



Stronger Smarter Institute Research & Impact Footprinting

Full Reading Review

“Maths as Storytelling”

Stronger Smarter Meta-Strategy links:

1. Acknowledging, embracing and developing a positive sense of identity in schools →
2. Acknowledging and embracing Indigenous leadership in school communities →
3. High Expectations Relationships →
4. Innovative and Dynamic School Models →
5. Innovative and dynamic school staffing models

This Reading Review provides a summary and review of Dr Chris Matthews’ chapter on *Maths as Storytelling*, from the book *Aboriginal and Torres Strait Islander Education*, edited by Dr Kaye Price. Dr Matthews is a leader in the field of Indigenous pedagogies in mathematics. In this chapter, Matthews explores the connection between culture and mathematics and how Indigenous people have been positioned as mathematical learners. He explains the Cloud Model as a Culturally Responsive Pedagogical (CRP) approach to mathematics that embraces Indigenous student identity (Delpit, 1998; Lewthwaite et al, 2015; Perso, 2012). He shows how ‘Maths as Storytelling’ can be used as a pedagogical tool to develop Jarjums’ mathematical knowledges. This approach has been used state-wide in Queensland and adopted nationally through the ‘Yumi Deadly Maths’ program¹.

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¹ www.ydc.qut.edu.au

Stronger Smarter key insights

- ▶ Summary of ‘Key Points’ from the Research Paper
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Research Mapping

Why the research? – Research Questions and Approach

Science Technology, Engineering and Maths (STEM) is a key political driver in future education. Matthew’s paper is important to highlight as it focuses on research which embraces Indigenous Knowledges, celebrates Indigenous identity and provides a scaffold for deepening higher order thinking processes within a STEM frame. While Matthew’s research focuses on mathematics, there are further applications of his pedagogical model.

Matthews skillfully weaves his knowledges of applied mathematics and theory with his embodied and learnt cultural knowledge as a Nunukal man. The power of this approach and definition of the pedagogy is in Matthew’s third space creation, the balance or definition of the spaces of overlap and seeking of areas of balance and interface (Ganma theory, Yirrkala CEC, 1998; Chilisa, 2012; Yunupingu in Craven; 1989, Davis, 2010). At the Stronger Smarter Institute, we define this cross ways or connected spheres as applying the **Stronger Smarter Approach** (Stronger Smarter Institute, 2017). Matthews’ work is a further definition of the Cultural Interface theory that Nakata (2007) developed and value adds to the pedagogical development of Yunkaporta’s ‘8 ways of Learning’ curriculum tools².

As Matthews explores connections to his people, his culture and his knowledges, a design to deepen learning and provide a stronger Indigenous footprint in mathematics understanding is to put subjectivity back into practice. There is a purported belief or underlying assumption prevalent academically and Matthews would argue, across society, that mathematics is devoid of bias – in essence it is imagined as solely objective. The western knowledge systems connected to science and mathematics abound with this mythology and construction of objectivity. This mythology is representative of a systemic knowledge construction and deconstruction of Indigenous knowledges and Indigenous identity as deficit. Matthews describes this knowledge base, this system of learning as ‘Terra Nullius’ education.

Matthews offers the Cloud Model as an alternative. In the Cloud Model the perception of mathematics shifts from a rigid objective discipline that must be learned to a creative process in which students express their own language and creativity. Using this model he has designed a Culturally Responsive Pedagogical approach to the teaching and learning of mathematics. The pedagogical tool, Maths as Storytelling, has the potential to impact deeply on the teaching and learning of mathematics for Indigenous students.

² www.8ways.wikispaces.com

What is Maths?

Matthews begins by posing the question, what is mathematics? He uses data collected in professional development sessions and lectures, where he asks participants for their views on ‘what is mathematics?’ Several themes emerge (see Figure 7.1):

- ▶ The first theme is that mathematics is a tool that must be learned to solve complex problems – it is about numbers, operation and problem solving.
- ▶ The second theme is about what participants feel about mathematics. Some say they love it, but many say they don’t.
- ▶ Everyone agrees they use mathematics in their everyday lives – for shopping, timetables, cooking and trades. But ‘everyday’ mathematics is limited to concepts such as measurement, space and estimation (arithmetic or early algebra).
- ▶ When the discussion comes around to ‘high level mathematics’ (such as matrices and calculus), it is understood that it is used by professionals such as engineers, and is the knowledge of the ‘elite’. In this discussion a stereotype emerges of the mathematics ‘nerd’ or ‘social recluse’ with an innate ability to comprehend the incomprehensible.

