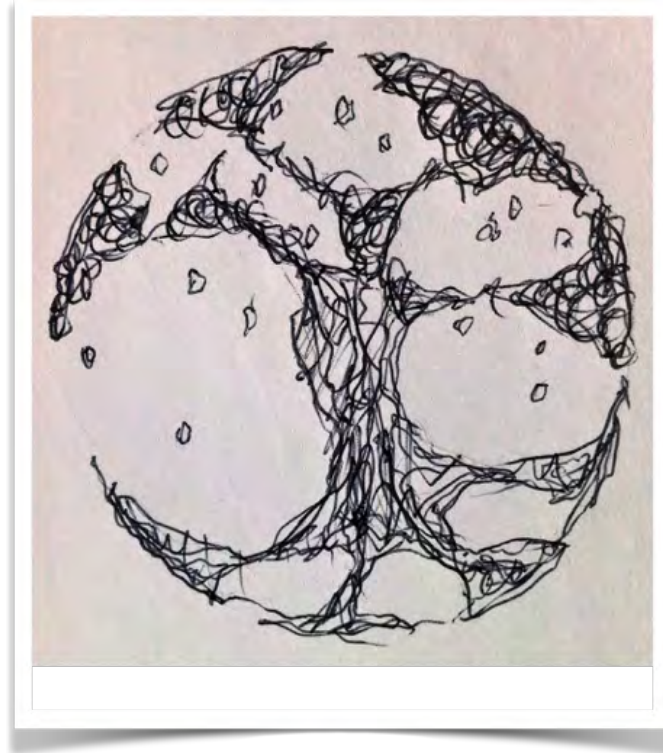# Whose Knowledge?:

Science Education, Indigenous Knowledges and Teacher Praxis

A thesis submitted by

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Abstract

This study investigated how a group of secondary school science teachers considered the implementation of a Cross-Curriculum Priority that mandated the inclusion of Aboriginal and Torres Strait Islander histories and cultures in all learning areas. The inclusion of Indigenous content and perspectives, as a way of promoting intercultural understanding, has been advocated in the Australian context for some time. However, classroom implementation has been lacking with teachers feeling unsure about how to satisfy these curriculum initiatives. With the introduction of the new (national) Australian Curriculum such content and perspectives were mandated. This context enabled an exploration of science teachers' responses to the Cross-Curriculum Priority as they attempted to translate the intent of the curriculum into classroom practice.

The investigation took place through a collaborative and collegial approach using Participatory Action Research. A group of five teachers from different schools proceeded through cycles of inquiry, action and reflection framed by the curriculum requirements. Across the participant group these cycles operated asynchronously as the individual teacher participants had to negotiate their schooling contexts while still being guided by group participation. The teacher participants' needs and perspectives directed the topics of discussion and progress of the cycles. Advice and guidance around cultural sensitivities inherent in the research were given by three Critical Friends of the project, who all self-identified as Aboriginal people. A bricolage approach was taken to data collection allowing the capture of the experiences of the participants through interviews, group meetings, one-on-one discussions with the researcher, documentary analysis and observation of classroom activities. Data were analysed using a critical theory and pedagogy lens.

The study showed that teachers approached the Cross-Curriculum Priority with a hope that it would lead to socially just learning opportunities for both Indigenous and non-Indigenous students. Teacher participants took different approaches to implementing lessons in the science classroom and not all of them

implemented classroom activities with Indigenous content or perspectives. The study found that the approach and classroom implementation taken by teachers are related to their epistemological, pedagogical and political positioning. The neo-liberal context of the Australian schooling system was also found to confine and constrain teachers' efforts in classroom implementation. The study recommends that all of these interconnected factors need to be considered in understanding how teachers engage with such a curriculum innovation. The findings of this study will assist in moving beyond the rhetoric around such curriculum initiatives towards practical implementation of science education inclusive of Indigenous knowledges and perspectives in classrooms.

Certification of thesis

I certify that the ideas, analyses and conclusions reported in this thesis are my own work, except where otherwise acknowledged. I also certify that the work is original and has not been previously submitted for any other award.

_____   9 February 2016

Renee Desmarchelier

Signature of Candidate   Date

ENDORSEMENT

_____   9 February 2016

A/Prof Robyn Henderson

_____   9 February 2016

Dr Lindy Abawi

Signature of Supervisors   Date

Acknowledgements

I acknowledge the Giabal and Jarowair peoples of the Toowoomba area who are the traditional custodians of the lands this project was conducted upon. I extend my respect to elders of the past and present and recognise the current generation as the elders of the future.

The first people I need to thank are my participants. Without you there would have been no project and no thesis. I acknowledge all of your hard work and thank you for putting yourselves out there. I really believe we have made a great contribution to understanding how engaging with Indigenous knowledges 'works' in science education.

I sincerely thank my supervisors, A/Prof Robyn Henderson and Dr Lindy Abawi. Thanks for taking in an orphan (or maybe a run-away). Without your prodding and gentle encouragement this thesis would not be what it is. It was your belief in my academic skills that got me to the end. Thanks for your understanding, encouragement, insight and hours and hours of work. I also thank A/Prof Jon Austin for his encouragement and knowledgeable assistance along the way.

Most importantly, I thank my family. To my children Elysia, Tate and Saffron - this is for you. I'm such a proud mum. Thanks for being such great kids and allowing me the opportunity to do this work and give it the time it needed to see it to completion. Elly, thanks for bringing Mum lunch so I didn't have to get up and interrupt my train of thought. To my wonderful husband Simon – I could not have done this without you. Your support and belief in me is always unwavering and words can't describe what that means to me. Love you. It is Simon's artwork that appears on the title page of the thesis and in chapters to represent the methodological journey.

List of publications related to this work

Journal Article:

Baynes, R. (2015). Teachers' attitudes to including Indigenous knowledges in the Australian Science Curriculum. *Australian Journal of Indigenous Education,* Advance online publication. doi: http://dx.doi.org/10.1017/jie.2015.29

Book chapters:

Baynes, R. (2013). The Tree of Life as a methodological metaphor. In W. Midgley, K. Trimmer & A. Davies (Eds.), *Metaphors for, in and of educational research* (pp. 145-155). Newcastle Upon Tyne: Cambridge Scholars Press.

Baynes, R. (2015). Humanization in decolonizing educational research: A Tree of Life metaphor. In M. A. Peters & T. Besley (Eds.), *Paulo Freire the global legacy* (pp. 103-114). New York, NY: Peter Lang.

Peer reviewed conference proceedings:

Baynes, R., & Austin, J. (2012). *Indigenous knowledge in the Australian national curriculum for science: From conjecture to classroom practice*. Paper presented at the International Indigenous Development Research Conference 2012, Auckland, N.Z.

