A Novel Approach to Developing Literacies in Indigenous Knowledge Systems and Western Science Knowledge: Lessons from Primary School Students in Australia

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This paper describes practices and lessons learned from a novel approach to promoting student literacies in both Indigenous knowledge systems (IKS) and Western science knowledge (WSK). Aboriginal and Torres Strait Islander students and their school communities within the South East region of Queensland were drawn together through their participation in the Queensland Department of Education, Training and Employment's iDream Challenge. The iDream Challenge was a university-government partnership scheme to engage Indigenous primary school students in schooling aspirational programs using technology-based challenges, designed by university partners. The iDream challenge activities that this paper focuses on was designed by the authors, two academics from a south-east Queensland University who asked students to explore both Indigenous knowledge and Western Science knowledge about a misunderstood animal (i.e. sharks, bats, snakes). The goal of this challenge was to generate student literacies in both IKS and WSK through the investigation of their animal. The results highlight that the students perceived Indigenous knowledges as relational to both the social and natural environment. Rather than focusing on the misunderstood animal, student representations of Indigenous knowledges told of a deeper moral message of what it means to live as an individual alongside other entities within a community. This knowledge was perceived as having communal ownership. WSK was presented as 'truth' through short factoids about the misunderstood animal and was not linked as 'belonging' to any person, community or social construction. In all ten projects, the students combined these knowledges to advocate for their animal. These projects illustrate strong examples of student agency, engagement and enjoyment with their learning in this cultural interface, which also affirmed the strategic purpose of the iDream Challenge to promote student aspiration and engagement in schooling.

Introduction

Successive governments acknowledge the need for partnership programs engaging Aboriginal and Torres Strait Islander (Indigenous) students in schooling (DEET 1993; Education Qld 2000; Robertson et al 2005; Behrendt, Larkin, Griew & Kelly 2012). As such, school-community-education partnership programs have a long history of policy support. Within South East (SE) Queensland state schools, 11.7% identify as Aboriginal and/or Torres Strait Islander (DETE 2014), which is significantly higher than the national average of 2.2% (Wilks and Wilson 2016). Whilst many education projects are geared towards Indigenous students in rural and remote regions of Australia,

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this paper focuses on a university-government project that engaged Indigenous students in urban and urban fringe areas of Queensland. Therefore, this paper contributes to the literature about education strategies for Indigenous communities in plain sight of urban decision-makers in Government.

In this project, entitled the iDream Science challenge, our university designed a science education challenge that required students to combine Aboriginal and Torres Strait Islander and Western Science knowledge (WSK). It required Elder permission to use appropriate terminology and Indigenous knowledge from the students' local area/country, local definitions and representations of Indigenous knowledges, and a reflection upon the relationships between Indigenous knowledge systems (IKS)[1] and Science. The outcome was the generation of a video using a relevant iPad application.

The videos revealed various understandings of IKS and WSK as they were 'enacted-in-action' (Quennerstedt, 2013) by Indigenous and non-Indigenous students and their teachers. Drawing on Dewey's (1938) definition of transactional understanding, Quennerstedt's (2013) research on students' video-recorded lessons establishes a claim that *knowing* and, therefore, questions of epistemology, can be seen as something students *do*, something practical. Wickman (2004: 325) argued that practical epistemologies are those "epistemologies that are used in a specific practice", such as the making of this video in which students' and teachers' beliefs and actions around how IKS are conceptualised and positioned in relation to WSK are depicted.

Embedded within this iDream challenge was the importance of reflecting on the wider socio-cultural framing of knowledge (the philosophies, agendas, history and practices) in order to generate literacy in both local IKS and WSK knowledge bases. Becoming literate in both ways of knowing implies placing knowledge within its social context (as described later in the paper). It should be noted that the iDream challenge was not intended to be implemented as part of the formal Science curriculum, but rather as part of an informal agenda where primary students could undertake this project during a time allocated by their teacher, or during their own time. As such, this challenge was not formally linked to the Australian Curriculum. However, in the implications and conclusion section of this paper we offer suggestions within the Australian Curriculum (Science) and Cross-curriculum priorities where this challenge could have been linked.

The intellectual web of life: Biocultural diversity and the need for literacy in IKS

The integration of IKS within formal school curricula is endorsed by the United Nations around human and children's rights (UN 1989) and Indigenous people's rights (UN 2007; MaRhea and Anderson 2011). The United Nations Educational Scientific and Cultural Organisation (UNESCO, 2010) highlights:

> *...formal education systems have disrupted the practical everyday life aspects of Indigenous knowledge and ways of*

[1] This paper will use the term Indigenous Knowledge Systems (IKS) to acknowledge there are as many knowledge bases as there are Indigenous peoples. This plurality recognises and values the many philosophies, forms and types of Indigenous knowledges globally.

> *learning, replacing them with abstract knowledge and academic ways of learning. Today, there is a grave risk that much Indigenous knowledge is being lost and, along with it, valuable knowledge about ways of living.* (1)

The emerging multidisciplinary field of biocultural diversity links cultural diversity with nature. Cocks et al. (2012) explains that in order to survive for thousands of years, Indigenous Peoples (IP) engaged in holistic, analytical observations of the natural environment, built awareness of natural patterns and relationships, and deeply integrated this knowledge of the local ecology into their cultural processes, languages and stories. Increased environmental knowledge led to enhanced cultural knowledge (Toledo and Barrera-Bassols 2008). Biological, cultural and linguistic manifestations co-evolved together to form complex, adaptive socio-ecological systems (Maffi 2007; Matsuura 2005). However, these traditional ways of knowing the world are marginalised in Western societies, favouring Western knowledge bases (Whatman et al. 2017) To varying degrees, each Indigenous culture continues to maintain and practice what has been learned from their Ancestors while adapting to present day understandings and conditions (Toledo et. al, 2001). As they adapt, they continue to enhance the biodiversity of knowledge and understandings of their local communities. The knowledge, stories, language and philosophy of these communities reflect the biodiversity of that specific location and will only be retained if culturally diverse languages and stories are actively prioritised and practised (Toledo and Barrera-Bassols 2008).

In this way IKS refers to more than just language, grammar and syntax, but constitutes a repository of cultural memories that underpin what Krauss (1992) calls *the intellectual web of life* which is not only essential to human survival, but crucial to the healthy functioning of the biosphere. Common to many IKS is the recognition of kinship, that all aspects of the biosphere are a part of a complex relationship and linked to spirit. This recognition of the connection of spirit to all living and non-living components of the biosphere allows the cultivation of respectful, responsible and moral relationships between these diverse parties. For humans, concepts such as caretakers and stewards speak to the need to be mindful of the responsibilities associated with maintaining these relationships (Whyte et al. 2016). Martin (2003: 209) advised that “we are part of the world as much as it is part of us, existing within a network of relations amongst Entities that are reciprocal and occur in certain contexts”. Other beings and entities have reciprocal responsibilities to humans. Protocols must be observed to ensure humans learn from other beings, entities and nature itself. Whyte et al. (2016: 31) suggests “it seems Indigenous protocols may approach the human condition as not a struggle to know the universe; the condition rather is to know ourselves well enough so we can act morally in the universe”.

