

Numeracy, mathematics and Indigenous learners: *Not the same old thing*



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Caty Morris has worked in Aboriginal Education in both New South Wales and South Australia for about 15 years, in remote, regional and urban settings. She began her career as a primary school teacher in the Adnyamathanha community of Nepabunna in the northern Flinders Ranges; was Coordinator of Aboriginal education in the Western Area of South Australia, based at Port Augusta; taught at Redfern and Darlinghurst Primary Schools and Ultimo TAFE in Sydney; was a Project Officer for the Aboriginal Education Directorate in New South Wales and Aboriginal Education in South Australia; a Math Consultant in the Bronx District of New York City; a Curriculum Manager in Department of Education and Children's Services, South Australia; and is currently Manager of the Closing the Gap project *Make it count: Numeracy, Mathematics and Indigenous learners* for the Australian Association of Mathematics Teachers, funded by the Department of Education, Employment and Workplace Relationships.



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Dr Chris Matthews is from the Quandamooka people of Minjerrabah (Stradbroke Island, Moreton Bay, Queensland). In 2003, Chris completed a PhD in Applied Mathematics at Griffith University and has the privilege of being the first Indigenous Australian with a PhD in Applied Mathematics. Chris is currently employed as the Coordinator of the Indigenous Research Network, Griffith University and his research interests are in applied mathematics and mathematics education. These two fields have strong interconnections and enable Chris to explore questions such as: As an Indigenous Australian, why would you study and/or practise mathematics? How objective is mathematics and how does culture determine the teaching, learning and practice of mathematics?

Abstract

This paper begins with two narratives: the first from an Aboriginal mathematician and the second from a non-Aboriginal teacher. The two stories are woven together to draw out the notion of culturally responsive mathematics pedagogy and what this might mean for educators working with Indigenous students in the teaching of Western mathematics to close the two-year gap in learning outcomes. At the same time, consideration is given to what 'the same old thing' is and why we need to be doing something different. The *Make it count* project, funded by the Commonwealth Department of Education, Employment and Workforce place Relations (DEEWR) and managed by the Australian Association of Mathematics Teachers (AAMT), is attempting to do something different. Three case studies, drawn from the project's eight Clusters, illustrate significant and transformative change in students, in teachers, and in the curriculum.

Chris's story

The story of my education is one of survival by thriving in mathematics. I experienced racist attitudes from teachers and particularly from students which were publicly humiliating. My Aboriginality was often questioned and generally not supported. I was lucky that I was good at mathematics which gave me a safe haven from dealing with race and culture, plus my success within the subject built my self-confidence academically. My academic success allowed me to go to University to follow my interest in mathematics (and computing), and to eventually obtain a PhD in applied mathematics. What is interesting about my education is that my Aboriginality and mathematics was kept separate and, consequently, I continued to question why an Aboriginal person would undertake a

career in mathematics. How will this benefit my community?

Caty's story

My teaching career began with the offer of a permanent position in an isolated Aboriginal community. My first year in this community was very bumpy and very difficult. I was offered advice by the non-Aboriginal principal and time and again it didn't seem to work. For example, even though the community was predominantly Aboriginal, the Western culture dominated the school and I was expected to teach Western things in Western ways to non-Western children. I knew I couldn't keep on doing 'more of the same'.

Fortunately, a new principal arrived and big changes were soon in place. At last I was able to observe and participate in local cultural practices (Gutierrez & Rogoff, 2003) in both the classroom and the community, and bring students' lived experiences into the classroom. Every day I would wake up to a new experience and I thrived on the never-ending cycle of teaching and learning with my students. I was able to tap into local funds of knowledge (Gonzalez, & Moll, 2002) and try different ways of teaching and, because of this, became a better teacher (and a better person). My students became a lot more engaged in learning and classroom dialogue, and their confidence and learning outcomes improved.