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Chapter 1: Introduction

*Opportunities only come when they are made, when the power of hegemonic
common-sense is challenged.*

(Apple, 2000b, p. xix)

Foreword – A personal journey

This project came to be through grappling with my own epistemological
challenges while studying a Graduate Diploma in Learning and Teaching. I had
been a scientist and science educator at university level for about 10 years and
discovered that my passion lay in teaching rather than scientific research. So,
after completing my Master of Philosophy in crop science, I enrolled in a teacher
education program with a view to teaching secondary school science.

It was in this program that I discovered Paulo Freire (2009) and his book
Pedagogy of the Oppressed. This encounter challenged me in ways that I am still
coming to understand. In my efforts to elucidate a completely new way of
making sense of the world and uncover the unacknowledged social structures of
power that I had always felt surrounding me but had never been able to identify,
I delved deeper into areas of critical pedagogy encountering Giroux (2005) and
Kincheloe (2010, 2008). As many have experienced before me, I had found a
language to help me make sense of the world and understand the overt and
subtle ways that power works to inform whose knowledge is seen as legitimate.

During my Graduate Diploma studies, these experiences led me to ask how I, as a
school science teacher, could and should engage with critical pedagogy and other
ways of knowing in my classroom. At this time, I attended a workshop on
embedding Indigenous perspectives in the curriculum. At first, the idea of
teaching science from an anything other than a Western perspective challenged
my professional identity. I had spent my professional life engaging with and

teaching (part of) the Western story of science and wondered how anything else could be considered legitimate in a science classroom. At the same time, the potential for enacting a critical pedagogy of science was right in front of me.

As a Masters student I had become disillusioned with the scientific research industry. The competition for grant money and the ways in which this impacted upon not only people's stress levels, but also on what research could be conducted, did not fit well with me. I had been working in alternative pest management systems for horticultural crops, looking at the potential of large-scale companion plantings. This was generally viewed as fine for a Masters research project, but not something that would gain on-going funding. This was my introduction to alternative knowledge systems and has become a passage into considering Indigenous knowledges. There are a few pieces of writing that acted as a bridge between my Masters thesis and this one. Particularly important in that cross-over were Alteri's (1994), *Biodiversity and pest management in agroecosystems* and Agrawal's (1995), *Dismantling the divide between Indigenous knowledge and scientific knowledge*. These were my introduction to thinking differently within a scientific frame and they acted to increase my unease with a Western science only framing of science education. Although, at the time I did not have the language to name this discomfort and the idea of teaching anything other than the canonical version of science I had been taught was still challenging.

While completing my Master of Philosophy qualification, I lectured and tutored in a number of foundational courses in the university's Bachelor of Applied Science program. One of these courses was a first year information access and communications course that was taken by students across a number of programs. I co-taught this course with a woman from the Anthropology Department. The course required the students to become familiar with how to read and review journal articles. To this end, we both supplied our tutorial groups with articles from our respective fields. My anthropology-based teaching partner supplied an article from a colleague whom she admired and who had worked closely with a particular Indigenous nation. He had been initiated into

the group and was considered a member of the extended family and community. This paper concerned the nation's environmental knowledge around seasons.

Reading the paper was my first encounter with Indigenous Australian knowledges. I recall at first being confronted by its differing writing style to the strictly empirical research papers I was used to. However, I quickly became more interested in the content of the paper, making links to what was presented and my Western scientific understanding of ecology. It was initially puzzling to consider what was presented as cultural knowledge within my scientific epistemology. It required some mental manipulation to make sense of what I was reading in a scientific frame. At this point I was not particularly interested in understanding the knowledge from an Indigenous perspective and probably in quite a neo-colonial way, was impressed with the way that the knowledge fitted within my scientific schema.

When I attended the workshop on embedding Indigenous perspectives in curriculum as an intending science teacher, the memory of this paper resurfaced. At that time, I had recently taught a unit on ecology while on teaching practicum and, even with my new-found interest in Indigenous knowledges in science, had not considered including the type of knowledge described in the paper. The workshop helped me see these and other opportunities to consider multiple ways of knowing in the classroom. This was not without complexities, trepidation about 'getting it right', or anxiety around pedagogical approaches.

It was these experiences that made me want to understand how the process of including non-Western ways of knowing in the classroom worked for other science teachers. It seemed to me, that without exploring this, it would be difficult to get any traction within the education system to see these other ways of knowing really gain prominence in science classrooms. As such, this work was born of personal, epistemological conflict, with an assumption that this might be difficult for others trained in purely scientific ways of understanding the world. It has led me on a decolonising journey of discovery about the nature of knowledge and myself as an educator and researcher. I was fortunate to be

commencing the work at a time when the new Australian Curriculum was being formed and implemented (Australian Curriculum Assessment and Reporting Authority, 2009b). This gave me the opportunity to engage with a group of sympathetic fellow travellers in science education in a policy environment where Indigenous perspectives were being mandated.

Methodologically I had to unlearn my scientific ways, although I found them sneaking in at the most unexpected moments. At first, trying to understand critical qualitative and Indigenous methodologies was a bit like trying to turn my mind inside out. Even basic ideas such as what constituted data were problematic for me with my ingrained scientific mindset. As such, the following presentation and analysis of the research problem and data represented a hard fought journey of perseverance in order to advance understanding of the possibilities of science education. It was a personal battle of breaking out of the formerly unseen barriers I was constrained by, then a joint project of opening up different ways of knowing within what has traditionally been a purely Western scientific discourse.

This thesis has been framed by this experience and my continuing journey as an educator. It was necessary for me to understand what the implications of teaching science were, the inherent power differentials between knowledges and more practical concerns around knowledge and the implementation of the Australian Curriculum. My own journey is reflective to a large degree of the teacher participants of the project. While each individual saw different challenges, some overarching theoretical, philosophical and practical issues were shared.

But who am I? – Positioning myself

I recognise the fundamental importance of identifying myself in my research work so it can be understood from what perspective I speak. Without openly declaring who I am, the veracity and integrity of this work would be open for

question on the basis of working from a position of unacknowledged privilege (McLaren, 2007). S. Wilson (2008) discusses the importance of fully identifying oneself to hold true to Indigenous research paradigms in terms of relational accountability and building a proper relationship between the readers and the story. I have chosen to include more personal details in this positioning of myself than may usually be included by doctoral candidates. This may be particularly important to Indigenous readers of this thesis. As Wilson points out, "I cannot know beforehand who will read this book, I cannot be sure of the relationships that readers might hold with me or the ideas I share" (p. 6). Providing this background is intended to assist in forming a proper relationship with readers, whoever they may be.

I am a non-Indigenous woman who grew up on Butchulla Country on Queensland's Fraser Coast. As a child, I spent a lot of time on World Heritage Listed K'Gari (Fraser Island) and this incredible environment profoundly impacted my understanding of the natural world. My experiences were, at the time, however, not at all linked to any understanding of Indigenous Australia. The small town I lived in did not, at the time, have any representations of Indigeneity that I can recall. I do not remember being aware of the local Indigenous community and I was taught very little about the Indigenous history of the local area or of Australia in general. This absence in the curriculum was common at the time and it continues to be a silence that my teacher education students at university acknowledge.

