



The Australian Journal of **INDIGENOUS EDUCATION**

This article was originally published in printed form. The journal began in 1973 and was titled *The Aboriginal Child at School*. In 1996 the journal was transformed to an internationally peer-reviewed publication and renamed *The Australian Journal of Indigenous Education*.

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Embedding Indigenous Perspectives in Teaching School Science

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Some Indigenous students are at risk of academic failure and science teachers have a role in salvaging these equally able students. This article firstly elucidates the research entailed in Indigenous science education in Australia and beyond. Secondly, it reviews the cultural and language barriers when learning science, faced by middle and senior year students of Aboriginal and Torres Strait Islander descent. Finally, it outlines the effective strategies that science teachers could adopt to better engage these students in learning school science. In summary, the article will highlight the need for teachers to realise the importance of crossing borders from teachers' school science culture to students' culture. This holds implications for teaching practice and teacher identity in today's classroom.

■ **Keywords:** cultural and language barriers, school science, crossing borders, academic failure

How do you teach and learn from Indigenous Australian students who make up more than 8% of the total student population in Queensland schools (Australian Human Rights Commission, 2008) unless you understand how they see and experience the world? How do you make Indigenous students understand school science unless you have an insight in what is meaningful and relevant to them? These basic questions are fundamental when engaging other cultures, particularly working with Indigenous students.

This article will initially provide an insight of Indigenous science education research followed by the current educational status (middle–senior years) of Aboriginal and Torres Strait Islander students. The article attempts to identify and comprehend their cultural and language barriers. Furthermore, it demonstrates how the understanding of these barriers of engagement is used to work out effective strategies to engage Indigenous students in learning school science. Interweaving the 'barriers of engagement' and 'effective strategies to engage' enables educators/government, parents and the community to assist Indigenous students who are at risk of academic failure. Finally, an informed critical reflection on the personal implications of these research findings is elucidated in regard to teaching practice/teacher identity.

Indigenous Science Education Research

Indigenous knowledge is highly debatable, yet a focal issue in Indigenous science education. Debate about the nature of Indigenous knowledge, the nature of science and the relationship between the two, has been ongoing, with little sign of moving towards a resolution (Clark, 2006; Simon, 2003). Multiculturalists support discussions of 'Maōri epistemologies' (Salmond, 1985, pp. 240–241) and 'Aboriginal ontologies' (Christie, 1991, p. 26) hence lending credibility to the idea that 'Indigenous sciences' are whole, separate systems of knowledge, which are of equal status to western science. Indigenous knowledge and science are two incommensurable discourses, neither of which can be judged against the criteria of the other (Lyotard, 1988). The understanding of this difference has inspired authorities to incorporate Indigenous knowledge into science programs, or contextualise western science in

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Indigenous settings. Unfortunately, these efforts have often resulted in tokenistic inclusivity in that they produced caricatures of cultural knowledge (McKinley, Stewart, & Richards, 2004), without accounting for sociopolitical relationships. More recently, Aikenhead (2001) proposed a cross-cultural approach to science teaching. He argued that western science is a cultural entity itself (i.e., one of many subcultures of Euro-American society) and while students exist in a cultural or subcultural setting, whether it be in the form of varying language, class, ethnicity, geographic location, they need teachers who are willing to be 'culture brokers'. These teachers can identify the students' cultural borders and assist them in crossing those borders.

In education, knowledge and language are intricately interwoven and the discussion of one cannot be fully separated from another (Aikenhead, 2001). English language in school science can present a strong barrier to Indigenous students, firstly, because of the importance of language politics in Indigenous education (Williams, 2007), and secondly, due to the complex vocabulary of the science language (Harlow, 1993).

Current Educational (Middle–Senior Years) Status of Indigenous Australian Students

Indigenous education in Queensland schools includes the education of Aboriginal students and Torres Strait Islander students and the education of all students about Indigenous Australian communities and its cultures (Queensland Department of Education and Training [DET], 2009). In contrast to pre-2001, educational attainment among Indigenous peoples has started to improve. The National Schools Statistics Collection showed that, in 2007, the apparent retention rate for Indigenous full-time students from Year 7/8 to Year 10 was 91%, and to Year 12 was 43%. Year 12 completion rates improved in all states and territories, with the largest increases recorded in Tasmania (17%–22%), the Australian Capital Territory (42%–46%) and Queensland (26%–30%; ABS, 2008).