Matthews then poses the question that if mathematicians working with high level mathematics are stereotyped as ‘not being normal’, the result is a cognitive gap between everyday mathematics and high level mathematics. This stereotype and cognitive gap will impede access to mathematics for all students, and significantly will further marginalise Indigenous students who are already marginalised by the education system.

Matthews offers an alternative view of mathematics from Praeger (2008) writing in the Australian Mathematical Society (AMS) gazette. Praeger reflected on her passion for mathematics, which comes down to three interconnected essential elements: power, truth and beauty.

- ▶ **Power** – The power of mathematics is that it allows practitioners to make sense of the world and transform society. Mathematical thinking applies to all facets within society.
- ▶ **Truth** – There is truth in the precision of the mathematical language. If students engage in the search for truth under guiding assumptions, they will develop critical and logical thinking skills.

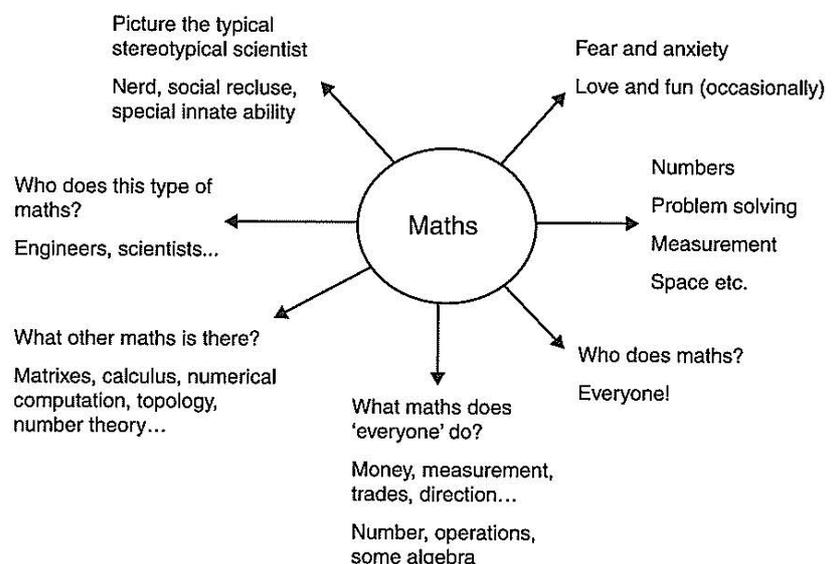


Figure 7.1 Emerging themes from the question ‘what is mathematics?’

- ▶ **Beauty** – There is beauty in mathematical patterns and the power to solve real world problems.

Praeger quotes mathematician and philosopher Bertrand Russell that mathematics ‘possesses not only a truth, but a supreme beauty; a beauty cold and austere, like that of sculpture’. Matthews uses this as a springboard to the deconstruction of the abstract question “What is Maths,” and notes that a dichotomy starts to emerge:

- ▶ Mathematics is a powerful tool that can solve real-world problems through its rigour, precision and logic.
- ▶ Through this objectivity, absolute truth is found – we are removing subjective notions that could bias the situation.
- ▶ Yet we can also discuss mathematics as beauty, as a practice like music. This suggests that mathematics could be situated in the subjective as well.

The issue arises that many students experience mathematics in its abstract form only, and the loss of beauty and connection leads to the negative stereotype and definitions of a type of learning style. This disconnection from lived experiences leads students to the view of ‘why am I learning this? I’ll never use it again.’ Matthews suggests there is an overwhelming need to create a new pedagogical paradigm where mathematics is seen as a creative act and students can express themselves through mathematics in the same way they would in music or visual arts. In other words, students can reflect on their reality, create mathematical relationships and use mathematics to convey these understandings.

Pedagogical Tools

Matthews introduces The Cloud Model (Fig 7.2), which shows a cycle in which the development of mathematics starts with the reality of the observer, and mathematics is an abstract representation of this reality. The model has three main interconnecting ideas that inform the process of abstraction and creativity: creativity, symbols and cultural bias.