I am the elder child (followed by a much younger baby sister) of working class parents. My father did not finish formal schooling before leaving to work and my mother completed secondary school and additional training to work in the sugar industry. They worked very hard to move into the middle class by the time I was a teenager and made many sacrifices to ensure that I would be the first in my family to attend University. There was never room for doubt that I would obtain my degree and my qualifications have been a source of great pride for my parents, particularly my father.

I am a wife and mother to a family of my own. I have two older children, a girl and a boy (both born while studying my Masters qualification) and a little (toddler) girl who was born through the progress of this doctoral study. I am fortunate to have a partner who understands the importance of this work to me and has supported me incredibly through the time of my study.

I am a lecturer at a regional university teaching Critical Pedagogies and Indigenous Studies to a diverse range of students including anthropology, human services, social sciences and education students. I commenced in this position during the time of my doctoral study. Part of my main teaching commitments has been the delivery of a course in Indigenous perspectives for intending educators. In addition, I've taught courses on Indigenous knowledges and topics around Indigenous identity.

These are the experiences that I see as framing who it is I am in relation to this study. I acknowledge that I come to this work from a position of non-Indigenous privilege that has made it easier for me to be situated educationally to do this work.

Introduction – Positioning this study

In Australia, the inclusion of Aboriginal and Torres Strait Islander perspectives in school curricula has long been identified in educational policy as a priority area of development in order to promote understanding and mutual respect between Indigenous and non-Indigenous members of society (Department of Education and the Arts, 2006). The education authority in each state has required teachers to embed Indigenous perspectives; however, many teachers express concern that they lack the necessary knowledge and skills to implement these (Harrison & Greenfield, 2011). The Australian Curriculum, developed by the Australian Curriculum, Assessment and Reporting Authority (ACARA) (2011b) includes a concern for reconciliation through education. The curriculum contains both a Cross-Curriculum Priority (CCP) and a General Capability that work towards

promoting intercultural understanding in students (ACARA, 2014). One of three cross-curriculum priorities, the *Aboriginal and Torres Strait Islander Histories and Cultures Priority* aims to deepen students' knowledge of Australia through engaging with Indigenous cultures (ACARA, 2011a). Within the science curriculum, this involves investigating "the ways traditional knowledge and Western scientific knowledge can be complementary" (ACARA, 2011c).

As with any curriculum initiative, it is the classroom teacher who is ultimately responsible for engaging students in the required learning. Curriculum change generally requires changes in teachers' practices. The introduction of differing ways of knowing requires change in perspectives and pedagogy (Kanu, 2011a) and may challenge teachers' epistemologies. This challenge may be accentuated for science teachers due to the (unacknowledged) nature of science as culturally specific and the need therefore for teachers to facilitate cultural border-crossings for themselves and their students (Aikenhead, 1996).

While some authors have addressed the role of teachers in implementing the incorporation of Indigenous knowledges and perspectives in schooling (for example, Burridge & Evans, 2012b; Harrison & Greenfield, 2011; Nakata, 2011), the voices of teachers are not often addressed in the research on this issue (Kanu, 2011a). As Nakata (2011) identified, "there is a gap between the big statements and the more detailed guidance teachers and schools might require… teachers tend to be the ones left to work out how Indigenous issues are to be worked into classroom practice" (pp. 1-2). Teachers' attitudes, perceptions and beliefs about any curriculum innovation have been identified as crucial to the success of implementation (Kanu, 2005, 2011a).

Rationale of the study

The role of school based education in reconciliation was recognised in the *Adelaide Declaration on the National Goals for Schooling in the Twenty-First Century* (The Adelaide Declaration) (Australian Department of Education

Training and Youth Affairs, 2000). To promote a socially just education system, it was an agreed national goal drawn from The Adelaide Declaration and restated in the *Melbourne Declaration on Educational Goals for Young Australians* (the Melbourne Declaration) that all students should "understand and acknowledge the value of Aboriginal and Torres Strait Islander cultures to Australian society and possess the knowledge, skills and understanding to contribute to and benefit from, reconciliation between Indigenous and non-Indigenous Australians" (Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA), 2008, p. 9). Working from the Melbourne Declaration, the MCEETYA four-year action plan outlined the establishment of the Australian Curriculum, Assessment and Reporting Authority (ACARA) to develop national reforms in curriculum to be implemented in all jurisdictions from 2011 (MCEETYA, 2009). As the national curriculum body, ACARA developed the draft Australian Curriculum (ACARA, 2010a) including a concern for reconciliation through education. Three cross-curriculum perspectives were proposed, one of which - *Indigenous perspectives* - aimed to "ensure that all young Australians have the opportunity to learn about, acknowledge and respect the history and culture of Aboriginal people and Torres Strait Islanders" (ACARA, 2009a). Cross-Curriculum perspectives were re-named Cross-Curriculum Priorities (CCPs) and the Indigenous Perspective was renamed the *Aboriginal and Torres Strait Islander History and Cultures Priority* for the implementation of the Australian Curriculum (ACARA, 2013b). In addition to the national perspective, in Queensland, state schools were to embed Aboriginal and Torres Strait Islander perspectives in school practice, including curriculum and pedagogy, by 2012 (Queensland Government, 2009).

The inclusion of Indigenous perspectives in both the Queensland state curriculum and the Australian Curriculum provided the impetus for the broadening of scientific understanding beyond purely Western ideas in the classroom. Drawing on the intent described above, descriptors in version 1.0 of the Australian Curriculum, under the content strand *Science as a Human Endeavour*, noted that "different cultural groups have different perspectives on science" (ACARA, 2010a). Similarly, the Queensland Studies Authority (QSA)

defined part of their 'core business' as being to "embed Indigenous perspectives in new and revised P–12 curriculum material" (QSA, 2008). Such inclusions necessitate a negotiation between Western and Indigenous perspectives and the facilitation of a dialogue between the different epistemological foundations of knowing that underpin each.

The underlying epistemologies of the science classroom warrant investigation in terms of the social assumptions and 'claims to knowledge' generated through the educative process. To date, the use of alternative and Indigenous knowledges and perspectives have not been prominent in science education in Australia. Curricular content has been limited to a view of science as an objective and universal knowledge system, derived solely from Western rationality and ways of knowing (Stanley & Brickhouse, 2001). The presence of only one way of knowing the scientific world, a "White Western Way" (Austin & Hickey, 2009, p. 223) of knowing, has implications for the perceived legitimacy of other forms of knowledge. The potential of a multicultural (Snively & Corsiglia, 2001), multiscience perspective (Ogawa, 1995) has been largely unrealised or ignored.