Despite these improvements, however, Indigenous peoples aged 15 years and over were still half as likely as non-Indigenous Australians to have completed school to Year 12 in 2006 (23% compared with 49%). They were also twice as likely to have left school by Year 9 (34% compared with 16%). Sadly, these relative differences have remained unchanged since 2001 (ABS, 2008).

Barriers of Engagement Faced by Indigenous Australian Students

Students may fail to complete their secondary education because they are disaffected with school. A student perceived to be disaffected is said to be at-risk (Batten & Russell, 1995).

Low academic achievement has been identified as the consistent predictor of school drop out (Battin-Pearson et al., 2000). Convincingly, low academic achievement may be thought to result from low ability levels. Meta-analysis of several research studies has led American researchers to conclude that IQ explains only 25% of the variation in schooling outcomes (Sternberg, Grigorenko, & Bundy, 2001). Boon (2008, p. 86) pointed out that cultural context may be a good indicator of the substantial differences observed between Indigenous and non-Indigenous educational outcomes which in turn leads to either academic resilience or at-risk trajectory.

The relevance of the school curriculum is a key factor in Indigenous students leaving school early (Fleming, 2005). The western worldview of intelligence emphasises facts, explanations, decontextualising and producing knowledge for the sake of it to progress society (Aikenhead, 2001). On the contrary, Indigenous worldview of intelligence accentuates value, spirituality and holistic views, contextualising and producing knowledge for cultural outcomes to maintain society (Northern Territory Department of Employment, Education and Training [NTDEET], 2006). This conflict of knowledge may impact the emphasis placed on schooling. In addition when there is Indigenous material present in the curriculum, it implies cultural homogeneity. Indigenous communities and societies in Australia display great diversity in culture, custom and language. Appleyard (2002, p. 31) argues that this loss of identity can lead to a loss of self esteem and respect, culminating in educational failure.

Cultural exclusion is an essential factor in the high rates of attrition among Indigenous students (Fleming, 2005). There is evidence to support the argument that the contemporary disadvantage faced by Indigenous people has its roots in the colonial past and that ensuing government policies have discriminated against Indigenous people (Thomson, 2002). In addition, the concept of racism constructs a further barrier for Indigenous students and would certainly affect their desire to go to school.

Indigenous students face the challenge of translating and understanding English language as a medium of instruction in school science. Aboriginal English may not suffice in some instances, to translate and understand the context–language interface in both written and oral discourse (Tangen et al., 2010). It can be 'disempowering' for Indigenous students when a science lesson burdens them with firstly, a separate worldview that challenges their own, secondly, a language that they does not relate to, and thirdly, a context that has history of discriminating their ancestors.

Effective Strategies to Engage Indigenous Students in Learning School Science

Some effective strategies that can engage Indigenous students in learning school science are discussed under the characteristics of 'quality teaching and learning' for Indigenous students outlined by the Australian Academy

of Science (2009). These strategies aim to address cultural and language barriers.

Teacher–Student and Teacher–Community Relationships

A teacher's expectations are a major determinant of Indigenous students' achievement in school science (Ministerial Council of Education, Employment, Training and Youth Affairs, 2001). An effective educator differentiates teaching approach (e.g., use of games, demonstrations, role-playing, drama, music, and art) to accommodate different learning styles and uses language in purposeful ways 'to promote inclusive practices via use of multiliteracies and multimedia' (Watts-Taffe & Truscott, 2000, pp. 261–262). Scaffolding instruction to encourage 'academic wiseness' among both Indigenous and others students will provide a framework that builds on the students' strengths.

Educational outcomes of Indigenous students have improved in the presence of Indigenous personnel in the school system (Winkler, 2006). Indigenous Elders (the carriers of language, values, and worldviews) can assist in crossing borders. The use of Aboriginal and Torres Strait Islander education workers (AIEWs) provides association and awareness of cultural rules and expectations hence allows meaningful connections to be established between teachers, schools and the community (Moyle, 2005).