These two stories not only provide the reader with the standpoint of the two authors (Nakata, 2007), but also show an interesting juxtaposition in mathematics education. Chris's story is from an Indigenous perspective where there is no relationship between mathematics and Aboriginality, while Caty's story, a non-Indigenous perspective, demonstrates that meaningful educational outcomes can only occur when the teacher has an understanding of Indigenous students'

lived experiences. Caty's story is one of growth from transformational experiences that have provided her with insights into a different world view. Chris's story is about survival and trying to find a place even at the cost of his Aboriginality. These two stories highlight the need to ask the question: 'Is it important to connect Indigenous cultures and mathematics to improve educational outcomes for Indigenous students and, if so, how can this be achieved within Australia's education system?'

What is mathematics?

First, we must ask a foundational question: 'What is mathematics?' Recognising that this is a difficult question to answer, the Australian Mathematics Society, through its gazette, sought the views of their members. As expected, the answers were varied, but what is interesting is that members used expressions such as 'it [mathematics] is a social construct', 'symbolic expression of relationships', 'abstracted natural patterns', 'a way of looking at the world'. These types of statements indicate that mathematics is a cultural practice and the mathematics itself (e.g. symbols and language) is a cultural product.

The mathematics that is experienced by most people (through our education system) does not provide any cultural connection, nor does it provide connections with the students' world view. Mathematics is often portrayed as objective, with little connection to people and their experiences, resulting in responses like 'Why are we learning this?'. As argued by Matthews et al. (2005), the mathematics (and science) curriculum has devalued Indigenous cultures by directly and indirectly positioning Indigenous cultures as primitive. This view was expressed by Deakin (2010) when questioning the inclusion of Indigenous Mathematics in the National Curriculum. Deakin (2010) states that Indigenous Mathematics

'does not exist' and it is not 'beneficent to bestow on aspects of Aboriginal and Islander cultures a significance that they do not, in fact, possess'.

We would argue that maintaining such a disconnection between Indigenous people and mathematics is detrimental to the educational outcomes for Indigenous students, and we need to explore the notion of culturally responsive mathematic pedagogy.

Culturally responsive mathematics pedagogy

While there has been a significant amount of research internationally about culturally responsive mathematics pedagogy (CRMP) (e.g. Gutstein et al., 1997; Malloy & Malloy, 1998; Matthews, 2003; Tate, 1994; Wagner et al., 2000), very little has been done in the context of urban and regional classrooms with Indigenous students in Australia. What has been done is usually based on remote contexts, or lacks clear articulation into the classroom.

We know, however, that at the heart of quality teaching of students in mathematics are the professional judgements about teaching and learning; judgements based on teachers' knowledge, experience and evidence in relation to pedagogy, their students, and mathematics. If teachers are to provide quality experiences in mathematics, they will need deep content knowledge and deep pedagogical knowledge. However, for many Indigenous students, this is not enough and mathematics remains a gatekeeper to future prospects. A teacher's approach to teaching Aboriginal students' mathematics needs to take into account Aboriginal people and their culture, Aboriginal children's mathematics understandings and explicit mathematics teaching (Perso, 2003). We suggest that using this as a starting point we have a basis for what we are calling Culturally Responsive Mathematics Pedagogy (CRMP).

There is very little research about what constitutes a highly effective teacher of mathematics in the context of Indigenous learners. What we need is teachers with high levels of mathematical pedagogical content knowledge, but beyond this are able to teach in ways that are 'relevant and responsive to social realities and cultural identities' (Martin, 2007) of their students. *Make it count* is developing its own ideas in relation to this and encouraging people to tell their stories of transformation. We are very aware that we don't want 'more of the same' and heed Harrison's (2007) timely advice as he warns researchers that research in Indigenous education:

... is at a dead-end. Researchers are still heading out into the field to look for new knowledge to answer old questions. The same epistemology dominates how we look, and where, while the methodology provides the research with a forced choice, one where either the students or the teacher is blamed for the lack of outcomes in Indigenous education.

(Harrison, 2007, p. 1)

He challenges us to find something different. It would seem that the generation of new questions are

therefore vital to the generation of new knowledge in this field.