With the introduction of the Australian Curriculum in 2013 (ACARA, 2010b), this project took place at a time when educators were confronted with the epistemological considerations necessary to teach both Western science and Indigenous ways of knowing. Most science educators have, at minimum, engaged in science content and pedagogy throughout their pre-registration study, as well as having opportunities for professional development in the area of science as part of their professional practice. This is largely derived from a Western perspective. The idea of '*what is science?*' is usually based on Western systems of knowledge, leaving teachers' expertise in the negotiation of alternative knowledges and perspectives in the classroom lacking. Teachers may then question where the expertise in these alternative knowledge systems should come from and how they fit with the epistemological positions educators had previously engaged with in the schooling system. This leads to the basic problem that this project looked to explore: *How do current educators*

meaningfully engage in the teaching of Indigenous knowledges when they are
largely unfamiliar with the epistemology and knowledge required?

Research Problem: The introduction of the *Intercultural Understanding General Capability* and the *Aboriginal and Torres Strait Islander Cross-Curriculum Priority* in the Australian Curriculum meant that teachers were required to engage with content and epistemologies with which they may have been unfamiliar. The inclusion of Indigenous perspectives and knowledges in science classroom teaching is one such problematic example.

This problem will be addressed through the investigation of the following three research questions.

Research Questions:

1. What are participating teachers' attitudes and beliefs relating to the possibilities and challenges of including different ways of knowing in the science classroom?
2. What processes do teachers engage with when incorporating Indigenous knowledges into their conceptualisation of science education?
3. What happens when teachers engage with Indigenous knowledge as part of their practice in science education?

The first research question recognises that through agreeing to be involved in the study, teachers had some level of commitment to the incorporation of Indigenous knowledges in their teaching practice. The question examines how teachers frame the importance of including different ways of knowing in the learning area of science and recognises that these ideas may not be held without some trepidation about implementation. Question two concerns not only the pragmatic processes teachers employ but the epistemological and intellectual processes necessary for the (re)conceptualisation of science education that includes Indigenous understandings. The phrasing 'what happens when' in the third question was intentionally open-ended to allow for the organic nature of

the project and encompass the range of implications that may include pedagogical, epistemological, institutional, or social justice dimensions.

The project sought to engage teachers in problematising their current practice and to build new pedagogical possibilities in regard to the new curriculum. To do this, the project focused on the views of selected, current teachers of science from across several schools in order to chart and record the engagement of teachers with the curriculum and Indigenous knowledge in science education. Co-operative work allowed teachers to interact with like-minded colleagues they would not normally work with to co-construct their responses to the CCP.

Context of place

The research took place in the Queensland regional city of Toowoomba, where the disrupted nature of the local Indigenous population is well recognised. Toowoomba's Indigenous history mirrors histories of many Queensland and indeed Australian cities. European settlement came to the area initially in search of productive pastures for animal grazing around 1840 (Copland, Richards, & Walker, 2006). Initially, some local Aboriginal leaders assisted European exploration of the area. It did not take long for these relations to break down and for conflict to arise in the form of the Frontier Wars that were occurring in all areas of European settlement (Reynolds, 2006). Between 1842 and 1844, numerous white men were reported killed by Aboriginal people (Copland et al., 2006). Copland et al. report a visitor to the area in the 1850s who described how this conflict resulted in retaliation in which whole tribes (sic) were rubbed out. These conflicts combined with disease and disruption to traditional food sources through the introduction of grazing stock, resulted in reductions in the Aboriginal populations by about 30% by 1843. Between 1859 and 1893, Aboriginal groups of the area dispersed onto stations to work, or became fringe dwellers and cadgers (Riethmuller, 2006).

Under the Queensland *Aboriginals Protection and Restriction of the sale of Opium Act 1897*, most aspects of Aboriginal people's lives were controlled and people were removed from Country to reserves where they were completely separated from white society (E. Wilson, 2005).   During this time, most remaining Aboriginal people of the Toowoomba area were removed and reportedly the last Aborigine of 'full descent' (sic) from the region died in 1902 (Riethmuller, 2006). While there is some evidence that descendants of the region were living in family groups in the reserves, an anthropologist in 1934 officially found no descendants of the 'tribes' (sic) from the Toowoomba area. Today, there are very few people who know and claim the Toowoomba area as their Country.

Acknowledging the almost complete genocide that occurred in the area in which this study took place is an important contextualisation in terms of the critical intent of the project and this thesis. From an Indigenous perspective, this history still resonates in the land and people of the area, influencing current relationships between Indigenous and non-Indigenous people. The relationships between Indigenous and non-Indigenous knowledge systems, ontologies and epistemologies are also influenced by such a history.   In recognising this historical context, the importance of the project occurring in this area is also recognised, as too are its complexities and complications.

Overview of the thesis

Chapter 2 - Theoretical and educational background

Chapter 2 provides the necessary background in order for the reader to position the project both theoretically and within the Australian educational context. The theoretical framework of the project is explicated and contextualised within critical theory and pedagogy.   The evolution and implementation of the Australian Curriculum is discussed.

Chapter 3 - Literature review

Chapter 3 charts a course through literature that is important to understanding the context, theory and complexities of the research. As with all literature reviews in doctoral work, it necessarily contains only the works most relevant to my framing and thinking about the project. It is organised into two sections. Section 1 considers the intersections in literature about epistemology, curriculum and pedagogy. A broad approach to understanding epistemology and how it relates to curriculum and pedagogy is taken, drawing from different discourses from psychology, educational psychology and critical theory. Section 2 considers Indigenous knowledges and their relationship to power and school science. Literature around the 'why' and 'how' of science education inclusive of Indigenous knowledges, as well as the attitudes of teachers towards the idea, are examined.

Chapter 4 - Methodology

Chapter 4 explains the methodological approach taken in the project and how this was enacted in the method of research. The rationale for a critical qualitative approach is explained. Literature considering critical and Indigenous methodologies is examined and a Participatory Action Research (PAR) method that considers both is outlined. Methods of data collection and analysis are given and an outline of the process of the research is explained.

Chapter 5 - The beginning: Participants and their contexts

This chapter is the first drawn from the data of the project. Explanation is provided as to who the participants in the project were, and how they were situated in relation to Indigenous knowledges in their science classrooms. Thematic analysis of data gathered in the initial phases of the project related to positioning of the participants is given.

Chapter 6 - The PAR cycles

The process and progress of the research is described in Chapter 6. This chapter outlines what happened in each PAR cycle and is organised not only around the cycles themselves but the critical moments of teacher participation in these cycles. As such, it also contributes to understanding the *Little Stories* of teacher participation and places primacy on the voices of the teachers.