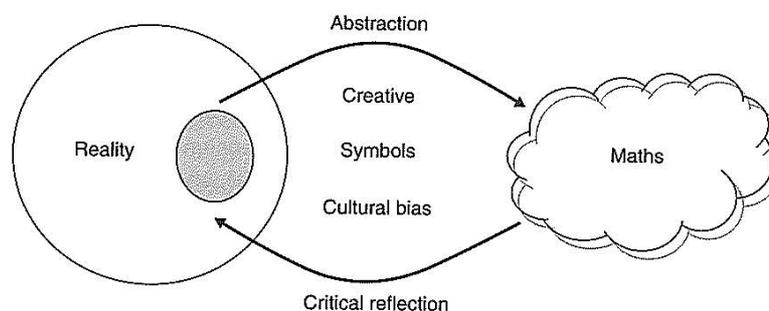


Figure 7.2 The Cloud Model (Matthews, 2009, p. 47)

Creativity

By virtue of the dynamic of observation and abstraction, Matthews contests that

- ▶ Mathematics “is a creative act similar in nature to other creative pursuits such as music, dance, language and visual arts”.
- ▶ Mathematics has a particular lens on the world through the notion of quantification (measuring) and explores how these quantities connect, relate and interact.
- ▶ These relationships form patterns and structures of mathematics that strongly reflect the patterns and structures in our reality whether rainfall patterns or the growth of a sunflower.

At the Institute, we would suggest that this connection of the world to patterns also relates to Gaibarau’s definition of the South East Queensland Indigenous Knowledge definition of Mimburi as a process of flow – the continual flow of every living thing and the relationships with one another (Gaibarau in Steele, 1983).

Symbols

Matthews attests that, like any language, mathematics has its own language and conventions so that ideas can be communicated readily. The symbolic language of mathematics has a strong connection with oral language, as concepts are first communicated through the oral language of the observer (Matthews cites Shafer, 2010). However, a problem arises when we classify the mathematical language as a subset of the English language and over-emphasise the learning of this mathematical language rather than mathematical skills. For a student who doesn't speak English as their first language, this becomes another barrier.

Cultural Bias

Matthew’s Cloud Model shows mathematics as a social construct with a cultural bias. The observer expresses their culture in the way they perceive reality, and during the abstraction process cultural bias exists in the oral language. Matthews suggests this bias should not be seen as a negative but we simply need to recognise this and see it as an opportunity for students to move freely within their worldview. In the same way, the **Stronger Smarter Approach** asks educators to recognise how 'out of awareness' cultural biases may impact on their teaching practice.

The Cloud Model

Matthews suggests the Cloud Model can be used as a theoretical framework to develop new pedagogies in the teaching and learning of mathematics. In the Cloud Model the perception of mathematics shifts from a rigid objective discipline that must be learned to a creative process.

The Cloud Model defines a symbolic language of mathematics rather than as part of a specific oral language. In teaching mathematics as part of the notion of self-expression, students can use their own language to explore the ideas and concepts embodied in mathematical symbols. In this way, the Cloud Model empowers teachers to

communicate deep knowledges through languages which are understood by the Jarjums.

Indigenous people and mathematics education

In addition, Matthews points out that Indigenous students are dealing with an extra layer of perceptions that non-Indigenous people have of them. Schools are microcosms of society, and the education system inadvertently creates barriers of access and therefore success for all students. Matthews suggests that as educators it is important to understand this. When the majority of teachers and principals are non-Indigenous, the relationships acted out every day between teachers and students, parents and communities are significant.

Matthews cites two studies:

- ▶ Howlett et al's (2008) study on student perceptions gives an example of the pre-conceived and entrenched ideas in relation to the negative perceptions of mathematics. "...I had a preconception that our people couldn't get to a standard like that."
- ▶ In a study by Howard (1998), students documented perceptions in relation to science. A common view was "you must become 'white' to succeed in education"

Terra Nullius

Matthews goes on to look at how Australia was colonised under the doctrine of terra nullius. The doctrine was only overturned in the early - mid 1990s, following the landmark Native Title case widely known as the Mabo Case and eventually through law via the Native Title Act.

Through an underpinning of unequal power relations and inequitable relationships, terra nullius devalued, dispossessed and marginalised Indigenous people.

The romanticised image of the 'Nobel Savage' has seen Indigenous people and cultures institutionalised and 'museum-ified'. Indigenous people were (and to some extent still are) seen as a relic "making way for the best stage of evolution".