Supportive Classroom Environment

Teachers need to be culturally responsive and be aware of the conflict between western science and Indigenous knowledge. Science teachers should make an effort to include the students' worldviews and needs in the learning context, for example, when teaching the strand Life and Living (Queensland Studies Authority [QSA], 2004) students could be asked to identify personal understanding of similarities and differences compared to the other familiar living things. The Australian National Curriculum includes the topic Science and Culture under Science as a Human Endeavour strand that proposes discussions on health issues and cultural knowledge; traditional sustainable practices; aboriginal weather features/seasonal calendars; and Aboriginal X-ray art, and understanding on animal biology (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2010).

Indigenous languages are inseparable from students' experiences in school science. Teachers can motivate students by using students' Indigenous language as an asset rather than a deficit in learning. Indigenous words and their concepts contain rich sources of hidden knowledge about the natural world (Michelle, 2008). Teachers could encourage use of Indigenous language in school science which requires observations, hypotheses, experimental results, and the development of explanatory theories. This strategy could be used to inform classification of plants and animals in science. Indigenous students can be encouraged to work out the meanings of Eurocentric

science ideas in their first language and translate them back into English. This can improve teachers' understanding of students' knowledge, and also motivate students to understand both worldviews.

Recognising Indigenous Students' Knowledge Systems

When a teacher recognises and uses Indigenous knowledge from students, the classroom environment changes positively, creating a new shared responsibility for learning. This fosters reciprocal respect and increases students' willingness to accept a teacher's agency. It is paramount for Indigenous and other students to view themselves as good learners (Sarra, 2003). Ownership of learning in turn results in positive self-identity hence producing much better outcomes for Indigenous students.

Learning Strategies/Approaches

Literature identifies learning strengths among Indigenous students. These include (a) holistic more than analytic, (b) visual more than verbal, (c) oral more than written, (d) practical more than theoretical, (e) reflective more than trial-and-error, (f) experiential more than passive, and (g) oriented to story telling sessions more than didactic sessions (Hughes, More, & Williams, 2004). School science usually emphasises the latter rather than the former components of learning. Teachers need to be aware that a classroom that encompasses the recurrent learning strengths of Indigenous students will engage most Indigenous learners.

Links With Indigenous Communities

Local artefacts and community events in class that connect with the science curriculum can be introduced to make school more relevant. Teachers' familiarity with and application of the Indigenous talking circles foster the expression of multiple perspectives, a critically important aspect in scientific problem solving. Teachers can empower students as they explore, describe, and share positive contributions made by Indigenous people in fields related to Eurocentric science and technology that includes the preparation and uses of drugs in 'bush medicines' and land management using fire ('firestick farming').

Education Queensland has accepted the challenge to 'close the gap' between Indigenous and non-Indigenous student outcomes. The *Closing the Gap Indigenous Education Strategy* discretely embeds the Aboriginal and Torres Strait Islander perspectives in the curriculum (Prep to Year 12) in an attempt to address cultural engagement. Some of the initiatives include use of cultural activity in curriculum, cultural awareness training for teachers, cultural and spiritual rituals and the National Aboriginal Islander Day Observance Committee (NAIDOC) activities (DET, 2009). Educators, parents and the community can be hopeful that these timely and admirable strategies can address the risk of academic failure in Indigenous Australian students.

Implications for Teachers

Research on Indigenous students warrants teachers to appreciate the cultural differences that an educator needs to work with to achieve positive educational outcomes for all. Empathy and respect for cultural identities need to be priority values in a classroom to ensure support for Indigenous students in the learning environment. Teachers need to embrace a multifaceted role in their classroom settings. They need to understand the cultural perspectives of a learner other than themselves when they introduce scientific concepts. And as a culture broker, they should help students cross borders between their culture and the subculture of school science. These practices will produce a culturally responsive teacher that is crucial to the customised design of any learning space. This is essential to the maturity of Australia as a nation and fundamental to the development of an Australian identity.

Conclusion

The best way to engage Indigenous students is for educators to begin to build cultural bridges between their familiar scientific world and the students' cultural world. Language and culture should be used as an asset rather than barriers to learning in today's classroom. More specifically, (a) use of culturally diverse instructional material, (b) helping students to cross borders, (c) appointing cultural guides from the community, and (d) scaffolding instruction, can effectively engage students. In making links with the different communities teachers increase awareness and connection between the student, the subject and themselves. Embedding Indigenous perspectives when teaching science will help Indigenous students find meaning and relevance in the education system that might improve students' retention rates and alleviate their risk of academic failure.

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