Chapter 7 - Epistemologies, pedagogies and politics

The analysis of participants' *Little Stories* moves to a theoretical analysis in Chapter 7. Data are considered from across the project and my analysis as the researcher-participant is brought to the fore. An interaction paradigm for understanding the ways in which epistemologies, pedagogies and politics influenced individual teachers' participation in the project is given and discussed.

Chapter 8 - The Grand Narrative of neo-liberalism

Chapter 8 moves from the *Little Stories* of teachers' participation to naming the *Grand Narrative* influencing and confining how teachers were able to engage with the project. The context of neo-liberal education in Australia is discussed and theoretical analysis is given in terms of themes and analysis arising from the previous chapters. The complexities around moving from rhetorical acceptance to practical implementation of the CCP are discussed.

Chapter 9 - Concluding Reflections

This chapter directly addresses the research questions and shows how they have been answered by the study. The limitations of the research are identified and discussed. A path forward in terms of including Indigenous knowledges in science education is considered.

Notes on how to read this thesis

Writing this thesis (as with any thesis I am sure) was a complex task. In order to represent the project on paper I have used several formatting tools to define areas such as participants' voices, my voice as a researcher-participant and attempts to present a differing perspective. For example, Chapter 4 uses brown text to differentiate between discussion from a critical qualitative position and an Indigenous methodological position. To ensure the reader knows when I am foregrounding my own voice in analysis of participants' *Little Stories*, text boxes and purple text have been used.

Notes on terminology

The use of terminology to describe Indigenous peoples, knowledges and cultures is complex and contested (L. T. Smith, 1999). Different conventions exist in the literature, as the reader will notice in direct quotes taken from reference sources which have been written as the author presented them in-text. Indigenous groups in different global contexts choose to name themselves differently. In Australia, traditionally, people were identified through their language group name. This is still the preferred identification where applicable (Pascoe, 2008). However, some individuals do not know their language groups due to the severe disruption and genocidal practices of successive Government policies.

In line with the curriculum documents, this thesis uses the term 'Indigenous' to refer to all Aboriginal and Torres Strait Islander peoples, knowledges and cultures and to all Indigenous groups worldwide. The term is considered to be a proper adjective, hence the necessary capitalisation. A noun, such as peoples, always follows *Indigenous*. In order to recognise the diversity of language groups that contribute to both Aboriginal and Torres Strait Islander groups in Australia, nouns such as 'peoples' and 'cultures' are presented in their plural form. It is not my intention to use 'Indigenous' as a homogenising term and it is used with the recognition of the rich cultural, linguistic and knowledge diversity

that is Indigenous Australia. Where references have presented terms related to Indigenous knowledges, cultures and peoples that I do not consider to be appropriate, these are followed by (sic) in text to acknowledge that the words are not ones I would choose myself.

Chapter 2: Theoretical and educational backgrounds

Such a consciousness would encounter the possibility that the de/legitimation of knowledge is more a socio-political process than an exercise of a universal form of disinterested abstract reason.

(Semail & Kincheloe, 1999, p. 17)

This chapter outlines two key areas of contextual background necessary to understanding the construction and findings of this project. Firstly, making clear the researcher's theoretical (and political) position is a cornerstone of critical practice and essential when working with Indigenous knowledges and peoples (Semali & Kincheloe, 1999; Smith, 2012). The theoretical framework section outlines the theoretical position that informed my work. As such, it should aid and guide the reader in understanding and placing the work in the wider field of qualitative research. Secondly, understanding the educational context of Australian schooling and curriculum at the time this project was being conducted is essential to making sense of the positioning of the project and its findings. The educational context section outlines the conceptualisation and implementation of the Australian Curriculum.

Theoretical framework

Education as a practice of liberation

This research started from the premise that education is not a politically neutral act (Darder, 2015). As such, education has the possibility of becoming liberatory practice, making concrete difference in the lives of the marginalised (Freire, 2005). The work drew theoretically on the writings of Paulo Freire (Freire, 1989a, 1989b, 2005, 2009) realising that peoples' action on social reality can

either preserve the status quo, or radically transform the world of oppression (Freire, 1970). As such, the project was framed in terms of understanding praxis as the action of people upon their world in order to change it (Freire, 2009). In particular considering the ways teachers might engage praxis within science education inclusive of Indigenous knowledges.

I also worked from a position that in order for praxis to come into being, people need hope that things can be otherwise. Drawing on critical theorists such as Freire and Hall, Giroux (2000) describes hope as "an act of moral imagination and political passion that partly enables educators and other cultural workers to think otherwise in order to act otherwise" (p. 345). Freire (2008) describes hope as an existential concrete imperative and hopelessness as leading to paralysis, immobilising our ability to recreate the world. Hope however, needs to be anchored in practice. Freire (2008) wrote "there is no hope in sheer hopefulness" (p. 2).

In order for authentic liberation and a process of humanisation to occur, "those truly committed to the cause of liberation can accept neither the mechanistic concept of consciousness as an empty vessel to be filled, nor use the banking methods of domination" (Freire, 2009, p. 79). This reflects a rejection of the 'banking' concept of education that Freire described as "an act of depositing, in which the students are depositories and the teacher is the depositor" (p. 72). In this way, I frame education as part of becoming more fully human and firmly a process of humanisation rather than dehumanisation.

This theoretical framing informs my critical pedagogical approach to school education. With this, I understand educational practice as a politically contested space that is shaped by history and challenged by a wide range of interest groups (Kincheloe, 2008). This approach calls for an ideological stance where teachers identify "sources of power, how power works, and how the marginalized are repressed due to sources of power" (Steinberg, 2012, p. viii). It is through critically reflecting on power structures, and the socially and historically

constructed nature of knowledge that students and teachers achieve a critical consciousness (Freire, 2009).

Official knowledge, curriculum and ideology

Following on from an approach that calls for teachers to recognise the historical and socially constructed nature of knowledge in education, I also recognise the need to consider the form and content of curriculum. How particular knowledges become important in the classrooms is intimately related to the principles of social and cultural control in a society (Apple, 2004). Some knowledges achieve the status of 'official knowledge' being defined as worthwhile to be passed onto future generations (Apple, 2000b). I see the recognition of the power these knowledges then hold within schooling and therefore society more broadly as important to the context of considering Indigenous knowledges in science education.