Knowing ourselves as humans *in relationship* with all aspects of the universe, rather than *knowing the functioning of universe*, may be one of the great philosophical differences between IKS and WKS. If local IKS are able to be shared, then its respectful inclusion must become a priority in education systems locally, across the globe. Generating citizens who are literate in, and respectful of, their local IKS, may help to promote social and ecological justice

by focusing on what it means to live *in relationship* with all aspects of the biosphere.

We acknowledge a groundswell in many educational fields promoting the inclusion of IKS due to a widespread recognition that IKS have been neglected in Western forms of education. This field is larger still as there are multiple names associated with it, such as Traditional Ecological Knowledge (TEK). Afonso (2013) advocates that TEK is viewed as another term for IKS which is also underpinned by the above ideology. Environmental Education maybe another, although, Environmental Education is a broad and multifaceted field, and not all aspects endorse or include biocultural diversity or TEK. IKS offer an ideology and pedagogy resulting from long-term, ecological sustainable relationships between people, cultural understandings and infrastructure, and nature. The authors support the growing academic community that believes IKS offers an important contribution to all forms of Western knowledge and education, and notes the important work by scholars such as Nakata (2002), Nakata and Langton (2009) and Thorpe (2013) in archiving an Indigenous Knowledges academy. As the iDream challenge centered on WSK, so too will this paper.

Generating Literacies: IKS and the teaching and learning of Western Science

WSK is about understanding the natural world around us (Sammel 2012a). Cultures worldwide endeavour to make sense of the natural world to understand patterns and survive. This is a common goal between WSK and IKS, however they are underpinned by different epistemologies and methodologies (Ogawa 1995). WSK is founded upon rationalism, reliabilism, coherentism, empiricism, and induction, deduction and abduction (Wenning 2009). Whyte et al. (2016: 25) suggest:

> *Indigenous peoples have their own systems of knowledge for observing, collecting, categorizing, recording, using, disseminating and revising information and concepts that explain how the world works. The historic origins of Indigenous Sciences are unique to each IP and differ from the dominant scientific disciplines.*

IKS have their own processes and validation mechanisms supported and endorsed by their own communities. WSK also has rules endorsed by the Western Scientific community. This paper differentiates between the epistemologies of WSK and IKS and recognises the privileging of WSK within the Australian school curriculum (Sammel 2009; 2008a). As we do not believe WSK is superior to IKS, we designed the iDream project to speak back to this privileging.

Formal science education teaches WSK (Aikenhead and Elliott 2010). WSK education generates WSK scientific literacy: developing students' abilities to work and think like a Western scientist and believe what Western scientists believe about a concept (Eisenhart, Finkel, and Marion 1996; Sammel 2012b). Holbrook and Rannikmae (2009: 279) suggest reconceptualising scientific literacy away from "being viewed as the

possession of conceptual understanding of pure Science abstract ideas" towards the "ability to make decisions related to the technological applications of scientific ideas or socioscientific issues facing society". We argue scientific literacy must be situated within a collective experience, rather than being thought of as an individual attribute. A student who is simply a "receptor" of science facts and is able to read, write and talk science is not necessarily scientifically literate, as they must also understand the fundamental conceptual, epistemic and socio-cultural dimensions associated with the scientific community. The scientifically literate student must appreciate the collective view of what it means to do science, or how to think, communicate and argue in the beliefs and language of science (Lemke 1990; Roth and Lee 2002).

Generating literacy in local IKS requires students understand conceptual knowledge of IKS and the worldview within which IKS are situated. IKS offer students a more relational worldview, where identities can be strengthened in relation to the natural and social world. Enhancing students' sense of kinship with plants, animals, water, mountains, earth, moon, sun, and sky is common practice among Indigenous Peoples but less so within WSK (Baker 2016). The philosophy of kinship with living and non-living aspects of the biosphere presents as a common theme in global IKS. It acknowledges spirit in ourselves and others, recognising the sacredness and interrelationship of all things, and necessitates respectful, thankful and equitable actions. Martin (2003: 206) advises that "all things are recognised and respected for their place within the overall system...these relations serve to define and unite, not to oppose or alienate". Understanding local kinship philosophies requires local community engagement, involving Elders, knowledge keepers and the natural environment. This process requires local protocols that honour this sacred reciprocity. By learning about and enacting these protocols, teachers and students are more likely to build long-term, respect-based relationships with the local IP.

Becoming literate implies placing the learned knowledge within its social context, as well as being able to think critically and creatively, analyse information, and more accurately appraise the associations and impacts of our countless individual or community based choices and actions. Promoting literacies in IKS and WSK encourages a more narrative approach to learning where students can reflect on the both constructed knowledges. These knowledges are not oppositional or contradictory but complementary lenses through which students can explore and learn about the world (Aikenhead and Elliott 2010; Baker 2016). It requires schools to continually work with local communities to embed respectful, conceptually accurate understandings of IKS, while encouraging students to reflect on the wider socio-cultural framing of both knowledge (the philosophies, agendas, history and practices). Generating this level of inclusion necessitates schools offer frequent opportunities to learn with IP. It important for non-Indigenous educators to understand the privileging of WSK over IKS. This means understanding how a colonialist mentality has categorised IP as *the other* and has ignored and denied IKS in education as a way to justify, protect and perpetuate its own privileged position (Howard 1999). Recognising this will require deconstructing hierarchies of knowledge where IKS are framed as deficient (Adams 1988; Lomawaima and McCarty 2002; 2006). Because all knowledge systems are

alive, and lived by teachers, students and their communities, we advocate schools can have a significant role in taking on the responsibility of addressing and undoing the privileged position of white ignorance.

In the past few decades IKS has theoretically gained traction in science education in Australia, Canada, South Africa and other African countries, the United States of America, Central and South America, the Middle East, and the Far East (Naidoo & Vithal 2014; Ogunniyi 2007). There is a growing body of research investigating IKS and science education in South Africa since 2001, when IKS became a central tenet educational policy (Naidoo & Vithal 2014). This inclusion has shown to increase motivation and peer interaction, cultural awareness and relevance, has provided a more positive learning experience for students (Bang & Medin 2010; Diwu & Ogunniyi 2012; McKinley 2005). However, the inclusion of IKS in science education is still in its early stage, and research highlights that many teachers lack understanding and experience implementing IKS in their classrooms, even after taking University courses teaching the implementation of IKS into Western science education. Research from Naidoo & Vithal (2014) illustrates when teachers do include IKS in science education, they may do so with different pedagogical assumptions and approaches. These approaches many include merging both knowledge bases, or leaving them separated to stand alone. If these knowledge bases are merged, two approaches can be observed. The first is where teachers offer a neutralised form of IKS whereby knowledge is restructured so it aligns and supports WSK. The second involves teachers who are comfortable and familiar with IKS, and able to use their own background knowledge to integrate and validate both knowledge bases. This research also advises that teachers may include IKS into WSK, but present them as distant and separated. Identifying IKS and WSK as distinct is validated by assessment and examination pressures that rarely include IKS, but focus on WSK. Afonso (2013) advocates that the majority of teaching approaches illustrate a common pattern where the inclusion of IKS is still based in an assimilationist agenda, where teachers serve hegemonic agendas due to being inherently conditioned to legitimate WSK in their science education classrooms.