David Unaipon

As an example of the 'silencing' of Indigenous people, Matthews uses the public and well-known figure, David Unaipon. Unaipon was a member of the Ngarrindjeri people of South Australia. In his work from the 1900s, he invented the modern shears that have revolutionised the shearing industry. Using Newton's laws of motion, he converted curvilinear motion into linear motion to invent the hinge that drives the modern shear. In his scientific endeavor, though, Unaipon could not secure the patent and never received any additional economic benefit. He was silenced in the Australian history references too. Although Australia was known as the economy that 'rode on the sheep's back', and Unaipon's invention revolutionised the shearing industry, it was only well after his death that he received any historical or academic attribution for his designs (Simons, 1994 and Shoemaker, 1989 in Matthews). Unaipon is commemorated on the \$50 note, but Matthews says whenever he asks the question in lectures 'Who has heard of David Unaipon?' the "silence is deafening".

(Matthews, 2015, p.111).

Matthews suggests that terra nullius created a void in the psyche of mainstream – creating a population of non-Indigenous people who know little about Indigenous people. In the absence of knowledge, the void has been filled by stereotypes that misrepresent Indigenous people and where Indigenous knowledges and cultures are seen to have no relevance in a modern, advanced, technological, industrial society.

Although these misconceptions are being refuted through academic knowledge, lived experiences and examples of Indigenous leaders in the field, Matthews explains “the silencing of Indigenous people still continues today” and used the story of David Unaipon as an example.

Matthews quotes Reconciliation Australia's survey, the 'Reconciliation Barometer' undertaken in 2008 and 2010 where the majority of respondents, both Indigenous and non-Indigenous believed that relationships between Indigenous and non-Indigenous Australia were poor, with low levels of trust. All those who participated in the survey valued better relationships. Matthews poses the question “does this dysfunctional relationship contribute to Indigenous student's underachievement?”

Indigenous education: A mathematical relationship?

Matthews suggests the development of positive relationships is fundamental to the teaching and learning of mathematics. This is not only the traditional teacher-student relationship but also the relationships between educators and parents and the community, and the relationships between “all people and mathematics itself”.

He then goes on to look at how the historical treatment of cultural knowledge like that of Unaipon is still being perpetuated through

Matthews cites two studies to show how terra nullius continues to impact today.

Deakin (2010)

Deakin comments on the Indigenous mathematics strand in the Australian curriculum and states that

- ▶ "Indigenous mathematics does not exist" and
- ▶ it is "neither useful nor beneficent to bestow on aspects of Aboriginal...cultures a significance that they do not, in fact, possess"

The reasoning behind Deakin's thinking is that Indigenous Australians did not build Gothic cathedrals.

Matthews describes this type of thinking is a prime example of 'terra nullius education,' and suggests it is derogatory to simply connect the construction of cathedrals with mathematics and in doing so dismiss all Indigenous Knowledges as having no relevance to mathematics? "

Jorgenson (2010)

Jorgenson's work draws on her experiences over 12 months as a remote area teacher, and uses this brief experience to explain why Western education should be assimilationalist, and that "learning school mathematics requires a conscious effort to take on board the knowledge structures of Western thinking".

Again, Matthews suggests that this view has an underlying assumption that mathematics exists only within Western knowledge frameworks, and that Aboriginal cultures have no connection with mathematics.

more recent researchers. He looks at two works by Deakin (2010) and Jorgenson (2010) which both dismiss Indigenous Knowledges as having no connection with mathematics, viewing mathematics only within Western knowledge frameworks.

Matthews suggests that to move forward to deeper relationships between non-Indigenous and Indigenous Australia, we need to break the silence and accept the doctrine of terra nullius as our shared history. We need to understand that terra nullius is a form of pedagogy which is 'all-pervading' in a majority of schooling contexts and understand the privileged positioning. In essence, Matthews says he is stating that we need to “unlearn what we have learned, value what we have historically devalued and start developing a trusting relationship”. If we are to move forward with a new and deeper understanding of mathematics and its potential to embrace Indigenous cultures, Matthews asserts, “we cannot afford to start from the premise of an assimilationist education paradigm that positions Indigenous cultures as deficit. Matthews signals that to create a meaningful relationships between people and mathematics, we need to see mathematics as a social construct or a cultural expression.

