Stronger Smarter Institute
Research & Impact Footprinting

Full Reading Review

"A pedagogical model for engaging Aboriginal children with science learning"

Stronger Smarter Meta-Strategy links:

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

This Reading Review looks at an article by Mark Hackling, Matt Byrne, Graeme Gower and Karen Anderson published in 2015 in the Teaching Science Journal of the Australian Science Teachers Association. The authors undertook an analysis of science lessons that were delivered by Scitech, a not-for-profit organisation based in Perth whose mission it was to increase the interest and participation for Aboriginal Western Australians in STEM education. The purpose of the study was to identify pedagogical practices that were particularly effective in engaging Aboriginal students in learning science. The authors propose a model to underpin approaches to teaching Aboriginal children, and possibly other children, who are not engaged with learning science.

Contents of this Review

Why the Research?

As reported by the Office of the Chief Scientist (2014), it is estimated that seventy-five percent of the fastest growing occupations now require Science, Technology, Engineering and Mathematics (STEM) skills and knowledges. As noted by the Chief Scientist (2014) students engaging with an education in STEM will develop skills in creative and critical thinking and communication skills which are all relevant and highly valuable to an increasingly wide range of occupations. Workplaces of the future will be adaptive and nimble, and employees will need to be reflective of this. It is imperative that Aboriginal and Torres Strait Islander students be an integral part of this future.

The Stronger Smarter Institute's Indigenous Knowledges in STEM (SSiSTEMIK) represents the Institute's commitment to this agenda. The Research and Impact team have a mandate to gather, collate and create specific Indigenous Knowledge (IK) responses to "creative and critical thinking". We believe IK's, Indigenous communities and students are best placed to deliver on these key elements. Currently there is a dearth of SSiSTEMIK specific research. We highlight this paper in gathering more specific SSiSTEMIK text.

Hackling, Byrne, Gower and Anderson (2015) make the connection of low attendance rates to reduced student educational opportunities which have an impact in poor educational outcomes and decreased employment opportunities for Indigenous students. They provide evidence through NAPLAN (literacy and numeracy) and NAPSL (science) testing, as reported by ACARA (2013) that demonstrates that Aboriginal and Torres Strait Islander students' levels of achievement are significantly lower than their non-Indigenous counterparts, in fact they are around two and a half years behind in all domains of literacy, numeracy and science. Also reported through ACARA (2013) is the correlation with students' levels of achievement and the remoteness of schools, that is students' levels of achievement decline with increased remoteness.

The authors acknowledge that engagement through science is a way to provide opportunities for students to be physically and intellectually engaged which leads to learning. They note other key issues or considerations that need to be taken into account when delivering science programs to Aboriginal students:

▶ An acknowledgement that the culture of schools reflects the values and beliefs of the dominant culture.

▶ That science has its own language and ways of representing ideas which would require a cultural border crossing for students.

▶ That some science concepts may not be able to be translated for Aboriginal students because there is no equivalent science concept in their first language.

- Teacher's capacity to teach science is an important consideration because they may not approach or interact with students in the most culturally responsive way resulting in particular students being more advantaged than others and lastly,

- An acknowledgement that engagement is a multidimensional concept which needs to have behavioral, emotional and cognitive components. As Fredericks, Blumenfeld and Paris (2004) note students are engaged when they are behaviorally involved in learning tasks, experience enjoyment in science learning and are actively processing science ideas that motive them to learn more.

What is the Research?

In June-July of 2011 Scitech through its Aboriginal Education Program (AEP), delivered science programs to remote schools in Western Australia. Hackling, Byrne, Gower and Anderson (2015) who evaluated the program, reported that the program was the most significant initiative that addressed the science education needs for Indigenous students in Western Australian remote schools at the time. The authors showed that these visits by Scitech had significantly impacted students' rating of their enjoyment of science, curiosity about science phenomena and their rating of science as a favorite subject. The Scitech AEP team comprised three Scitech presenters and two researchers. The three Scitech presenters were non-Indigenous and not teacher trained but had a background in science communication. They completed internal Cultural Competency training prior to their visits to assist them in developing relationships with Aboriginal children. Out of the two researchers, one was Aboriginal and the other was non-Indigenous. The non-Indigenous researcher also completed internal Cultural Competency training prior to visiting the schools.