Make it count: Numeracy, mathematics and Indigenous learners

Make it count is a national project striving to improve the learning outcomes of Indigenous students in mathematics. It is part of the Australian Government's 'Closing the gap – expansion of intensive literacy and numeracy programs initiative'. The project has established eight clusters of schools across Australia to find something new that will make a difference through the development of CRMP as illustrated in Diagram 1 below. We want to make it clear that when we talk about CRMP, we do not mean maths worksheets with boomerangs around the border. *Make it count* is a work in progress and the following three case studies illustrate current progress in developing new thinking, new language and new practice in relation to evidence-based CRMP.

Three case studies

Student transformation: Andrew switches on to mathematics

Ruby is a middle primary teacher in an urban school. She is very experienced

in using the Accelerated Literacy (AL) pedagogy and explicitly teaching the cultural orientation necessary to engage in school learning. (For example, in literature she draws attention to why authors choose particular adjectives – so the reader will like the main character.) Ruby has the results to show that she is making a difference in the literacy outcomes of her Aboriginal students. Her Cluster is applying AL principles to the teaching of mathematics through the use of explicit, scaffolded and highly sequenced pedagogy. Ruby discusses the change in one of her Aboriginal students:

At the beginning of the year and throughout most of term one Andrew, a Year 4 Aboriginal boy, presented as a quiet, under achiever who was lacking in confidence particularly in the area of mathematics.

Towards the middle of term one I changed my pedagogy in this subject area and brought it into line with how I taught Accelerated Literacy. For our maths lessons my teaching Mentor and I planned a series of scaffolded, sequential lessons in the area of 'place value' ... We noticed immediate results in both enthusiasm and confidence building within the classes ... Andrew in particular, began to shine in the lessons. He gradually became more confident to offer answers. He now asks questions when he doesn't understand ... He goes home and shares what he knows with his parents who have been delighted with this transformation. They have written notes in his diary that confirm this:

Teacher change: Aaron's story

Aaron is an experienced teacher. He describes how he used to feel about maths. 'I really hate maths. Maths Sucks'. Aaron knows that this stems back to the way he was taught maths as a student and says that, 'The old way of learning through equations didn't work for me

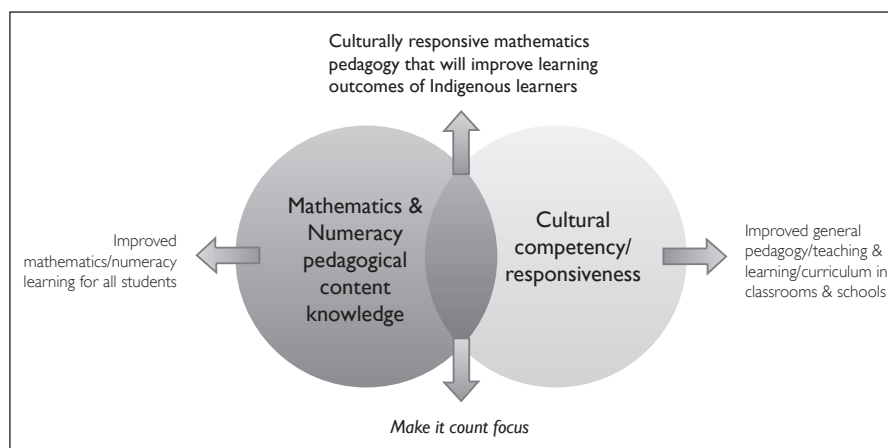


Diagram 1:

MONDAY	MATHS - Subtraction with trading - 20/20 • excellent work overcoming the frustration in trading numbers. You conquered the sums & made the frustration of the math fun to do proud of you!	What ANDREW'S DIARY tells me: This was not set as homework. He just went home and did it himself every night for the week. (I always say to the children that they can practise Maths at home. Until this, hardly any children ever did extra Maths at home.)
TUESDAY	MATHS - Subtraction with trading - 10/10 • FANTASTIC WORK • YOU MADE TRADING FUN AND EASY! Great! So good to see you practising!	Andrew's mum commented on his enthusiasm in his diary. 'He conquered his frustration of the Maths', wrote Mum.
WEDNESDAY	MATHS - Subtraction with trading • YOUR MAKING these sums look easy 10/10	By Thursday Andrew has started solving written, question problems and was able to transfer these into symbols and calculate successfully. 'Proud of you Andrew', says Mum.
THURSDAY	MATHS - Subtraction with trading • Maths in Sentences Great! Confusing, excellent work COMPLETED SECTION (GOLD STAR) 40/48 Proud of you!	Surprisingly, at the next student-parent-teacher interview both parents attended and commented very favorably on Andrew's attitude, success and enjoyment in Maths. (After Andrew shared this homework, many children in the class started bringing in pages and pages of self-initiated practice of the current concept we were tackling.)
FRIDAY		

Diagram 2: Andrew's diary with comments from his mother

and I just turned off ... Incredibly, this became the way I taught maths to my students. I repeated the cycle ... and wanted to break this cycle ... by trying to come up with new ways to teach maths'. Aaron is a skilled teacher of Visual Arts and after a challenging discussion with his principal, settled on teaching mathematics through Visual Arts and using this as a means to encourage students to become numerate. An example of this was through teaching the golden ratio. Aaron 'was able to overcome many of his misapprehensions and find meaningful situations for the processes of mathematisation and contextualisation' (Thornton & Statton, 2011).

Aaron's transformation was also affirmed through the data he collected. Base-line data collected early in the year about what students' thought maths and numeracy were included,

'Involving numbers', 'Shapes, plus, take and times tables'. Towards the end of the year typical replies included, 'Maths is things like measuring, adding, take away, times, shapes and other stuff. Learning how do those things' and 'Numeracy is using maths, so like using measuring when you do cooking and if you were building, you need to be able to add and measure and we have done lots of art where we have used maths like measuring, times tables, adding, odd and even numbers, patterns'. Aaron thinks it is significant that, although in his class they hadn't considered cooking, the students made that connection for themselves.

Curriculum change: Camping out with mathematics

One of the Clusters held a mathematics camp to build and connect both mathematics and cultural identity in

Indigenous students. There were several activities at the camp, but one notable activity was learning mathematics through Aboriginal dance – a new approach being trialled for the first time. Students, working in groups, were challenged to create stories from mathematical equations (Matthews et al., 2007) and create a dance about these stories. From a survey conducted at the end of the camp, ten students from a total of 28 made explicit statements about 'a new way with maths'. Some of the statements from the students were:

'I like dance and the culture of the maths we are learning.'

'I learnt that maths does not have to be about sitting at a desk looking and copying off a board.'

'We mixed our culture and maths together and it surprised me. I can now walk away with a different understanding of Math and my Aboriginal heritage.'

From the evaluation of the camp we also know that not all students respond positively (5/28) and more needs to be done to engage non-Indigenous teachers in activities, to explicitly and specifically identify and draw out the mathematics in cultural activities and how such activities translate into the classroom.

Summary

Make it count is working at the 'ground level' with educators of Indigenous students as an alternative to the 'top-down' approach. Clusters are working as professional learning communities. Developing an evidence base and planning for sustainability are foregrounding their thinking. With the help of their Critical Friends (university-based researchers), some are re-interpreting and reconstructing what is already there, or taking 'more of the same' and re-purposing

resources, strategies and approaches. Others are working in completely new domains such as the development of mathematics resilience in Indigenous learners and the development of cultural competency that enables educators to better respond to the learning needs of their Indigenous learners.

The full evaluation of the project will be critical to establishing the evidence base. This includes student achievement, attitudes and experiences; teacher and school change; school–parent partnerships; and cultural competency of teachers and schools in relation to mathematics and numeracy.

It is becoming clear in *Make it count* that teachers who engage in culturally responsive mathematics pedagogy possess deep knowledge of mathematics content. They have (a) deep content knowledge, (b) strong pedagogical content knowledge, and (c) a strong culturally relevant pedagogy (Gay, 2000; Ladson-Billings, 1994). They have a deep commitment to Indigenous students and these students are empowered as a result of their mathematical experiences (Ernest, 2002).

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