So, while many authors believe, as we do, that the integration of IKS into WSK is a worthwhile endeavour for multiple reasons, there is mounting evidence that suggests it is problematic due to the nature of (science) education, foundational ideological assumptions; structural application; linguistic barriers and understandings; assumptions of teachers etc. that have led to limited inclusion (Afonso 2013; Aikenhead, & Jegede 1999; Asabere-Ameyaw et.al. 2012; El-Hani & Bandeira 2008; Jegede 1998; Keane 2008; Naidoo & Vithal 2014; Ogunniyi 2007; Ogunniyi & Hewson 2008).

The potential for the practice of incorporating IKS into WSK is still to be realised. But this does not mean that teachers are not endeavouring to do so. Although, ways teachers may engage with this practice may contradict the theoretical goals that advocate for its inclusion. For example, based on Howard's (1999) and Sammel's (2008b) work, it is essential to understand social positioning and to deconstruct white privilege[2] when integrating IKS

[2] White privilege defines the social norms, expectations, measures of success etc., and benefits people in the hegemonically privileged group by extending them unearned advantages and benefits.

with WSK. As such, we pose four possible scenarios for the inclusion of IKS in the teaching and learning of Science: the contributions, additive, transformative and social action approach (see Table 1).

Table 1: Four perspective approaches to incorporating IKS in science education (adapted from Howard 1999 and Sammel 2008b).

Approach	Contributions	Additive	Transformative	Community Engagement
Content implications	The focus is identifying heroes, holidays, and happenings Usually a one off inclusion of IK in a Science lesson IKS presented in isolation from the community or epistemologies that the knowledge is located in The is no acknowledgement or reflection of power privilege positioning of knowledge	Indigenous content may be repeatedly integrated into existing curricula Indigenous concepts may be presented without acknowledgement of episiotomy or local context There is no or minimal acknowledgement of power or privilege positioning There is no critique of the hegemonic curriculum ideology or framing	There is acknowledgement of power and privilege positioning of Science Teacher seeks to become educated around how power plays out in the curriculum Teacher seeks to become educated in the content, epistemologies & protocols of IKS Teacher may or may focus on local IKS Teacher may or may not engage with local Elders or knowledge keepers	Elements of the transformative approach are included however, this is achieved by building relationships and working with the local Indigenous community. Structural and philosophical changes are made to the teaching and learning of Science to embed local IK in collaboration with local Elders and knowledge keepers. School demonstrates commitment to ongoing professional development of teachers with special emphasis given to local community knowledge. School facilitates, encourages, and provides resources for teachers to build relationships with local Indigenous community/ies. Content and evaluation developed and taught in conjunction with local Elders and knowledge keepers. Dedicated space given to Indigenous resources.
Pedagogic implications	Teacher makes a value judgements as to the type of Indigenous knowledge that would 'contribute' to the existing, unchanged Science content being taught Teacher may not communicate with any IP when making this choice Teacher may interpret the IK themselves Teacher may not focus on local IKS There is no or minimal recognition of epistemological difference.	Teacher 'adds' more Indigenous content to existing Science content but does not change pedagogy Teacher may not communicate with any IP when making choices around knowledge inclusion Teacher may interpret the IK themselves Teacher may not focus on local IKS There is no or minimal recognition of epistemological difference.	Schools leadership team encourages a systematic embedding of IKS. Epistemological difference is recognised and valued. Structural & philosophical changes are made to the Science curriculum to seek respectful embedding of IK Discussions of 'respectfulness' may or may not be made in consultation with local IP Teacher includes an evaluation element that includes IKS.	Indigenous Elders or knowledge keepers work with the teacher to co-develop the curriculum and are given an honoured (and funded) position in the classroom as negotiated Students asked to critically reflect on what is taught and to actively engage with their local Indigenous community/ies. School and community develop strategies to ensure correct protocols are used to enhance positive attitudes and perceptions about local IKS IK is placed within local context and the different epistemologies underpinning local IKS and Science are discussed in order to promote a deep understanding and valuing of both knowledges.
Consequence	Tokenistic and othering Presented as a comparison with students not seeing or understanding IK in its designated local context, or the value of IK in relation to the Science they are learning Students may have negative stereotypes confirmed about IP and IKS	May add more IK content than just a tokenistic perspective. IK may be directly compared to 'Scientific truth' and may be viewed as 'interesting stories'. This positioning constructs IKS as deficit. Students see limited value in IK in comparison to Science.	An educational goal is to help all students value IKS in their own right Privileging and marginalisation of knowledge are discussed The continuous embedding of IKS seeks to offer students the opportunity to understand IKS Local IKS may or may not be offered and so IK may or may not be understood within the local context	Additional to the transformative outcomes, students are encouraged to learn and respect local protocols Students are given the opportunity to understand the deeper moral messages embedded in local IKS about what it means to live as an individual within their community. Schools formally develop and maintain active partnerships with local Indigenous communities where protocols and process are developed for staff to be mentored and work with Elders and knowledge keepers (and these positions are respected and funded).

Table 1 highlights that good intentions to integrate IKS in science education are not enough. Even the most well-meaning teacher, without understanding white privilege and social positioning, can perpetuate positions of dominance and exclusion. Without understanding the complexity inherent within this task, and the without a depth of knowledge in Indigenous histories, cultures and educational studies, research has shown that teachers do not know where to start, fear doing or saying the wrong thing, and so may not attempt to acknowledge or embed IK knowledges in their classroom activities (McLaughlin and Whatman 2015).

We suggest that it is not for teachers to solely carry this challenge of reimagining an Indigenised science curriculum. While teachers may struggle with epistemic tensions around embedding IKS into curriculum (see Nakata 2011; Whatman and Duncan 2012), emerging research addresses how students conceive of, and act in this space. Nakata (2007) argues Indigenous and non-Indigenous knowledges co-exist in a cultural interface of competing knowledge systems, whether teachers have the capacity to see them or not. Indigenous students live, study, work and navigate this space, these competing lifeworlds, on a daily basis (Nakata 2007). Acknowledging that students navigate this position, this research interpreted h*ow students made sense of this cultural interface* and emerging complexities, and *how they enacted their understanding in practice* by blending IKS and WKS within the

challenge criteria. To place the iDream Challenge in its governmental context, the following section provides a brief history of educational policies and positioning in Australia.