Accordingly, I approached curriculum knowledge as problematic and was aware of the ideological basis of curriculum formation. In this respect, I consider Apple's (2004) questions about the selective tradition of knowledge in curriculum to be important to the project:

> Whose knowledge is it? Who selected it? Why is it organised and taught in this way? To this particular group? The mere act of asking these questions is not sufficient, however. One is guided, as well, by attempting to link these investigations to competing conceptions of social and economic power and ideologies. (p. 6)

Apple denies the supposed neutrality of curriculum generated through institutional epistemologies such as the positivistic epistemologies described by Kincheloe (2010). He contends "there is an increasing accumulation of evidence that the institution of schooling itself is not a neutral enterprise in terms of its economic outcomes" (Apple, 2004, p. 7). Apple recognises that there is more than economic capital at stake, schools also distribute and preserve cultural capital. With this position,

we can now begin to get a more thorough understanding of how institutions of cultural preservation and distribution like schools create and recreate forms of consciousness that in enable social control to be maintained without the necessary necessity of dominant groups having to resort to overt mechanisms of domination. (p. 2)

Urging a struggle against epistimicides (the extinguishing of epistemic positions) in curricula, Paraskeva (2011) recognises the way hegemonic epistemology (defined as that predominantly of the White male) has violently imposed a coloniality of knowledge. Paraskeva posits that particular kinds of knowledge and 'science' have been able to acquire a dominant position while other knowledges from outside Western rationality have been silenced. Drawing only on dominant knowledge leads to what Freire (2009) calls dehumanising pedagogy, a pedagogy that actually oppresses both the oppressed and the oppressor.

However, importantly for this project, Apple (2000b) reminds us that "the powerful are not *that* powerful. The politics of official knowledge are the politics of *accords* or *compromises*" (p. 10). These compromises occur at different levels, through political and ideological discourse; at the level of state politics, at the level of what is taught in schools, at the level of the daily activities of teachers and students in classrooms, and at the level of how we are to understand all of this. As such, they are not impositions but represent how dominant groups try to create situations where the compromises favour them. As a result it is possible to understand how accords and compromises "enable social control to be maintained without the necessary necessity of dominant groups having to resort to overt mechanisms of domination" (Apple, 2000b, p. 2).

Knowledge – scientific and Indigenous ways of knowing

When problematizing school curriculum and the politics of knowledge selection, the basis of what knowledge 'is' needs to be considered. As Adyanga Akena (2012) contends, "what could count as knowledge in society is often a product of

a consent among constituent groups. Politics, ethnicities, and group ideologies influence the notion of rational knowledge" (p. 604). Adyanga Akena's ideas echo Apple's (2000b) proposition of 'common-sense', where ideology becomes seen as 'natural' as people go about their daily lives.

In this project I considered the epistemological construction of Western knowledge as addressed by Kincheloe (2010). He used a description based on the recognition of the positivistic epistemology applied to society by public institutions such as those involved in the military, economy and education. Kincheloe's categorisation considers this epistemology to be:

- Formal – knowledge is produced by formal scientific methodologies that are inflexible despite changing circumstances;
- Intractable – based on the assumption that the world is an inert, static entity;
- Decontextualised – phenomenon are studied in isolation from the diverse contexts they occur in;
- Universalistic – strict scientific method leads to knowledge that can be applied to all domains of the world and universe;
- Reductionistic – factors that are most easily measured are focused on failing to acknowledge the multitude of factors that shape the production of the knowledge; including questions about the position of the researcher;
- One dimensional – shaped by the belief in one true reality that can be discovered and completely described.
  (Kincheloe, 2010, pp. 22-23)

Much knowledge contained in school curricula is based on Western understandings produced through this positivistic epistemology (Kincheloe & Tobin, 2009). Particularly in the case of science, a one-truth curriculum often leads science teachers to a kind of scientism where teachers find it challenging to move beyond their attempts to enculturate all students into the value system of Western science (Aikenhead, 2001). With educational policy operating from Kincheloe's described positivistic epistemology, democratic curriculum that

involves exploring where knowledge comes from, its rules of production and the ways in which we can assess the quality and purposes of production becomes antithetical (Kincheloe, 2010).

What is science?

The status afforded to science within Western society cannot be denied. Since World War II, research and development in the area of science has attracted vast sums of money and is usually conducted by large institutions, both government and privately owned, for the 'common-good' of the people (Illich, 1981). Scientific achievements are honoured at every level, from the local school science fair to Nobel Prizes (Salmon et al., 1992). The popular media, academic and scholarly fields alike appeal to a sense of legitimacy through 'scientific proof', whether it is to sell an age-defying beauty cream or market a new pharmaceutical drug. The word *science* is also used to attach a desired legitimacy to fields of study (e.g. Creation Science, Christian Science, Administration Science) through appealing to the authority of science and scientists (Chalmers, 2004).

Where does this authority to validate and legitimise knowledge come from? *What is Science?* in attempting to define a 'Standard Account of Science' Cobern and Loving (2001) suggest that "science is a naturalistic, material explanatory system used to account for natural phenomena that ideally must be objectively and empirically testable" (pp. 58-60). Their 'Standard Account' also recognises science as about the world as it 'really is', thus presupposing that there is order and causation in nature. Similarly, Chalmers (1991) suggests that science is commonly thought of as 'proven knowledge', where "personal opinion or preferences and speculative imaginings have no place" (p. 1) and knowledge is reliable because of its objectivity.

Deriving from its classical base, in the modern era science claims a collective perceiving of rationality via the scientific community and the authority, through scientific method, to produce universal knowledge in the form of scientific

theories (Stanley & Brickhouse, 2001). Western Modern Science (WMS) operates on the basis of a Cartesian materialistic world that is both reductionist and mechanistic (Ogawa, 1995). The acronym WMS has also been taken to represent 'White Male Science' (Pomeroy, 1994 as cited in Aikenhead, 1996) reflecting the Eurocentric, male history of the Scientific Revolution, Enlightenment and succeeding modern scientific era.

I recognise the contestations around what science 'is'. The objectivity and universality of science leads to it being seen as 'externalised knowledge' where the scientific community legitimises what knowledge counts as science. Therefore people need to be scientifically literate in order to gain access to the body of knowledge that science offers. Lyotard (1984) contends that "one is a scientist if one can produce verifiable or falsifiable statements about referents accessible to the experts" (p.25) and that scientific knowledge is, in this way, set apart from narrative knowledge and is not a direct and shared component of a social bond. Similarly, Nandy (1992) views science as 'structured isolation' operating through Cartesian dualism and its self-legitimating nature. In this way, I recognise that scientific knowledge holds a certain power to decide what is considered as 'scientific' and operates to subjugate other forms of knowledge.

What are Indigenous knowledges?

The term Indigenous knowledge is used to describe a plethora of localised knowledge systems developed by Indigenous peoples worldwide. Whilst each Indigenous group's ways of knowing and objects of knowledge differ, some commonalities exist between these systems in comparison to Western ways of knowing. In the context of this research, the complex nature of Indigenous knowledges and their status in relation to Western knowledge are important.

