

Indigenous mathematics: Creating an equitable learning environment



Grace Sarra

Queensland University of Technology

Dr Grace Sarra is presently a Senior Lecturer at the Queensland University of Technology.

Born and raised in Townsville, Grace is of Aboriginal and Torres Strait Islander heritage and the eldest of five children. Her mother is of Aboriginal (Birrigubba) and South Sea Islander descent and her father is of Torres Strait Islander heritage from the Central Islands (Mauar) in the Torres Strait.

Grace has been teaching in schools from the early years through to the secondary levels and in tertiary institutions for almost 20 years. Her interests are in the area of Indigenous education, with a particular focus in school change and leadership, social justice and inclusive education.

Abstract

This summary provides an overview of how a change in school leadership can successfully address competencies in complex situations and thus create a positive learning environment in which Indigenous students can excel in their learning rather than accept a culture that inhibits school improvement. Mathematics has long been an area that has held back Indigenous students in improving their learning outcomes, as it is a Eurocentric subject (Rothbaum, Weisz, Pott, Miyake & Morelli, 2000; De Plevitz, 2007) and does not contextualise pedagogy with Indigenous culture and perspectives (Matthews, Cooper & Baturu, 2007).

Introduction

In Australia, Indigenous students continue to be the most educationally disadvantaged group within the area of mathematics education, with performance lagging two years behind that of non-Indigenous students according to the testing programs in numeracy (MEECDYA, 2008). Only 23 per cent of Indigenous people aged 15 years and over complete school to Year 12 compared to 46 per cent for non-Indigenous students, and young Indigenous people record the lowest levels of post-compulsory school enrolments (Lamb, 2009).

Of importance for educators is the recognition that for change to occur in the academic performance of Indigenous students, schools need to change their deficit views about what our Indigenous children can achieve. There is also the need to change the mind-set of Indigenous children about what they can achieve.

YuMi Deadly Maths is a unique mathematics program for Aboriginal and Torres Strait Islander students that aims to:

- enhance mathematics learning outcomes
- improve participation in higher mathematics subjects and tertiary courses
- improve employment and life chances.

The YuMi Deadly Centre

The YuMi Deadly Centre is a new centre that focuses on pedagogies for Indigenous learning. It is a combination of a Torres Strait Islander word (YuMi) meaning 'you and me' and an Aboriginal word (Deadly) meaning 'smart'. It bases its activities on the slogan 'building community through learning'. It was begun by mathematics educators, but has since joined with educators specialising in Indigenous philosophy and pedagogy and school change and community involvement strategies. Although based at Queensland University of Technology, the centre also has staff at Griffith University. It can be contacted at www.ydc.qut.edu.au.

The philosophy of YuMi Deadly Maths is based on a realisation that mathematics is an abstraction of everyday life which empowers people to solve their problems, and this abstraction has to take account of local culture and context. This cultural and contextual abstraction is enhanced if it is integrated with positive identity change with respect to school, heritage and ambition. This unique program presents mathematics in a new way that views mathematics as a living, growing creative act in which Aboriginal and Torres Strait Islander students can excel through active participation and valuing of Indigenous communities' ways of knowing and doing.

YuMi Deadly Maths is centred on a whole-of-school change, and has been influenced by the philosophy and success of the Stronger Smarter

Institute. Its approach is underpinned by five key objectives:

- 1 acknowledging, embracing and developing a positive sense of Aboriginal and/or Torres Strait Islander identity
- 2 acknowledging and embracing Indigenous leadership in schools and school communities
- 3 building and maintaining strong community–school partnerships
- 4 changing beliefs, and ensuring ‘high expectations in leadership’ and ‘high expectations in classrooms’
- 5 ensuring productive teaching and learning pedagogy is meaningful to the social and cultural contexts of the Indigenous learner.

The YuMi Deadly Maths program can help to overcome systemic issues whereby many Indigenous students perceive mathematics as a teaching area in which they must become ‘white’ to succeed (Matthews, Watego, Cooper & Baturu, 2005), and as a subject that can challenge their identity (Pearce, 2001). Deficiencies or under-performance in mathematics for Indigenous students is not due to their innate intelligence (Cooper, Baturu & Warren, 2005), nor is their social and cultural background at fault (Sarra, 2003). What is needed is for educators to examine the structures and cultures of the education system (Cronin, Sarra & Yelland, 2002) that are the link between school practices and Indigenous student outcomes.

What is mathematics?

