expected two years of growth between Year 3 and Year 5, with an effect size of 1.0 representing a two-year advancement in student achievement. Between 2009 and 2011, 10 of the 11 schools participating in the ACTION project recorded an effect size of at least 1.0, with many achieving well over the figure. One school even achieved an effect size of 2.0, representing a four-year gain for those students over the two-year period.

Students were not the only beneficiaries of the project. Teachers too showed solid improvement in their pedagogical content knowledge, especially in areas that were targeted as part of ACTION. A strong focus on addition and subtraction in 2010 for instance led to a 38 per cent increase in teachers' ability to understand the demands of a student learning task described on a questionnaire. Attitudinal surveys also highlighted benefits of the project to teachers including improved confidence in identifying the child's current level of knowledge and more effective planning to meet students' individual needs. Teachers valued the opportunity to observe demonstration lessons and the time allocated to reflect on what they had seen and incorporate new ideas into their planning.

The success of the project is evident in the ongoing commitment of participating schools. "Now that the funding period has ended, each school has continued to fund teacher release so that teachers can interview their students at the beginning of each year to ascertain current levels of mathematical understanding. One principal remarked recently, 'It's not, how can I afford this with my limited budget, but rather, how can I not afford to do this'," reports Hodgson. In fact, the pilot was so successful that the Tasmanian Catholic Education Office is now providing funding for an ACTION mathematics strategy that will see the initiative rolled out to all Catholic schools in the state.

Schools and education departments are not the only places that are investigating ways to improve mathematics learning in Australia. Publishing companies such as Oxford University Press are also investing in identifying ways to help educators improve student learning. "As a department of Oxford University, Oxford University Press – Australia is committed to bringing high quality publishing and educational resources to Australian educators that are research-based and shown to improve the learning outcomes for students," explains Education and Professional Development Manager, Julie Baillie. She recently travelled to England to learn about and become an accredited trainer in a new mathematics

resource called Numicon. Ruth Atkinson, Romey Tacon and Dr Tony Wing developed Numicon as a result of a research project investigating why students who may be successful in other curriculum areas do not do well in mathematics.

The team decided on an approach that uses visual structured imagery to support students' understanding of arithmetic, and created materials to facilitate multi-sensory learning with this method. At the heart of the Numicon program is a set of ten 'shapes' that represent the numbers from one to 10 and can be used as a basis for number exploration. According to the summary of the research project (Tacon, Atkinson and Wing, 2004), "We wanted children to develop an understanding of number that relates numbers to each other (relational understanding). For example,

Numicon provides a multi-sensory primary maths teaching program

fitting together the 3 and 7 shapes provides a visual model of why the answer is 10 and how 3 + 7 relates to 2 + 8 and 4 + 6. They could then draw on this understanding when it came to solving new problems." The emphasis in Numicon activities is on understanding the number system thoroughly, seeing patterns and making connections, rather than on rushing students into formal recording of equations, a methodology that is in sync with the new Australian Curriculum. It also moves students away from a reliance on counting as the primary problem solving strategy.

The schools in the UK that have used Numicon have registered sound, and sometimes dramatic, improvement in student outcomes in the area of arithmetic. Prior to the introduction of Numicon, at the end of Key Stage 1 (approximately equivalent to Year 2 in Australia) the distribution of student achievement in standardised tests at Peacehaven Infant School, for example, showed a large percentage of students two levels below the benchmark, with some students four levels below. Two years later, none of the cohort of students at the end of Key Stage 1 was four levels behind, few were two levels behind, and the greatest percentage of students was one level above the standard. The results appeared to be sustained over time; as the students moved to a local junior school they continued to achieve well in mathematics, even though Numicon was not used once the students reached Key Stage 2.

Anecdotal evidence also supports the success of the approach. The Numicon Project Report from 2008–2009 found that "Teachers commented that Numicon supported children in learning specific concepts that in previous years had been difficult or in some cases not understood – in particular, number bonds to 10 as rapid recall (instead of calculations), one more and one less, odd and even, understanding subtraction as difference, as well as 'take away,' inverse operation, repeated addition and its link to multiplication." Though not the only resource used in classrooms, teachers found that Numicon complemented the strategies and materials that they were already using.

Students, too, appear to enjoy using Numicon, a happy by-product of which is increased engagement in maths. The Project Report described how "Teachers found very quickly that Numicon began to take over, the children wanted to continue their learning and explore Numicon further at wet play-time, and were more confident and engaged..."

The full Challenges for Australian Education: Results from PISA 2009 report (Thomson, De Bortoli, Nicholas, Hillman & Buckley, 2010) concluded that "An important aspect of mathematical literacy is engagement with mathematics: using and doing mathematics in a variety of situations," and Numicon certainly offers schools an opportunity to do just that. As Julie Baillie explains: "Numicon provides a multi-sensory primary maths teaching program that engages learners with its visual, auditory and kinaesthetic approach."

Out of the 20,000 primary schools in the UK, 6000 are now using Numicon. Baillie attributes its success in large part to the fact that Numicon was developed from a classroom-based research project and offers both student-tested resources and professional support for teachers. "It is not often a resource comes along that you *know* will have a positive effect on the teaching and learning of mathematics," she asserts.

Maths is often the subject treated as the unpopular nerd in the curriculum, pushed aside when time runs short in favour of the more popular areas of reading and writing. If our student outcomes are to improve, however, we need more initiatives and resources that focus on how to effectively teach maths, and a commitment to allocate the time and effort necessary to make a difference to students. With increased attention, students might indeed one day think that maths is better than a Mars Bar, or at least understand how maths can help them buy one. ET

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