The iDream Challenge – an EATSIPS initiative

One of the key recommendations of the many reviews of Indigenous education over the decades (Yunupingu 1995; Tripcony 2001; Martin 2009; Mellor and Corrigan 2004; Behrendt et al. 2012; MATSITI 2016) has been the creation of regional advisory committees, as distinct from state advisory committees, to ensure local community involvement and decision-making that was appropriate for each unique region. This recommendation led to the formal recognition of state and regional advisory groups, such as the Queensland Indigenous Education Consultative Committee (QIECC), and its predecessors, and the distinct sections and programs within curriculum and Education Departments, such as the Embedding Aboriginal and Torres Strait Islander Perspectives program (EATSIPS) which was responsible for the iDream Challenge. EATSIPS is one such section that has supported the more modern approach to aspirational educational programs for Indigenous children. Whilst they are steeped in a history of "programs for" Indigenous children, premised on a persistent myth of low Indigenous aspirations (Behrendt et al. 2012; Nakata 2001), initiatives supported by EATSIPS have also commenced from a standpoint that the battle to embed Indigenous knowledges and perspectives in school curricula already has been won, hence their programs offer multiple ways of approaching this task. Partnerships between universities and community organisations (Whatman and Duncan 2012), as well as a focus on activities that commence in the Primary years (Behrendt et al. 2012) have been identified as essential for increasing Aboriginal and Torres Strait Islander student participation in university studies.

The iDream program, administered by the Indigenous Student Support Unit (ISSU-SEQ) from 2011 to 2014, was an innovative and well respected initiative that has revived an Aboriginal and Torres Strait Islander presence and influence on school curriculum. The iDream Challenge was designed to be what Parkes, McRae-Williams and Tedmanson (2015: 4) would describe as a future employment-related tertiary aspiration program for primary school students, incorporating key priorities such as supporting the development of skills in information and communication technologies (ICT). While not specifically a STEM program, it was intentionally designed as a university-school partnership. iDream aimed to "build student capacity to achieve their dreams, by working in teams to develop skills such as resilience, persistence, creativity, confidence, goal setting and team building while participating in challenges with an Aboriginal and Torres Strait Islander perspective" (https://idream.eq.edu.au/). Targeting students in years four to seven, the iDream Challenge spanned five educational regions of Queensland: Central Southern; South East, North Coast, Metropolitan, Darling Downs South West and Central Queensland.

Students were given specific challenges, requiring them to create a multimedia product with an iPad. Most students submitted an iMovie, though some created PowerPoints with narration and animation. This paper focused

on the science education challenge, where students were asked to investigate misunderstood creatures, that being an animal who usually receives negative press. The task inherently required deep knowledge, high expectations, supportive environments, explicit quality criteria and of course cultural knowledge, which are all features of quality pedagogy for Indigenous learners, as argued by Ladwig and King (2003), Lester (2006), and Donovan (2009). The iDream challenge criteria asked students to:

1. Seek appropriate Community Elder permission to use terminology and Indigenous knowledge from your local area/country;
2. Identify relevant information, include definitions and drawing conclusions from Western science and Indigenous knowledges of your topic;
3. Analyse this blended information to develop a visual display using a relevant iPad application, such as Doodle Buddy or similar (your choice); and
4. Credit who completed what aspects of the challenge - everyone who participated, including community permissions and any other production credits or thanks.

The student representations of their misunderstood creatures were viewed remotely, multiple times by the authors, via video content analyses and this methodology is explained in more detail below.

Method

Video Content Analysis of transactional understanding

Drawing upon the Deweyan understanding of "transaction", a transactional understanding of epistemology, the methodology attempts to identify how IKS and WSK were blended and reproduced in students' and teachers' words and actions as depicted in their videos. With a transactional understanding, knowledge, the knower and the environment are "mutually dependent", as "organisms-in-environment-as-a-whole" (Dewey and Bentley 1991, cited by Quennerstedt 2013: 313). Knowing can be conceived of as something that students and teachers "do", something "practical" and in a specific learning context, becoming an amalgamation of how and what (Quennerstedt (2013: 313-315). Thus, it means analysing *what* is taken for granted in the student practices and habits-of-action and *how* such habits are upheld with regard to the perceived purpose. This could include what students believe it is important to say, who is important to include, what it is important to do, even what it is essential to display in the background, even if no direct mention of it is made. For example, in the iDream videos the creators included 'props' - images, equipment, scrolling text and acknowledgements. All of these inclusions enable researchers to make tentative claims about what we interpret the knowers' to *know.*

Ethics of Video Content Analysis

These clips, though stored securely on an Education Department server with restricted access, can be considered a public video archive of ongoing knowledge practices created by both students and teachers. Informed consent to be on video was integrated into the school's acceptance to be included in the competition – that is, they created the videos and submitted them for judging, knowing that their work would become a matter of public record.

However, how their identities are treated beyond the boundaries of the initial challenge competition is a separate ethical matter. While there are clear ethical considerations as to protecting the right of individuals and communities (and their knowledges) to be recognised or protected, in line with Indigenous research protocols (AIATSIS 2012; Denzin, Lincoln and Smith 2008; NHMRC 2003), additional informed consent of each actor was not required by University Ethics procedures as no "human data collection" occurred (e.g. interviews). We were cognisant of the right of each group to have their community identities and knowledges protected or recognised in the creation of the videos, which is why permission to include it was a challenge criterion, but we opted to keep the specific identities of the schools and local communities de-identified in this analysis in keeping with qualitative research traditions. As the majority of participants were children, we acknowledged the need for additional care with children's understanding of informed consent (Harcourt & Quennerstedt 2014). They may not comprehend the long term ramifications of future representations of their ideas captured permanently on video. The intention then of this analysis is to explain the collective practice of students, teachers, Elders and other actors in the co-creation of their explanations, and therefore their meaning-making, of misunderstood creatures within a schooling context, without representing their meaning-making *on behalf of* the communities in which they belong.

Data collection and analysis

The authors received ten submissions to the challenge, from across every participating region in the South East, hence emanating from multiple Aboriginal countries. Each author watched the videos separately, looking initially to see if the students had met the four essential criteria. Videos which omitted any of the criteria were ineligible to win the competition but included in this analysis.

A second viewing of the videos focused on what the students were doing in the videos as much as what they were saying. How were they positioned in relation to others? What relations between themselves and their creature did they depict? How did they act towards Elders and teachers? And vice versa? What 'science facts' did they elect to include in the videos? Where did they source these 'facts'? Which did they choose to discuss first – IKS or WSK? Noting our interpretations of these relations and positionings of actors and entities enabled us to prepare separate lists.

A third step in the data analysis was to bring our separate lists together and critique them. Which team did we each feel had responded well to the challenge criteria and why? In what ways did the students identify IKS or WSK? What was the nature of IKS and WSK? What features or patterns could

be identified, such as imagery used or consistent relations? As two non-Indigenous academics with different disciplinary backgrounds and various local and international experiences with IKS, our own ideas about what we expected to see was an inescapable lens through which these transactional understandings were interpreted and the claims that follow.