The Scitech AEP team visited thirteen primary and district high schools in the Mid-West Education District of Western Australia. From these thirteen schools, five schools who had Indigenous enrolments of greater than 70% were selected as Case Study schools. Students involved with the AEP showed a significant increase in their ratings of their enjoyment of science, their curiosity about science phenomena and their rating of science as a favourite subject.

The researchers drilled down into the field notes from classroom observations and transcripts of classroom dialogue and identified a set of eleven pedagogies that underpinned the success of the Scitech presenters in achieving these high levels of student engagement.

Pedagogical Practices

What follows is a short description of each of the 11 pedagogical practices (Figure 1.) that were identified by the researchers as the practices that underpinned the levels of engagement and learning of science for Aboriginal students in five remote Western Australian schools.
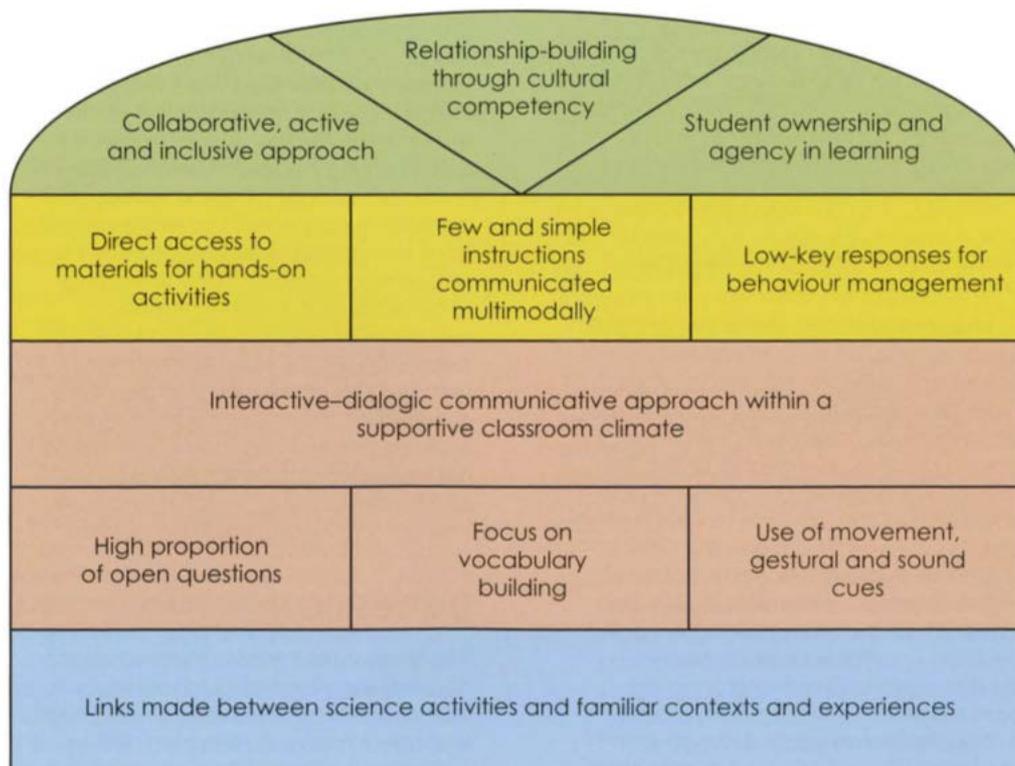

Figure 1. Pedagogical practices for engaging Aboriginal students with science learning

(from Hackling, Byrne, Gower and Anderson, 2015).

The Pedagogical practices shown in Figure 1 have four levels:

▶ Green – the top level is about building relationships and ensuring student ownership in their learning.

▶ Yellow – provides a pedagogical framework for engaging students through hands-on science activities.

▶ Beige - provides some specific pedagogical practices to maximise student engagement in classroom discourse.

▶ Blue – ensuring Culturally Responsive Pedagogies that link science to familiar contexts and experiences which enhanced the student's perceptions of relevance and assisted in facilitating the transfer of learning beyond the classroom.

Relationship building through Cultural Competency

The Scitech presenters recognised that relationship building was a key means of promoting Aboriginal student engagement in learning. They did this by

▶ Using a personal video to introduce themselves to the students prior to the school visits occurring to begin building a relationship with the students.

▶ Using students' first names in lessons so students felt recognised and acknowledged.

▶ Making concerted efforts to make other family connections with students to show that they were interested in who the students were which served to strengthen teacher and student relationships.