There is a proliferation of definitions of Indigenous knowledge. The core of many of these definitions centres around Indigenous knowledge systems being generally holistic, linked to unified cosmologies of being, collectively generated and understood contextually (not 'universally') (Chigeza, 2007; Maurial, 1999;

Mwadime, 1999). There is also a difference of social and intellectual goals between Indigenous knowledges and science (Metallic, 2009). In Indigenous knowledge systems, importance lies in the process of gaining knowledge as opposed to the knowledge itself and the importance of narrative and learned experience in the passing on of that knowledge (Chigeza, 2007). Epistemology is important to understanding Indigenous knowledges, and like all bodies of knowledge, Indigenous knowledges have their own ontological, conceptual/philosophical, methodological, and axiological groundings (Sefa Dei, 2011). Whilst Indigenous knowledges are embedded in the culture and traditions of local people, they are also dynamic and influenced by external systems and internal creativity (Mwadime, 1999).

The position of Indigenous knowledges as 'subjugated knowledge' (Foucault, 1980) is recognised (Langdon, 2009; Maurial, 1999; Shiva, 1993). As has the marginalisation of Indigenous knowledges through colonial domination of Western knowledge, presented and accepted as transcendent truth, where other cultural knowledge is represented as 'superstition' (Semali & Kincheloe, 1999). The acceptance of the universality of science often leads to the replacement of local Indigenous knowledge claims that do not conform to this way of knowing (Snively & Corsiglia, 2001). A particular challenge in positioning Indigenous knowledges lies in working to introduce, affirm and re-inscribe knowledges that have been positioned outside the system of knowledge production that governs what is seen as 'truth' (Sefa Dei & Simmons, 2009).

Intersecting knowledges

A fundamentally important part of this project was understanding the ways in which Indigenous and Western knowledges intersect. Whilst considering the differing epistemologies of Indigenous and scientific worldviews, it is necessary to avoid essentialism in terms of failing to discern the contingent, contested and changing nature of Indigenous knowledge systems (Nash, 2009). Also the recognition of the differences within a discrete categories such as Indigenous peoples or Indigenous knowledges is necessary (Semali & Kincheloe, 1999). The

concept of a historically placed, unchanging knowledge is not applicable to either Indigenous knowledge or science, nor is an assertion that they are in binary opposition.

Kincheloe and Steinberg (2008) warn that "once the binary opposition is embraced, we have to choose one and dismiss the other" (p. 143). Agrawal (1995) highlights the difficulties in separating Indigenous and Western forms of knowledge, contending that it is difficult to frame them as being untouched by each other due to historically recognised contact, exchange and communication. Agrawal also recognises the heterogeneity within both classifications of knowledge, suggesting that this makes it difficult to construct fixed and unchanging distinctions. Through embracing both Indigenous and Western knowledge the illumination of the processes of knowledge production is possible. Within an educational frame, the inclusion of Indigenous knowledges in Western curricula necessitates a negotiation of what may seem to initially be conflicting ways of knowing, in order to develop an approach that values both without putting them in opposition to each other. Herein lies the research problem this project considered.

The cultural interface, as the space where Western and Indigenous knowledges meet, can be a place of tension as well as of immense opportunity (Nakata, 2002, 2008, 2010). From his standpoint as a Torres Strait Islander man, Nakata (2011) conceptualises the cultural interface as the contested space between Indigenous and non-Indigenous peoples, knowledges and cultures. He describes the ways in which Indigenous peoples have not capitulated to the order of Western knowledge but have taken up what has been necessary to practical needs in people's lifeworlds (Nakata, 2010). Working from a cultural interface perspective accepts that knowledge systems are:

> culturally-embedded, dynamic, respond to changing circumstances and constantly evolve… It is about maintaining the continuity of one when having to harness another and working the interaction in ways that serve Indigenous interests, in ways that can uphold distinctiveness and special status as First Peoples. (Nakata, 2002, p. 29)

I recognise that in order for non-Indigenous people to work effectively in the cultural interface, there needs to be a preparedness to engage in knowledge from multiple perspectives. Kincheloe and Steinberg (2008) suggest the concept of multilogicality is central to non-Indigenous people's understanding of Indigenous knowledges. Mulitlogicality can be described as a critical complex concept that focuses on transcending reductionism by gaining access to a wide diversity of perspectives when involved with research, knowledge work, and pedagogy (Kincheloe, 2008). As Kincheloe and Steinberg (2008) explain, "In a sense, the single photograph of Cartesian thinking is replaced by the multiple angles of the holographic photograph" (p. 139). In order to work with diverse ways of knowing, it is first necessary to see the boundedness of Western knowledge systems and then embrace multiple epistemological viewpoints (Austin, 2011).

Recognising these theoretical complexities around working with two intersecting knowledge systems was an important starting point for myself as the researcher to be able to plan and engage in the project. Recognising the importance of not essentialising Indigenous knowledges, operating within the cultural interface and taking a multilogical approach framed my approach to project methodology, my research participants and data analysis. Particularly working with a canonical discipline such as science, theoretical and epistemological tensions were anticipated and realised, for both the participants and myself.

The educational background

The project was positioned to work with teachers at a time when major curriculum changes were happening. The beginning of conceptualising this project took place with the release of the draft Australian Curriculum documents. Research group formation and the data collection phase of the project coincided with the release of the Australian Curriculum Draft Consultation document (ACARA, 2010a) and The Australian Curriculum Version 1.0 (ACARA, 2011b).

During 2011, when the research group was first meeting, schools and teachers were required to become familiar with the curriculum and consider how they might implement it in 2012. Data collection finished within the first term of the staged implementation of the curriculum in Queensland[1].

This timing meant that the project engaged with teachers as they were experiencing a time of curricular uncertainty. This offered research opportunities to collect data as teachers and schools were grappling with the 'how to?' questions arising from a new curriculum approach. The research therefore, was uniquely positioned to explore the research questions and provide data around teacher participants' beliefs and attitudes to the implementation of the CCP.

The development of the Australian Curriculum has been seen as a political response to globalisation and re-occurring poor standardised test scores in literacy, mathematics and science in international rankings (Lingard & McGregor, 2014; Lowe & Appleton, 2014). *The Melbourne Declaration* (MCEETYA, 2008), provided a rationale for the development of a national curriculum to which all State and Federal Education Ministers elected to office at the time were signatories. School based education in Australia is the constitutional responsibility of State and Territory Governments. In 2007 when developments toward a national curriculum were started, all governments, State, Territory and Federal were held by Labor (Lingard & McGregor, 2014). While the development and implementation of a national curriculum were novel, there had been political manoeuvres over several decades to establish a uniform curriculum to eradicate inter-state variability, which was seen to impact on children moving across state borders (Lowe & Appleton, 2014). Since the initiation of national curriculum development, the political landscape of Australian has changed and now the Federal Government is a conservative Liberal-National Coalition and three out of seven states and territories have Liberal governments. This altered political landscape has renewed critical focus on the curriculum and the knowledge contained within it.