Mathematics as storytelling: Creating a relationship

Matthews explains two pedagogical approaches that have been developed from the Cloud Model: ‘Maths as Storytelling’ and Maths as Dance.’ Just as any strong narrative with meaning and feeling, Maths as Storytelling takes sequential steps in learning and sharing. These steps are:

1.

Understanding symbols

Students explore the use of symbols to construct abstract representations

2.

A simple maths story

Students act out a simple maths story

3.

Students representation - unstructured

Students represent the story using their own symbolism (see Fig 7.3)

4.

Students representation – structured

Teachers lead students through a more structured representation of the story using concrete materials

5.

Sharing symbol systems

Students represent another maths story with the same symbols

6.

Modifying the story

Teachers introduce algebra concepts by removing one unit of the concrete materials and challenge students to work out different ways for the story to make sense again.

Figure 7.3 from the chapter shows a Jarjum's simple maths story (Step 3).

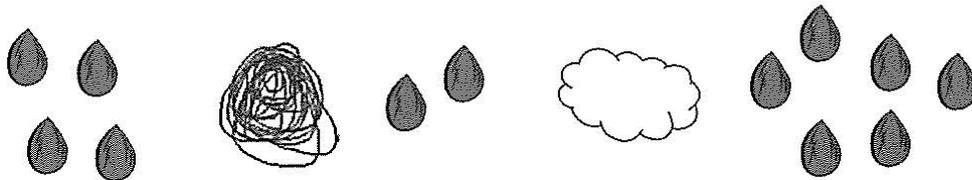


Figure 7.3 Year 2 student's representation of $4 + 2 = 6$

The joining story the Jarjum used was of a vortex sucking two groups together and a cloud picking them up and placing the two groups together as a whole.

Maths as Dance has similar steps where students create and perform a dance for their story. This was developed at a student camp where Matthews says the Jarjums “created amazing stories...about hunting...rain”. Moreover the songman who shared his deeper Indigenous Knowledges shared beats, rhythms and paint designs for their performances. This extra layering or symbolism of knowledge again exposed students to “different types of extraction”.

Conclusion

Matthew's concludes that the perception that mathematics transcends people is damaging, and we need to reconnect people by viewing mathematics as a cultural product. The beauty of mathematics lies in that fact that mathematics that is alive – a knowledge that connects with all people, allowing different expressions of ideas and the emergence of new ideas

In order to sustain such a pedagogy in schools, Matthews suggests that

- ▶ Schools need to develop positive relationships with the Indigenous people of their region – particularly through the leadership of principals.
- ▶ All education workers must accept and understand their position within the nation's shared history of terra nullius, since this is the starting point of the relationship between Indigenous and non-Indigenous people. Non-Indigenous people need to unlearn what they learned.
- ▶ Schools need to provide a space within their schools for Indigenous people to start a meaningful dialogue about their children.

The education system has created and reinforced certain perceptions of mathematics. Maths as Storytelling, applying Cloud Model of learning, provides a more Culturally

Responsive Pedagogy and enables the development of a more culturally relevant curriculum. The power of this pedagogy lies in the deep connection to Indigenous knowledges and the co-creation of curriculum materials. This is a salient point from mathematics research, connecting people to mathematics through their own cultural lenses. This model provides a flexibility of approach and depth in connection to the big ideas of mathematics which enables deeper cultural understanding to flow.

The development of the Maths as Storytelling to Maths as Dance shows how far the schooling environ can develop and support Indigenous practitioners in the sharing and developing of culturally rich and responsive curriculum and pedagogies. The investment in the higher order thought processing of this Nunukal man will help ensure that our education systems can move beyond terra nullius. To that end, as a truly empowering pedagogy, we leave with the words of the Jarjums in Matthew's study, "We mixed our culture and mathematics...and it surprised me. I can now walk away with a different understanding of Math and my Aboriginal heritage".

Summary of 'Key Points' from the Research Paper

Matthews essentially addresses all the **Stronger Smarter meta-strategies**, and the key point of his research are summarised below using the meta-strategy framework.

Metastrategy 1: Positive student identity

Matthews begins by looking at perceptions of mathematics as being the knowledge of the elite, and the stereotype of mathematics 'nerds.' In addition, there are cultural biases in mathematics perceptions, and Indigenous students are dealing with an extra layer of perceptions about how they are seen by non-Indigenous Australia. Matthews suggests this can all contribute to the relationship that Indigenous students will have with mathematics, and can ultimately contribute to their underachievement.