A collaborative, active and inclusive approach

The Scitech presenters conveyed a message of inclusivity by

▶ Using inclusive language to ensure all students contributed.

▶ Using a collaborative approach to convey the message that students and the presenters would be working together by regularly using of the language of 'we'.

▶ Ensuring that students had a sense that they were engaged and that they were also being supported by others in their learning.

Student ownership and agency in learning

The Scitech presenters conveyed high expectations that students can be scientists because they were engaging in the scientific process by

▶ Seeking input throughout activities and providing opportunities for students to bring their knowledge to the process.

▶ Giving direction and agency to students by providing opportunities for them to be responsive to the direction of the experiments.

▶ Refraining from giving answers to the students' questions, redirecting their questions to other students which allowed students to have more input and ownership in what they were doing.

Direct access to materials for hands-on activities

The Scitech presenters increased student engagement by having

- Activities that required students to manipulate equipment so that students were learning through doing.

- Students working in small groups of three which ensured each student could play an active role during the lessons.

- A high materials to student ratio to provide students with the opportunity to play active roles in their science investigations.

Few and simple instructions communicated multimodally

The Scitech presenters aimed to get students on task quickly by

- Giving few, direct and simple instructions which assisted with the smooth flow of lessons.

- Using visuals to enhance understanding when giving explanations and instructions.

- Ensuring that there were various modes of communicating instructions to students.

Low key responses for behavior management

The Scitech presenters applied 'fair' and 'firm' expectations by using

- Low key techniques to keep students on task and engaged which maintained the smooth flow of the sessions.

- Proximity, pauses and eye contact to keep students engaged and on task.

- Visuals, non-verbal cues and audio cues to assist with students understanding of what they were required to do and to keep students engaged - for example use of student's names by presenters.

An interactive-dialogic communicative approach within a supportive classroom climate

The Scitech presenters ensured that students participated in a supportive classroom by

- Encouraging student contributions and participation through praise as well as restating student's responses to signify acknowledgement and acceptance.

- Using a communicative approach with turn taking shared between presenters and students.

- Using a dialogic approach so that a range of student ideas were explored.

A high proportion of open questions

The Scitech presenters increased student engagement and learning by using

- A large number of open questions to elicit student input and engagement.
- Open questions that engaged students in higher order thinking.
- Open questions that offered students opportunities to explore their own ideas and own ways of explaining those ideas.

Focus on vocabulary building

Science has its own set of language and ways of generating, testing and representing ideas. The presenters recognised this and ensured that the students increased their understanding of science vocabulary and scientific concepts by ensuring

- That scientific words were used in the context of the science investigations.
- The use of scientific words in context through forming sentences.
- Students were exposed to scientific language and concepts through using their words and language to describe what was happening followed by the presenter rephrasing and inserting scientific vocabulary.

Use of movement, gestural and sound cues

The Scitech presenters ensured that messages were given multimodally by

- Using gestural and sound cues for each of the science process terms to focus attention on them and provide another way for students to make meaning.
- Using movement, role play and gestures to enhance the learning experience.
- Reducing the dependence on language as a representational form by providing multimodal representations of science phenomena.

Links made between science activities and familiar contexts and experiences

The Scitech presenters enhanced the students' science knowledge and understanding by

- Making links between classroom science and real-life situations
- Highlighting that science is everywhere

Summary of Key Points

▶ <u>Engagement in the learning process is a crucial step</u> in eliminating the impacts of social disadvantage on educational outcomes. By putting in place a set of pedagogical practices that improve student engagement, the researchers found that student behavior and attendance improved.

▶ <u>Relationship building is a key means</u> of promoting Aboriginal student engagement and learning. Aboriginal students learn in and through relationships and this a crucial starting point for any program that is serious about effecting positive change for Aboriginal students.

▶ <u>Culturally responsive instruction that connects learning to</u> the local contexts and everyday lives of students <u>can support</u> Aboriginal students to be successful in school science. This research demonstrates how the Scitech presenters achieved a culturally responsive instruction that valued Aboriginal students' languages and cultural backgrounds. While some of the strategies may seem simple, the application of a culturally responsive pedagogy is deep. We would suggest that the next step for schools is to get to a point where the presenter does not need to come from an external organization but is a member of the local Aboriginal and Torres Strait Islander community. Schools will see success where they recognise that a culturally responsive pedagogy needs to be co-designed and co-delivered by local elders, using the expertise of the local community..