Findings and Discussion

What are IKS perceived to be or to include?

Six out of ten projects identified IKS as stories that were allowed to be retold with permission by a local Aboriginal or Torres Strait Islander Elder or knowledge keeper who spoke to the class. The amalgamation of how and what was typically represented by the students sitting around an Elder in a semi-circle, or in deferential seating arrangements. Even though many of these knowledge keepers were not formally introduced, the students treated them, and their stories with deep respect. In four of these six instances the local knowledge keeper introduced and interpreted a story or painting to the students. In three of these cases he/she contextualised the local community knowledge underpinning the story or painting. In two of these six, students asked Elders questions about the chosen animals and the Elders responded. In the remaining four instances, the students themselves communicated a story and of these, two of the student groups named and thanked local Elders for permission to share their story. The other two stories were not from local origin, but found online. However, the students did acknowledge the people and the land from which the story came.

The majority of the projects presented IKS as relational to both the local people and the local natural environment. In all cases, the students acknowledging the people (with some naming the knowledge keeper) and the land from where the stories came. IKS were viewed as belonging to a specific regional community and told a story about the land, water, sky, and past and present animals, Entities and humans who lived on that land. All projects communicated an understanding of a sacred reciprocity between the stories, the social community and a kinship to Entities and the ecosystem. This student led process encouraged the biocultural diversity of local social and natural ecosystems to be preserved.

The projects also reflected an understanding that IKS have emerged over very long periods of time. IKS were presented as deeply historical knowledge that while not being contemporarily updated, were still relevant to the present. Historical, with timeless lessons. The videos shows the students viewed this knowledge with respect, and understood it to be generated and held within the community, by those trusted to hold it. In the majority of cases the students knew that a relationship with a local knowledge keeper must be initiated to seek permission to gain and also hold this knowledge. Each project reflected varying degrees of recognition of epistemological differences (locally generated knowledge, specific to regions, relational, including Entities, and derived over vast periods of time) to those of WKS.

Another common theme, present in all of the ten cases, was the identification of a deeper moral message about living within community. Students presented IKS as knowledges that told less about the misunderstood

animal and more about what it means to be human (a being) alongside their misunderstood creature (another being). The projects highlighted the student's recognition of kinship, the interconnection of all things, but not the recognition of spirit. Three projects unpacked the underlying morality embedded in the story, while the other seven just let it be acknowledged. There was no reflection on the social context of the Aboriginal or Torres Strait Islander community from which the knowledge came.

The majority of projects illustrated a local Indigenous Elder/knowledge keeper had the right to teach IKS. When the students themselves presented IK, they specifically acknowledged the keepers of that knowledge and identified the geographical area from which it came. However, there was no recognition or acknowledgement of issues of conceptual accuracy, or of epistemological or ontological differences between the knowledge base of the speaker or the original community from which the stories came. The majority of students worked with the local Indigenous community to allow for the recognition and understandings of the deeper moral messages embedded in the IKS and to communicate what this means for their communities and themselves. This ability is a key aspect of the Community Engagement approach (as outlined above).

What is Science perceived to be or to include?

While the 10 videos suggested that students had respect for the IKS presented, WSK was presented with a strong sense of pride for endorsing 'facts' or the 'truth'. Students represented IKS as something 'different to' WSK. IKS were represented as embodied knowledge, while WSK was depicted as not belonging to any community or any social construction, and focused on the animal in a decontextualised way. WKS was depicted as facts that could be told by any person without acknowledgement of a source. Identifying these 'facts' as 'Science' seemed to be the only validation needed, perceived as independent unto themselves and represented the 'truth' about that animal. WSK was not perceived as subjectively constituted or developed but as something that could be found online, in books or through a knowledgeable adult. It was presented as current information without history. Only half the student projects related Science facts to any kind of holistic understanding of the animal's positioning within an ecosystem. The majority of videos communicated inaccurate Scientific information.

Science information was presented as evolving, growing and changing, implying that people must seek out and repeatedly engage with it to gain a better understanding of this knowledge as time progresses. Science was perceived to have no inherent obligations except to inform people as to the 'truth' about the misunderstood animal. This understanding reflects Whyte et al. (2016) observation that WKS desires to *know* the universe, rather than to *know ourselves* in moral relationship with this universe. However, in all ten cases, the students did blend WSK and IKS to speak back against the vilification of their chosen animal, and to make some kind of social commentary about their chosen animal.

Researcher reflections on students' transactional understandings

As mentioned earlier under methodology, making meaning of these student projects is a product of interpreting and reflecting upon their intentions and their actions as depicted in the videos. All ten projects blended Indigenous and Western Science knowledges to better understand their specific animal. Even though it might not have been seamless, or sophisticated, by focusing on developing a better understanding of their chosen misunderstood animal, the students did highlight the two differing epistemologies for their one common goal. The students critiqued what knowledge they believed the general populace had about these animals and reflected on their own beliefs. They reflected on the plight of these animals and made visible the dominant social beliefs that had led to their marginalisation. A strong pattern emerged across the projects: the need to become aware of your own thoughts and beliefs, alongside the knowledge base of the community, in order to speak back to moral issues, such as marginalisation. Rather than focusing on validity, or what knowledge base was 'correct', or associated epistemic tensions, the students used what they wanted from both knowledge bases to make sense of their misunderstood creature. All projects modelled how to openly embrace both knowledge systems to generate an advocating stance towards the creature.

The videos did not compare the knowledge bases, but just let them sit beside each other, offering different insights into their animal. This may reflect Naidoo and Vithal's (2014) findings where IKS were taught as separate from WSK, however, in this case, the students chose what they believed to be key information for both sources, and brought this knowledge together to showcase their new understanding. Their final understandings reflected both paradigms - a deeper Scientific understandings, along with a deeper understandings of the moral message this animal teachers about self, and what it means to live in community with others, and the natural environment. In reflection, the chosen topic of marginalised creatures promoted much of this insight. By focusing on this misunderstood creature, the students did not focus on the knowledge bases themselves. The student seemed to enjoy and be open to new ways of learning about their animal.

There are lessons for teachers in this perspective. As outlined previously, teachers tend to value the epistemology of the knowledge base itself and place secondary importance on the topic. The students do not seem burdened with questions of which knowledge is 'more right or appropriate to teach'. They simply engaged with finding animal 'facts' in the case of the WKS, and making connections to the local Indigenous community in the case of IKS and blended both to make sense of their animal and its place within society systems. Together, these knowledge bases encouraged students to take an advocacy position. There was not one project that communicated support for continuing the marginalisation of their chosen animal. Each project showed students advocating for their animals and for their community to better appreciate and take action to support this species. In this way, the students' work reflected Whyte's et al. (2016) suggestion that the incorporation of IKS encourages us to know ourselves well enough so we can act morally in the universe and Martin's (2008) position that animals are entities worthy of consideration.