Dr Chris Matthews is an Indigenous research mathematician at Griffith University who is developing new pedagogies that focus on mathematics structure and that contextualise mathematics learning to Indigenous culture (Matthews, 2008). Figure 1 illustrates Matthews’ views of the epistemology of mathematics.

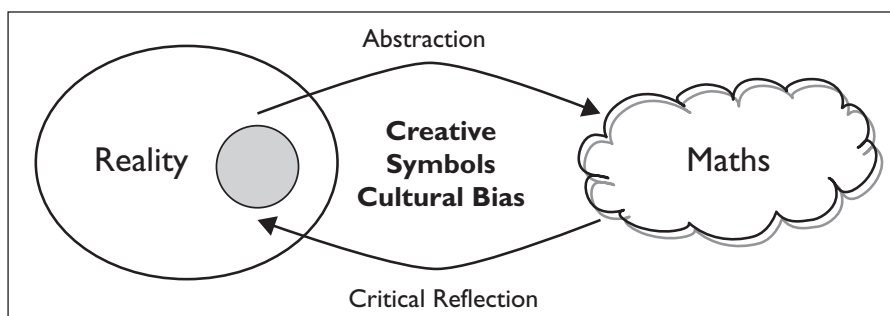


Figure 1: Epistemology of mathematics (Source: Matthews, 2008, Fig. 1)

According to Matthews:

Mathematics starts from observations in a perceived reality. The observer chooses a particular part of the reality (represented by a grey circle in Figure 1), and then creates an abstract representation of the real-life situation using a range of mathematical symbols, which are put together to form a symbolic language we call mathematics. The observer uses the mathematics in its abstract form to explore particular attributes and behaviours of the real life situation and to communicate these ideas to others. From the mathematics, it is essential that the observer critically reflects on their mathematical representation to ensure that it fits with the observed reality. Consequently, the abstraction and critical reflection processes form an important cycle where mathematics and its knowledge are created, developed and refined. I would argue that most students only experience mathematics in its abstract form (ie, they stay within the cloud in Figure 1) and do not experience and obtain an appreciation for the cycle of abstraction and critical reflection. I believe that developing pedagogy that is centred on this cycle will lead to an authentic mathematical literacy and allow students to achieve at a high standard (p. 48).

There are three main features of the model that need to be considered when developing effective pedagogy in mathematics, particularly for Indigenous students (Matthews, 2008). These are:

- 1 creativity as an essential component of the abstraction and critical reflection cycle. Allowing students to engage in this cycle gives them an opportunity to create their own mathematical representations, explore solutions to problems on their own terms and relate mathematical representations to other situations within their world view
- 2 symbols are the product of the abstraction process and, consequently, hold the meaning behind the real-world concept that is being modelled. It is therefore important that we teach the meaning behind mathematical symbols, instead of simply presenting them, so that students can recognise how mathematical concepts are related to their own perceived reality
- 3 the recognition of cultural bias within the practice of mathematics. Cultural bias exists in every aspect of the cycle – how we perceive reality, why we select a certain part of reality, what we deem to be important, and the symbols we create to represent meaning.

In short, an effective pedagogy will 'allow students to learn mathematics from their current knowledge (i.e., from the students' social and cultural background), thereby providing agency through creativity and ownership over their learning.' (Matthews, 2008, p. 48). From this ownership, we aim to foster a positive sense of identity for Indigenous students as learners of mathematics and provide an avenue for Indigenous people to relate mathematics to their reality – that is, their world view – which in the long term will shape the teaching and learning of mathematics.

Creating a positive school culture through change

There is a need for educators to deconstruct their deficit thinking about the underachievement of Indigenous students and to examine the role that schools and practitioners play in low achievement and failure (MACER, 2004). Garcia and Guerra (2004) have suggested that school reform often fails for students from low socioeconomic status and/or racially or ethnically diverse backgrounds because educators are unwilling or less likely to examine the causes of their underachievement and failure and, instead, have a tendency to blame the students, their families and their communities for poor academic results. Betsinger, Garcia and Guerra (2001) suggest that this is because educators believe that these children commence school without preparatory knowledge and skills to assist them in their formal years of learning as parents do not value or support their children's education.

Educators must be willing to assume some responsibility for the failure of Indigenous students, and change their beliefs and assumptions that Indigenous students and their families are responsible for poor academic results (Garcia & Guerra, 2004; Sarra, 2007).

Effective leadership is crucial in a school in which Indigenous children continue to fail academically due to disengagement, poor attendance, low expectations and a lack of student pride in self, school and their identity as an Aboriginal or a Torres Strait Islander. Strong and effective leadership can create and change the culture of a school, from dysfunctional to functional elements (Schein, 2004; Sarra, 2003) that encourage improved school attendance, deliver high expectations and instil a sense of pride in a child's heritage of Aboriginality or of being a Torres Strait Islander.