The Stronger Smarter metastrategy recognises the importance of a positive Indigenous student identity, and supports Matthews' view that we need to reconnect people by viewing mathematics as a cultural product. The **Stronger Smarter Approach and Philosophy** supports educators to move forward with a new and deeper understanding of mathematics as a cultural product with a strong relationships to Indigenous cultures, and away from an education paradigm that positions Indigenous cultures as deficit.

Metastrategy 3: High-Expectations Relationships

Matthews talks about the importance of relationships not only the traditional teacher-student relationship but with community and parents. For non-Indigenous Australia, building these relationships requires an understanding of terra nullius and Indigenous Knowledges. The importance of relationships is supported by both the **Stronger Smarter Approach**, and recent research from Far North Queensland by Lewthwaite et al (2015). The **Stronger Smarter Approach** uses the ideas of High-Expectations

Relationships and equal power-relating as a way to create equitable relationships between Indigenous and non-Indigenous Australia. The Stronger Smarter concept of High-Expectations Relationships (Stronger Smarter Institute, 2014) provides the tools to develop such relationships with their Indigenous students, families and communities.

Metastrategy 4: Innovative school models

Matthews explains relationships need to change around the conceptualization and delivery of mathematics in education. Relationships need to change between “all people and mathematics itself”. This requires innovative school models that use new pedagogies. Matthews notes that, “from this type of pedagogy, it is evident that students can start their learning in mathematics through self-expression that values the student's current knowledge”.

Matthew's Cloud Model provides a strength-based theoretical framework to develop new Culturally Responsive Pedagogies in the teaching and learning of mathematics. This model provides a flexibility of approach and depth in connection to the big ideas of mathematics which enables deeper cultural understanding to flow. This model, much like Dr Grant's Holistic Planner (Grant, 1998) or Yunkaporta's '8-ways' learning model, gives teachers an opportunity to step back and look at the curriculum and the pedagogy through a different and more culturally responsive lens (Perso, 2012; Lewthwaite, B. et,al, 2015).

Metastrategy 2 and 5: Embracing Indigenous leadership and Innovative staffing models

Finally, Matthews suggests for such Culturally Responsive Pedagogies and to truly support a positive sense of Indigenous student identity, there needs to be a meaningful relationships between the school and the local Indigenous community. School's need to recognise the value the community can bring to the school, to recognise the knowledge that Indigenous Education Workers bring to the school, and value their expertise as co-educators in the classroom.

Stronger Smarter Recommendations and Provocations

- ▶ The Stronger Smarter Institute endorses the use of Culturally Responsive Pedagogies (Lewthwaite et al, 2015). We recognises the Cloud Model as a 'Deadly Teacher' technique (Stronger Smarter Institute, 2017) that has the potential to not only close the education gap in mathematics but also provide a national learning tool which embeds Aboriginal perspectives.
- ▶ Matthews defines in a curriculum and pedagogical sense that a re-thinking and reorganisation of relationships needs to occur in order to develop more Indigenous Jarjum connections and outputs in mathematics. At the Institute we believe that High-Expectations Relationships are the underpinning of personal and school transformations (Stronger Smarter Institute, 2015). The insight with this research is that within the boundary or border of classroom applications, the relationships need to fundamentally shift and in the mathematics sense, deepen if real change is to occur.
- ▶ There is further deepening and sharing of research insight available through the Institute's data bases which our Research and Impact team can now further track and share.
- ▶ With over 2500 participants in our Stronger Smarter Leadership Program across 780 different schooling environments around the country, this is a Stronger Smarter Approach 'call to action' to educators to consider Culturally Responsive Pedagogies within their classrooms.

Supported by other research

- ▶ The fundamental difference of and experiences with mathematical knowledges is a national priority highlighted through STEM (e.g. National STEM school education strategy).
- ▶ This research paper's direction and articulation of Indigenous voice also speaks to the growing Indigenous Australian research voice of and on our identity construction. The Institute also signals the latest research conducted by Indigenous quantitative leads, Walter and Anderson. Their work on 'nayri kati' or good numbers goes a significant way in repositioning Indigenous quantitative data analysis away from the production of a 'gaps' conversation. It also provides a deeper analysis as to what 'terra nullius' teaching and 'deficit' constructs look like and how these impact on Indigenous perceptions of self and community (Walter, & Anderson, 2016).

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