As the students engaged with the challenge, they became open to the fact that there was not just one valid way of making sense of this creature and began to embrace and advocate for another way to understand their animal. To varying degrees, the overarching moral commentaries placed these understandings in context of the animal, themselves and the communities in which they live. At the heart of these different cultural knowledges was the goal of seeking to understand the world around us. Whether that understanding relates to ourselves, the communities we live in or making more sense of the members of other species with whom we share this planet with. The students' responses also highlight a deeper set of theoretical issues around how we value and conceive of the relationships between hegemonic and hierarchical knowledge systems. Misunderstandings generated from unfamiliar knowledge systems can often become the site for tension and struggles as teachers, indoctrinated to perceive there is only one valid worldview, consciously or unconsciously perpetrate hegemonic knowledge. Fearing negative repercussions from these tensions, teachers may shy away from conceptualising the blending of these different cultural knowledge bases. This was not true for the iDream students. These students offered new perspectives around understanding these marginalised animals and often critiqued the dominant knowledge systems within their society.

Implications and conclusions

The iDream Challenge remained a popular, state-funded initiative for four years, which Behrendt et al. (2008) notes can be considered a long running initiative in the ever-changing Indigenous education landscape. It was successful for a number of reasons, including the partnership approach with universities, the co-sharing of program costs (for example, prizes and curriculum expertise from universities), the embedded program support at regional level (EATSIPS 2011) and strong community engagement. The program ceased to be funded with a change in state government in Queensland in 2014. Despite the loss of state support, there are many lessons to be learned from these in-curriculum and extra-curricular challenges.

The iDream challenge was not part of a specific state curriculum or discipline, but was intended to be an extracurricular competition for primary school students. However, some schools opted to work within curriculum time. Even though this challenge was not derived from the Australian Curriculum: Science (ACARA, 2018), we believe it could have been included as part of the Cross-Curriculum Priorities, specifically teaching about 'Country and Place' (OI.1, OI.2, OI.3), or part of the Year 4 Biological Sciences, 'Living things depend of each other and the environment to survive' (ACSSU073) or the Year 5 Biological Sciences, 'The growth and survival of living things are affected by physical conditions of their environment' (ACSSU094).

The first lesson that can be learned relates to relationship building between schools and their local Indigenous community. In developing this particular iDream challenge, we, as university educators tasked with the design of the challenge, *mandated* many of the goals of the *Community Engagement* perspective illustrated in Table 1. Specifically, we asked that students: build relationships and work with local Indigenous communities;

ensure correct protocols are learned and used; embed local IKS; critically reflect on both knowledge bases; and are given the opportunity to understand the deeper moral messages embedded in local IKS. The submitted projects developed out of this criteria showed that students were able to navigate this cross cultural terrain and demonstrate the community engagement approach to IKS. Thus, these projects also illustrate how teachers can work with the local Indigenous community and facilitate the positioning of IKS and WKS alongside each other, allowing different insights into the same topic. This challenge stressed the importance of encouraging students and teachers to reflect on the wider, socio-cultural framing of knowledge (the philosophies, agendas, history and practices) in order to becoming literate in both knowledge bases. Secondly, these projects were novel as they explored the inclusion of IKS into WKS from the *perspective of primary school students*, offering new insights into how we might teach Science in order to promote deeper moral messages about living with each other and the natural environment. Students then modelled effective relational approaches to sourcing expertise in the local community. They developed a respectful re-telling of the story through the project from their engagement with the Elders. They also highlighted that the storytelling process contains deeper lessons, moral lessons, which all people should know.

But what does this mean for an ongoing dilemma in the Australian curriculum about who has the right or capacity to teach IKS? WSK was represented as being within the right or capacity of anyone to teach. It was perceived that anyone could communicate the facts about Science once this information was found. IKS were represented by stories held by someone within the Aboriginal or Torres Straits Islander community. In essence, the students in the iDream Challenge modelled the kind of relational teaching and respectful engagement that all teachers should follow when considering how to embed IKS in their curriculum, as per Australian Curriculum requirements. Even though research (McLaughlin and Whatman 2015; Whatman, Quennerstedt and McLaughlin 2017) highlights teachers' lack confidence in embedding IKS, reflections on the 10 iDream Science challenge projects show that students can and did negotiate this space of embedding IKS without the fear of not doing it correctly or not being adequately prepared. Specifically, the iDream videos illustrate strong examples of student agency, engagement and enjoyment within their learning journey in this cultural interface.

To sustain an integrated approach within schools requires ongoing support at all levels of education, within the disciplinary-specific context of science education - in curriculum, pedagogy and assessment for *all students* - not just within initiatives to promote Indigenous student participation in schooling. It necessitates recognising and nurturing knowledge relationships between schools and local Indigenous communities. These students navigated this space well - so can we all.

References

Adams, D.W. 1988. 'Fundamental considerations: The deep meaning of Native American schooling, 1880-1900'. *Harvard Educational Review* 58(1): 1-28.

Afonso, E. Z. 2013. 'Rethinking the history of inclusion of IKS in school curricula: Endeavoring to legitimate the subject'. *International Journal of Science and Mathematics Education* 11: 23-42.

Aikenhead, G. and Elliott, D. 2010. 'An Emerging Decolonizing Science Education in Canada'. *Canadian Journal of Science, Mathematics and Technology Education* 10(4): 321-338.

Aikenhead, G.S. and Jegede, O.J. 1999. 'Cross-cultural science education: A cognitive explanation of cultural phenomena'. *Journal of Research in Science Teaching* 36(3): 269–287.

Aikenhead, G.S. and Mitchell, H. 2011. *Bridging cultures: Indigenous and scientific ways of knowing nature*. Toronto, Canada: Pearson Education Canada.

Asabere-Ameyaw, A., Dei, G.S. & Raheem, K. 2012. 'The question of indigenous science and science education'. In A. Asabere-Ameyaw, G. S. Dei & K. Raheem (eds.). *Contemporary issues on African sciences and science education*. Rotterdam: Sense publishers, 15-28.

Australian Curriculum and Assessment Reporting Authority (ACARA). 2018. 'The Australian Curriculum: Science'. https://www.australiancurriculum.edu.au/f-10-curriculum/science/

Australian Institute for Aboriginal and Torres Strait Islander Studies (AIATSIS). 2012. 'Guidelines for Ethical Research in Australian Indigenous Studies'. Canberra. https://aiatsis.gov.au/research/ethical-research/guidelines-ethical-research-australian-indigenous-studies (accessed 8 March 2018)

Baker, J.J. 2016. 'Learning to Relate: An exploration of Indigenous Science Education. Unpublished doctoral dissertation'. Vancouver: University of British Columbia. https://open.library.ubc.ca/cIRcle/collections/ubctheses/24/items/1.0223887 (accessed 6 March 2018)

Bang, M. & Medin D. 2010. 'Cultural processes in science education: Supporting the navigation of multiple epistemologies'. *Science Education* 94(6): 1008-1026.