Organisational culture and leadership

The organisational culture and leadership in a school begins with the principals or the leaders who impose their own values and assumptions on a group. If the school is showing success and the underlying assumptions of members of the school community come to be taken for granted, a culture is created that will define for later generations of members the kinds of leadership that are acceptable. The culture now defines the leadership. But if the school runs into difficulties, if its environment changes to the point where some of its assumptions are no longer valid, leadership is evident once more. Leadership is now the ability to step outside the culture that created the leader and to start evolutionary change processes that are more adaptive.

This ability to perceive the limitations of one's own culture and to evolve the culture adaptively is the essence and ultimate challenge of good leadership (Schein, 2004).

If the culture of a school displays shared beliefs and assumptions that:

- are anchored in high expectations
- deliver productive and meaningful teaching and learning practices

- acknowledge and embrace Aboriginal and Torres Strait Islander identity
- build and maintain strong community relationships
- acknowledge and embrace Indigenous leadership

then deficit thinking will be replaced with solutions that will provide real and meaningful change and the opportunity to see transformative change in classroom practices and in the school.

Bringing about change: Teachers and researchers

The YuMi Deadly Centre is involved in a number of projects designed to improve outcomes for Aboriginal and Torres Strait Islander students in numeracy to assist them in gaining employment and life chances. Some of these projects are discussed below.

Early language and numeracy

Research findings from a project that focused on language and early numeracy (Sarra, 2008) have highlighted the importance of creating a learning environment that is caring, colourful, exciting, stimulating and reflective of possibilities that will engage children and adults in a collaborative approach to provide opportunities for Indigenous students to learn, no matter how diverse their cultural and social backgrounds.

The overall aim of this project was to identify and explain prior-to-school-age Indigenous students' ways of knowing and not knowing, learning and not learning early number language and processes, in order to obtain information on the prior-to-school activities that will best prepare these young students for success in school mathematics (in this application, *prior-to-school* encompasses the 2–4 age

group in home, daycare, play group and kindergarten settings).

The Tagai Maths for Employment project

In a project that focused on contextualising mathematics to culture and home language in the Torres Strait Islands (Ewing et al., 2009), the results indicated that before an Indigenous teacher could address the process of contextualisation and teaching mathematics to her students, she needed to understand the mathematics and contextualise it to her culture. For this teacher, the process was emancipatory, that is, it afforded the articulation and interchange between mathematics and her culture – the Torres Strait Islands (Ewing et al., 2010). Conversely, an Indigenous teacher aide viewed mathematics as something taught in school only, and thus disconnected from her culture.

DET TIME: Teaching Indigenous Mathematics Education project

The aim of the Department of Education and Training's Teaching Indigenous Mathematics Education (DET TIME) project is to increase the capacity of schools with high enrolments of Aboriginal, Torres Strait Islander and low socioeconomic background students to teach mathematics effectively to these students (Cooper et al., 2009), both to 'close the gap' between these students and other students and to increase the number of mathematics-trained people in Australia.

The DET TIME project is based on professional development and teacher change as part of a cycle of students' affective readiness, relevant external input, effective classroom trials, positive student responses, and supportive reflective sharing (Baturo, Warren & Cooper, 2004) that leads to further student readiness.

Skilling Indigenous Australia project

Indigenous Australians in regional and remote communities have high unemployment despite shortages of skilled workers in local industries. Due to previous low achievement in numeracy, Indigenous VET students fail to graduate from courses that would allow access to these industries and benefit their community. The Australian Research Council's linkage project 'Skilling Indigenous Australia: Effective numeracy learning for employment by regional and remote Indigenous students in vocational education and training courses' aims to study Indigenous students' learning of numeracy to develop theory regarding appropriate instructional methods. Significantly, it focuses on numeracy in relation to Indigenous knowledge, cultural empowerment, and community and employer involvement. Expected outcomes are increased Indigenous graduation and employment rates, and reduced welfare dependence in regional remote areas.

Conclusion

As educators it is important that we recognise the rich and dynamic culture of Aboriginal and Torres Strait Islander students and ensure that the construction of mathematics does not devalue it. A combination of student pride, high expectations, embracing Indigenous leadership, maintaining positive school–community relationships, and effective teaching and learning pedagogy that considers the social and cultural context of the learner is essential to make a change that will achieve equal and positive educational outcomes for Aboriginal and Torres Strait Islander students.