Stronger Smarter Provocations and Discussions

▶ To date there is limited research at the "intersection of Indigenous education and STEM" (Tynan & Noon, 2017). The Scitech program and the associated research contributes to the current body of knowledge about effective teaching of science to Aboriginal students. Hackling, Byrne, Gower and Anderson (2015) note the importance of scientific literacy for the future health and employment outcomes for all Australian citizens and state that further research is needed to better understand how programs like this one can increase opportunities for science learning for Aboriginal and Torres Strait Islander students. We strongly agree that this study provides a solid foundation from which educators can begin but also acknowledge that more research should be undertaken to support Aboriginal and Torres Strait Islander students to increase their levels of achievement in science.

▶ Since the inception of the Programme for International Student Assessment (PISA) testing in literacy, numeracy and science in the year 2000, Aboriginal and Torres Strait Islander students' levels of achievement have lagged behind their non-Indigenous peers by approximately two to two and a half years. Of particular interest are the latest results reported in PISA 2015 Reporting Australia's Results (Thomas, De Bortoli & Underwood, 2017). The report shows that Indigenous students have achieved significantly better results than their non-Indigenous peers in the following three areas:

  o Awareness of environmental issues

  o Environmental optimism

  o More knowledge of how science beliefs are constructed, even performing better than the average for all OECD countries.

The significance of these findings cannot be understated. Indigenous students demonstrate that they are more informed, more optimistic and have a better understanding of how value beliefs are constructed about science than non-Indigenous students. And yet, there is a complete disconnect between what Indigenous students know and their performance levels as demonstrated through NAPSL type testing (Thomas, De Bortoli & Underwood, 2017). Clearly, as educators, we have a responsibility to look further at what it is that we are doing or not doing in the classroom that is contributing to these achievement levels. As educators we need to capitalize on this clear interest and understanding of science that Indigenous students are demonstrating and translate that into higher levels of achievement. In a world where STEM is becoming so important, it would be catastrophic if we as educators did not take advantage of this.

- At the Stronger Smarter Institute, we focus on strength-based approaches. This research clearly supports the same approach. The focus is strongly on workable solutions and not on delivering watered down programs (Sarra, 2011). For example:

  o building students scientific vocabulary;

  o using open questions to assist students in honing their understanding of what concept was being taught;

  o the use of movement, gestural and sound cues to ensure clear communication; and

  o teachers delivering few and simple instructions multimodally to cater for different learning styles that aren't heavily focused on pen and paper modes of communicating.

  The presenters knew what the barriers to learning were for the students and they chose to implement strength-based solutions through the eleven pedagogical practices.

  At Stronger Smarter our specific response in this space is our new SSiSTEMIK program. It not only takes into account the pedagogical practices named in this research but goes to a deeper level to highlighting IK in STEM.

- The authors report that the Scitech presenters and researchers undertook Cultural Competency training prior to their visit to the schools. Cultural Competency training is an essential and necessary component for anyone who delivers or works with Indigenous programs or people. The Stronger Smarter Institute has been delivering Culturally Proficient training since its inception (2005). It is recommended that educators in IK space do deeper Cultural Competency training heading towards Cultural Proficiency other than just Cultural Awareness (Stronger Smarter Institute, 2017, Gorringe & Spillman, 2008).

Stronger Smarter Metastrategies

Metastrategy 1 - Acknowledging, embracing and developing a positive sense of identity in schools & **Metastrategy 3** - 'High expectations' leadership to ensure 'high expectations' classrooms, with 'high expectations' teacher/student relationships.

▶ A High-Expectations Relationships is an authentic two-way relationship built on 'firm' and 'fair' expectations (Stronger Smarter Institute, 2014). The Scitech program demonstrated how using High-Expectations Relationships and embracing a positive sense of cultural identity in students can improve engagement in science for Aboriginal and Torres Strait Islander students. The presenters used a collaborative, active and inclusive approach to learning. There was an expectation from the presenters that students would bring their own strengths and knowledge to the activity and collaborate with other students. By using the term 'we' the presenters included themselves in the group and created a safe space where students could build confidence and bring themselves into the activity.

▶ The presenters personalized their interactions with students, and the group work ensured that there was an expectation that all students would contribute to the activity. As a result, the sense of belonging in the classroom was high, and the group work and collaborative nature of the work meant that students had a sense that they weren't alone in the learning. All students were expected to take an active role and there were enough resources to ensure that this happened. This all contributed to student engagement and ultimately to student learning.