Behrendt, L., Larkin, S., Griew, R. and Kelly, P. 2012. *Review of higher education access and outcomes for Aboriginal and Torres Strait Islander people: Final report.* Canberra: Department of Industry, Innovation, Science, Research and Tertiary Education.

Belczewski, A. 2009. 'Decolonizing Science education and the Science teacher: A White teacher's perspective'. *Canadian Journal of Science, Mathematics and Technology Education* 9(3): 191-202.

Biddle, N. 2010. 'A human capital approach to the educational marginalisation of Indigenous Australians'. *Centre for Aboriginal Economic Policy Research working paper no. 67.* Canberra: The Australian National University.

Birnbaum Fox, J. 2009. 'Indigenous Science'. *Cultural survival quarterly* 33(1). https://www.culturalsurvival.org/publications/cultural-survival-quarterly/indigenous-science (accessed 8 March 2018)

Cajete, G. 1999. *Igniting the sparkle: An Indigenous Science education model.* Skyland, NC: Kivaki Press.

Cajete, G. 2000. *Indigenous science: Natural laws of independence*: Santa Fe, NM: Clearlight Publishers.

Cocks, M.L., Alexander, J. and Dold, T. 2012. 'Inkcubeko Nendalo: A Bio-cultural Diversity Schools Education Project in South Africa and its Implications for Inclusive Indigenous Knowledge Systems (IKS) Sustainability'. *Journal of Education for Sustainable Development* 6(2): 241-252.

Department of Education, Training and Employment (DETE). 2014. *Indigenous Student Enrolments by Region 2010-2014.* Brisbane: Queensland Government.

Denzin, N., Lincoln, Y. and Smith, L.T. (eds.). 2008. *Handbook of Critical and Indigenous Methodologies.* Thousand Oaks, CA: Sage Publications.

Dewey, J. 1938. *Experience and education*. New York, NY: Free Press.

Dewey, J. and Bentley, A.F. 1949/1991. 'Knowing and the known'. In J.A. Boydston (ed.). *The later works, 1925-1953,* (Vol. 16). Carbondale: Southern Illinois University Press, 1294.

Diwu, C.T. & Ogunniyi, M.B. 2012. 'Dialogical Argumentation instruction as a catalytic agent for integration of school science with indigenous knowledge systems'. *African Journal of Research in Mathematics, Science and Technology Education* 16(3): 333-347.

Donovan, M. 2009. 'Quality teaching and Aboriginal students: a NSW model'. *Journal of Australian Indigenous Issues* 12(1-4): 104-115.

EATSIPS-ISSU. 2011. 'Embedding Aboriginal and Torres Strait Islander Perspectives in Schools. Brisbane: DET'. http://indigenous.education.qld.gov.au/SiteCollectionDocuments/eatsips-docs/eatsips_2011.pdf (accessed 8 March 2018)

Eisenhart, M., Finkel, E. and Marion, S. 1996. 'Creating the conditions for scientific literacy: A re-examination'. *American Educational Research Journal* 33(2): 261-295.

El-Hani, C.N. & Bandeira, F.P. 2008. 'Valuing indigenous knowledge: To call it "science" will not help'. *Cultural Studies of Science Education* 3(3): 751-779.

Gadgil, M., Berkes, F. and Folke, C. 1993. 'Indigenous knowledge for biodiversity conservation'. *Ambio* 151-156.

Harcourt, D. & Quennerstedt, A. 2014. Ethical guardrails when children participate in research: risk and practice in Sweden and Australia. *Sage Open* 4(3).

Holbrook, J. and Rannikmae, M. 2009. 'The Meaning of Scientific Literacy'. *International Journal of Environmental and Science Education* 4: 275-288.

Howard, G.R. 1999. *We can't teach what we don't know: White teachers, multiracial schools*. Teachers College Press. New York.

Jegede, O. 1998. 'The knowledge base for learning in science and technology education'. In P. Naidoo & M. Savage (eds.). *African science and*

technology education into the new millennium: Practice, policy and priorities. Cape Town: AFCLIST, 151-176.
Keane, M. 2008. 'Science education and worldview'. *Cultural Study of Science Education,* 3: 587-621.
Krauss, M. 1992. 'The world's languages in crisis'. *Language* 68(1): 4-10.
Ladwig, J.G., and King, M.B. 2003. *Quality teaching in NSW in NSW public schools: an annotated bibliography.* Sydney: Department of Education and Training.
Lemke, J.L. 1990. *Talking Science: Language, Learning and Values*. Norwood, NJ: Ablex.
Lester, J. 2006. 'Focusing on Aboriginal Students'. *Scan* 25(4): 30-32.
Lomawaima, K.T. and McCarty, T.L. 2002. 'When tribal sovereignty challenges democracy'. American *Educational Research Journal* 39(2): 279-305.
Lomawaima, K. T. and McCarty, T.L. 2006. "*To remain an Indian": Lessons in democracy from a century of Native American education*. New York: Teachers College Press.
Ma Rhea, Z. and Anderson, P.J. 2011. 'Economic justice and Indigenous education: Assessing the potential of standards-based and progressive education under ILO169'. *Social Alternatives* 30(4): 25-31.
Maffi, L. 2007. 'Biocultural diversity and sustainability'. *The Sage Handbook of Environment and Society* 267-277.
Martin, K. 2003. 'Ways of knowing, being and doing: A theoretical framework and methods for indigenous and indigenist re-search'. *Journal of Australian Studies* 27(76): 203-214.
Martin, K. 2008. *Please knock before you enter: Aboriginal regulation of Outsiders and the implications for researchers.* Teneriffe, Qld: Postpressed.
Martin, K. 2009. 'Aboriginal worldview, knowledge and relatedness: re-conceptualising Aboriginal schooling as a teaching-learning and research interface'. *Journal of Australian Indigenous Issues* 12(1-4): 66-78.
Matsuura, K. 2005. 'UNESCO Universal Declaration on Cultural Diversity'. *Diogenes* 52(205): 141-146.
MCEECDYA. 2010. *Aboriginal and Torres Strait Islander education action plan 2010-2014.* Melbourne: MCEECDYA.
McKinley, E. 2005. 'Locating the global: Culture, language and science education for indigenous students'. *International Journal of Science Education* 27(2): 227-241.
McLaughlin, J. and Whatman, S. 2015. 'Recognising change and seeking affirmation: themes for embedding Indigenous knowledges on teaching practicum'. *The International Education Journal: Comparative Perspectives* 14(2): 113-124.
Mellor, S. and Corrigan, M. 2004. *The case for change: a review of contemporary research on Indigenous education outcomes*. Melbourne: ACER.
Naidoo, P.D. and Vithal, R. 2014. 'Teacher approaches to introducing Indigenous Knowledge in school Science classrooms'. *African Journal of Research in Mathematics, Science and Technology Education* 18(3): 253-263.