References

Betsinger, Alicia M.;Garcia, Shernaz B.;Guerra, Patricia L.(2001).Up

for Scrutiny. *Journal of Staff Development*, 22 (2) p24–27 Spr 2001

Cooper, T.J., Baturo, A., & Warren, E. (2005). *Sunset Maths Research Project. Report of Year 2003: First Draft* (110 pages). Unpublished report on the 2003 ARC Linkage grant, Centre for Learning Innovation. Queensland University of Technology.

Cooper, T.J.;Baturo, A.R.;Warren, E.;Doig, S.M. (2004). Young "White" Teachers' Perceptions of Mathematics Learning of Aboriginal and Nonaboriginal Students in Remote Communities. *International Group for the Psychology of Mathematics Education*, 28, Bergen, Norway, July 14–18, 2004. 8 pp.

Cronin, R., Sarra, C., & Yelland, N. (2002). Achieving positive outcomes in numeracy for Indigenous students. *Proceedings of the Australian Association for Research in Education Conference*, Brisbane, Qld. Accessed January 2007, from www.aare.edu.au/confpap.htm.

Ewing, B., Cooper, T., Matthews, C., Baturo, A., & Sun, V. (2009). *Tagai Maths for Employment Project*. Brisbane: YuMi Deadly Centre, Queensland University of Technology.

Ewing, B.F., Cooper, T.J., Baturo, A., Matthews, C., & Sun, H. (2010). Contextualising the teaching and learning of measurement within Torres Strait Islander Schools. *The Australian Journal of Indigenous Education*, 39(2010), 11–22.

Garcia, S., & Guerra, P. (2004). *Deconstructing deficit thinking: Working with educators to create more equitable learning environments*. Retrieved July 15, 2009, from <http://eus.sagepub.com>

Lamb, S. (2009). Modelling of post compulsory schooling enrolments. Retrieved August 08, 2009, from http://www.cgc.gov.au/__data/assets/file/0014/17024/2009_-_Modelling_of_post-compulsory_students.pdf

-
- Ministerial Advisory Committee for Educational Renewal, (2004). *A creative workforce for a smart state : professional development for teachers in an era of innovation*. Brisbane: Dept of Education and the Arts, 2004
- Matthews, C. (2008). Stories and symbols: Maths as storytelling. Retrieved August, 2009, from http://www.aeuvic.asn.au/professional/files/PV_Mathews_6_3.pdf
- Matthews, C., Cooper, T., & Baturo, A. (2007). Creating your own symbols: Beginning algebraic thinking with Indigenous students. In *31st Annual Conference of the International group for the Psychology of Mathematics Education*, July 8–July 13, 2007, Seoul: Korea.
- Matthews, C., Watego, L., Cooper, T.J., & Baturo, A.R. (2005). Does mathematics education in Australia devalue Indigenous culture? Indigenous perspectives and non-Indigenous reflections. In *28th Conference of the Mathematics Education Research Group of Australasia*, 2005, Melbourne, Australia.
- MEECDYA. (2008). National assessment program literacy and numeracy: Achievement in reading, writing, language conventions and numeracy. *Journal*. Retrieved from http://www.mceecdya.edu.au/verve/_resources/NAPLAN_2008-Full_Report.pdf
- Pearce, J. (2001). Indigenous students at university: Is teaching still a colonising process? Proceedings of the Australian Association for Researchers in Education Conference, Fremantle, W.A. Accessed October 2003, from www.aare.edu.au/confpap.htm.
- Rothbaum, F., Weisz, J., Pott, M., Miyake, K., & Morelli, G. (2000). Attachment and culture. *American Psychologist*, 55(10), (1093–1104).
- Sarra, C. (2003). Young and black and deadly: Strategies for improving outcomes for Indigenous students. In *ACE Quality Teaching Series – Practitioner Perspectives*, Paper No. 5 Deakin, Vic: Australian College of Education.
- Sarra, G. (2005). *Strong and smart: Reinforcing Aboriginal perceptions of being Aboriginal*, PhD Thesis, Murdoch University, Murdoch.
- Sarra, G. (2007), *Pedagogy that works for Indigenous students*, Unpublished Doctoral Thesis, Queensland University of Technology.
- Sarra, G. (2008). Unpublished paper: 1st Draft of Research Findings from ARC Discovery Grant – Cabbage Tree School.
- Schein, E.H. (2004). (3rd edn.). *Organizational Culture and Leadership*. San Francisco: Jossey –Bass.