▶ High expectations were shown as a high level of trust in the students to use the resources so that the learning was shared, rather than the teacher stepping the students through the activity. Students felt they were contributing to the direction of the lesson and believed that what they think and know actually matters. The presenters recognised that using this type of pedagogy (Inquiry-based learning) can initially be quite challenging for some students who are used to being able to 'hide' and stay silent in the classroom to find they are expected to talk and contribute. The presenters ensured that there was a set of rules and a safe space for the students to talk, and to recognize that 'getting it wrong' is all part of the learning process.

▶ Contextualising the science activities into the everyday experiences of the students enhanced their perceptions of relevance and assisted in facilitating the transfer of their learning beyond the classroom. The inclusive approach used by presenters ensured that all students were acknowledged for who they were as Aboriginal students and for the contribution they could make to what was being learned,

Students see themselves as 'scientists' because of high expectations and language that was used by the presenters. A positive sense of student identity was being developed because students had agency and ownership of the learning through the pedagogy that was being used. In this way, a third cultural space (Nakata, 2007; Davis & Grose, 2008) was created or a 'cultural border crossing' as described by Aitkenhead, 2001, where students are able to bring their own knowledge into the classroom. This also helped to bring a sense of wellbeing for Indigenous students in that they feel their education has direct connection to Country and by studying science they can both give back to their community but also share knowledge with wider Australia.

► The use of an Inquiry-based pedagogy (Hackling, Smith & Murcia, 2010) is not an easy prospect, particularly for classrooms where it can be difficult to control student behavior. However, this research has shown that this can work, providing there are a number of steps in place. This involves starting from a strength-based approach, building relationships with students, and setting up processes for hands-on activities and groupwork. In this way teachers take on the role of the facilitator for students learning and the students are the directors and co-creators for their own learning which will have positive effects on student learning.

Metastrategy 2– Acknowledging and embracing Indigenous leadership in schools and school communities.

The Stronger Smarter Approach takes a strength-based view to embrace all Indigenous leadership in schools.

► The presenters in this project embraced the leadership of students by giving agency back to the students and allowing them to take on a leadership role. The presenters started with high expectations and a positive sense of student identity and allowed students to bring their own language to the classroom, gradually building on that to replace it with scientific language. By connecting activities to everyday life, giving a connection to 'that's what I do at home' lead to a recognition of "that's science, I could be a scientist." In this way, educators don't necessarily need a strong understanding of every culture they teach or to be a holder of all knowledge but can be the facilitator of student learning. The presenters did this through opening questioning where students had to focus and hone down on their own understanding.

► It's important for students to know that what they are surrounded by in their everyday lives is science. This is key to having them see themselves as 'scientists'.

▶ While this program provides a solid footprint for Aboriginal lead researchers to follow, input and feedback from Aboriginal and Torres Strait Islander Education Officers (AIEO's) and other Aboriginal community members on the content of the lessons would further enhance research by ensuring their Indigenous voice is included (Rigney, 2017).

Metastrategy 4 & 5 – Innovative and dynamic school models & staffing models in complex social and cultural contexts.

▶ We see this pedagogical framework as a solid starting point for any science program that is seeking to make a difference to Aboriginal and Torres Strait Islander students levels of achievement in science. We believe this begins with engaging students through peaking their curiosity, by giving students ownership and responsibility for their learning, by making the science relevant, by connecting it to their everyday lives, by making the learning enjoyable and by building authentic two-way relationships while operating within a high expectations relationship framework.

▶ The importance and integral nature of including AIEOs in the professional development sessions demonstrates the importance of AIEOs in the education of Aboriginal students. This can also serve to be the way in which these science lessons can have localised and Aboriginal and Torres Strait Islander perspectives embedded and delivered.

▶ The remote Western Australian schools in this study recognised that science needs to be taught by science specialists and brought in the Scitech AEP specialists. Putting funding into these types of programs ensures that students are receiving specialist knowledges. However, we also recognize that not all schools can have access to ongoing funding that allow these programs to be implemented all the time. What these schools have achieved by providing professional development to existing classroom teachers and AIEOs is begun to build the capacity and confidence of their own staff to teach science. At Stronger Smarter we encourage sustainable and localised solutions that benefit Aboriginal and Torres Strait Islander students and see local community working with schools to deliver the learning. We call this taking on the Responsibility for Change.

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