Nakata, N. 2001. ‘Cultural education: for us or for them?’ In Loos, N. and Osanai, T. (eds.). *Indigenous Minorities and Education: Australian and Japanese perspectives of their Indigenous peoples: the Ainu, Aborigines and Torres Strait Islanders.* Tokyo: Sanyushu Publishing Co, 334-349.

Nakata N, 2007. ‘The cultural interface’. *Australian Journal of Indigenous Education* 36*(S*): 1-7.

Nakata, M. & Langton, M. 2009. *Australian Indigenous Knowledge and libraries*. *UTS ePress*. http://epress.lib.uts.edu.au/researchpublications/bitstream/handle/10453/5722/2005002475.pdf?sequence=1 (accessed 8 March 2018)

Nakata M, 2011. ‘Pathways for Indigenous education in the Australian curriculum framework’. *Australian Journal of Indigenous Education* 40*:* 1 -8.

National Health and Medical Research Council (NHMRC). 2003. *Values and Ethics: Guidelines for ethical conduct in Aboriginal and Torres Strait Islander Health Research.* Canberra: Commonwealth of Australia. https://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/e52.pdf (accessed 7 March 2018)

Parkes, A., McRae-Williams, E. and Tedmanson, D. 2015. ‘Dreams and aspirations of mobile young Aboriginal Australian people’. *Journal of Youth Studies* 18(6): 763-776.

Ogawa, M. 1995. ‘Science education in a multi-Science perspective’. *Science Education* 79(5): 583-593.

Ogunniyi, M.B. 2007. ‘Teachers’ stances and practical arguments regarding a science-indigenous knowledge curriculum, paper 1’. *International Journal of Science Education* 29(8): 963-985.

Ogunniyi, M.B. & Hewson, M.G. 2008. ‘Effect of an argumentation-based course on teachers’ disposition towards a science-indigenous knowledge curriculum’. *International Journal of Environmental Science* 3(4): 159-177.

Quennerstedt, M. 2013. ‘Practical epistemologies in physical education practice’. *Sport, Education and Society* 18(3): 311-333.

Robertson, B. 2014. ‘Foreword’. In Muller, L. *A theory for Indigenous Australian health and human service work: connecting Indigenous knowledge and practice*. Crows Nest, NSW: Allen and Unwin.

Robertson, B., Demosthenous, C.M., Dillon, B., Van Issum, H. and Power, C. 2005. ‘Talking-Up Vocational Education and Training for Indigenous Peoples in Australia [online]’. In Searle, J., Beven, F., and Roebuck, D. (eds). *Vocational Learning: Transitions, Interrelationships, Partnerships and Sustainable Futures Proceedings of the 13th Annual International Conference on Post-Compulsory Education and Training,* Gold Coast, Queensland, 5-7 December, 2005 (pp.412-418). Brisbane, Qld: Australian Academic Press.

Thorpe, K. 2013. ‘Protocols for libraries and archives in Australia: incorporating Indigenous perspectives in the information field’. *IFLA WLIC 2013 Conference Paper, Singapore*. https://www.sl.nsw.gov.au/sites/default/files/ThorpeKirsten-Indigenousprotocols.pdf (accessed 6 March 2018)

Roth, W.M. and Lee, S.H. 2002. 'Scientific Literacy as Collective Praxis'. *Public Understanding of Science* 11: 33-56.

Sammel, A. 2008a. Traveling with and through your backpack: a personal reflection on the infrastructure of Science education. *Cultural Studies of Science Education, 3* (4), 843-857.

Sammel, A. 2008b. Research into the Limits and Potential of Students Engagement in Whiteness Pedagogies in University Settings. *Re-Orienting Whiteness Conference.* December 3rd-5th, 2008. Melbourne, Vic, Australia.

Sammel, A. 2009. A Circle is more than a Straight Lined Curved: Mis(sed)Understandings about First Nations Science, in C. Shick, and J. McNinch (Eds.). *I thought Pocahontas was a Movie* (pp. x-y) Regina, Canada: Canadian Plains Research Center.

Sammel, A. 2012a. *Aboriginal Perspectives in the Teaching and Learning of Science*. LAP LAMBERT Academic Publishing, Germany.

Sammel, A. 2012b. *Science teacher identity and justice education*. LAP LAMBERT Academic Publishing, Germany.

Toledo, B.E. and Barrera-Bassols, N. 2010. 'The biocultural heritage of México: an overview'. *Landscape* 3: 6-10.

Toledo, V.M. 2001. 'Indigenous peoples and biodiversity'. *Encyclopedia of biodiversity* 3: 451-463.

, P. 2001. 'The Commonwealth referendum of 1967 and Australian Indigenous citizenship'. *Journal of Australian Indigenous Issues* 4(2): 26-33.

United Nations (UN). 1989. 'Convention of the Rights of the Child Document A/RES/44/25'. http://sithi.org/admin/upload/law/Convention%20on%20the%20Rights%20of%20the%20Child.ENG.pdf (accessed 8 March 2018)

United Nations. 2007. 'Declaration on the rights of Indigenous Peoples (UNDRIPS)'. https://www.un.org/development/desa/indigenouspeoples/declaration-on-the-rights-of-indigenous-peoples.html (accessed 8 March 2018)

United Nations Educational Scientific and Cultural Organisation (UNESCO). 2010. 'Indigenous Knowledge and Sustainability'. http://www.unesco.org/education/tlsf/mods/theme_c/mod11.html (accessed 8 March 2018)

Whatman, S., Quennerstedt, M. and McLaughlin J. 2017. Indigenous knowledges as a way to disrupt norms in physical education teacher education. *Asia-Pacific Journal of Health, Sport and Physical Education* 8(2): 115-131.

Whatman, S. and Duncan, P. 2012. Learning from the past: In policy and practice. In J. Phillips, and J. Lampert (Eds.). The Importance of Reflection: Introductory Indigenous Studies, 2nd Ed, (pp.114-140). Frenchs forest, NSW: Pearson Australia.

Wenning, C.J. 2009. 'Scientific epistemology: How scientists know what they know'. *Journal of Physical Teacher Education* 5(2): 3-15.

Wickman, P.O. 2004. 'The Practical Epistemologies of the Classroom: A Study of Laboratory Work'. *Wiley Periodicals, Inc. Sci Ed* (88): 325-344.

Wilks, J. and Wilson, K. 2016. 'A profile of Aboriginal and Torres Strait Islander higher education student population'. *Australian Universities' Review* 57(2): 17-30.

Whyte, K.P., Brewer, J.P. and Johnson, J.T. 2016. 'Weaving Indigenous Science, protocols and sustainability Science'. *Sustain Science* 11(1): 25-32.

Yunupingu, M. 1995. *National Review of Education for Aboriginal and Torres Strait Islander Peoples - Final Report.* Canberra: Australian Government Printing Service.