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[1] States were able to decide their own implementation timelines (Lowe & Appleton, 2014)

Lingard and McGregor (2014) offer one of the few academic articles (available at the time of writing this thesis), that examines the interplay between national politics and policy in the formation of the curriculum. While noting that historically Labor governments had been more centralist and conservative governments had been more federalist, Lingard and McGregor posit that the bipartisanship apparent in the development and implementation of the Australian Curriculum reflects "the reworking of the nation in the context of globalisation and the human capital framing of education policy" (p. 93). They characterise the Australian curriculum as a vernacular representation of the Global Educational Reform Movement (GERM):

> This approach to school and system reform in response to globalisation has the following features: prescribed curriculum, focus on literacy and numeracy, top-down, test-based accountability, standardised teaching and learning and market-orientated reforms (e.g. Management models from the private school sector, school and parental choice discourses) (Sahlberg, 2011, p.103). (Lingard & McGregor, 2014, p. 96)

Critical of this approach, Lingard and McGregor note that while policies reflect GERM in terms of assessment and accountability, the Australian Curriculum represents a discipline-based approach that "may soon be more reflective of last-century models of school subjects, than those connected with and responsive to global needs and contexts" (p. 103). The foregrounding of 'doing' over 'knowing' and a discipline-based approach in the Australian Curriculum is relevant to the inequalities of knowledges this thesis considers. A focus on high-status knowledges that facilitate civic participation and economic reward foregrounds the knowledge of the powerful (Lingard & McGregor, 2014).

The progress of the Australian Curriculum followed a precise process involving writing, consultation and development. Following agreement at the State, Territory and Federal level on *The Melbourne Declaration*, the Australian Curriculum, Assessment and Reporting Authority (ACARA) was established in 2009 (ACARA, 2013a). ACARA followed a four-phase curriculum development

program (ACARA, 2013d). The first phase, 'shaping', involved the production of a Shaping Paper for each discipline area, informed by 'expert advice', to provide direction on purpose, structure and organisation of the learning area.   Shaping papers were then open for consultation including public comment and targeted consultation with 'key stakeholders'. The second phase was the writing phase where teams of writers, supported by expert advisory groups, developed the curriculum including content descriptors and achievement standards.   Again, these draft curriculum documents were subject to consultation and revision. The third implementation stage saw ACARA provide the curriculum on-line but implementation and curriculum support were the responsibilities of the States and Territories.   The final stage of monitoring and evaluation is ongoing. it involves the systematic collection and analysis of data on the effectiveness of the curriculum.   This has been followed by Review of the curriculum that is discussed in Chapter 8.

As implementation of the curriculum is the responsibility of the States and Territories, each jurisdiction decided its own timeline.   In Queensland, the implementation process commenced in 2011 with teachers and schools becoming familiar with the English, Maths and Science curriculums with full classroom implementation from 2012 (ACARA, 2012).   The State based education authority, Education Queensland (now the Department of Education, Training (DET)), had responsibility for implementation but stated that it was the responsibility of each school to arrange appropriate professional development, which proved challenging with tight budgets, short timeframes and several learning areas to implement simultaneously (Lowe & Appleton, 2014). As such, Lowe and Appleton describe the curriculum implementation as a top-down initiative driven by factors external to the school and teacher.

The introduction of the CCPs addressed three key areas identified in *The Melbourne Declaration* as being of benefit to individuals and Australia as a whole (ACARA, 2013c). The CCPs are intended to "provide dimensions which will enrich the curriculum through development of considered and focused content that fits naturally within learning areas" (ACARA, 2013c, para. 1). In this way

CCPs are supposed to enable teachers to deliver the content of the learning area while developing knowledge, understanding and skills in the CCP. In the document *The Shape of the Australian Curriculum* (ACARA, 2009b), available at the time of the commencement of this project, CCPs were initially called Cross-Curriculum Perspectives and were to be represented "in learning areas in ways appropriate to that area" (p. 13). The shaping paper stated that curriculum documents would be explicit as to how the perspectives would be dealt with and how links could be made between learning areas. Through 2011, which represented the data collection phase of this project, a continuum of learning for each CCP had purportedly been developed to attempt to ensure "strong and coherent inclusion in the Australian Curriculum" (ACARA, 2010c, p. 20). Lingard and McGregor (2014) describe the CCPs as a curriculum approach based on what the education system wants students to become contextualised through an idea of contemporary Australia (recognising a need for reconciliation with Indigenous Australians) and global political concerns (like global warming and a focus on Asia).

The *Aboriginal and Torres Strait Islander histories and cultures* CCP was designed to take account of:

> the underlying elements of Identity and Living Communities and the key concepts of Country/Place, Culture and People. Aboriginal and Torres Strait Islander Identities are represented as central to the priority and are approached through knowledge and understanding of the interconnected elements of Country/Place, Culture and People. (ACARA, n. d.-a, para. 1)

ACARA provide Figure 1 to visualise the conceptualisation of the CCP.

Figure 1: Organising ideas of the Aboriginal and Torres Strait Islander histories and cultures CCP (ACARA, n. d.-a)

Each organising idea is broken down into coded elements to enable further explanation. For example, OI.1 (Organising Idea 1) under Country/Place is "Australia has two distinct Indigenous groups, Aboriginal Peoples and Torres Strait Islander Peoples"; and OI.5 under the Culture organiser is "Aboriginal and Torres Strait Islander Peoples' ways of life are uniquely expressed through ways of being, knowing, thinking and doing". While it is necessary to be explicit as to what each CCP is intended to encompass, the expression of ideas is particularly Western in its organisation. As Nakata (2002) points out:

> in incorporating understandings of indigenous knowledge into curriculum areas… it must be acknowledged that we are screening it through a filter that positions it to serve our educational objectives, and which draws on our prior theoretical investments in knowledge and knowledge practice. (p. 192)

ACARA provides general advice on how the Aboriginal and Torres Strait Islander histories and cultures CCP fits with the science curriculum:

> The Australian Curriculum: Science values Aboriginal and Torres Strait
> Islander histories and cultures. It acknowledges that Aboriginal and

Torres Strait Islander Peoples have longstanding scientific knowledge traditions.

Students will have opportunities to learn that Aboriginal and Torres Strait Islander Peoples have developed knowledge about the world through observation, using all the senses; through prediction and hypothesis; through testing (trial and error); and through making generalisations within specific contexts. These scientific methods have been practised and transmitted from one generation to the next. Students will develop an understanding that Aboriginal and Torres Strait Islander Peoples have particular ways of knowing the world and continue to be innovative in providing significant contributions to development in science. They will investigate examples of Aboriginal and Torres Strait Islander science and the ways traditional knowledge and Western scientific knowledge can be complementary. (ACARA, n. d.-c, para. 5-6)

The Science curriculum is organised into three strands, Science Understanding, Science as a Human Endeavour, and Science Inquiry Skills (ACARA, n. d.-b). Science Understanding encompasses facts, concepts, principles, laws, theories and models established by scientists over time and students' abilities to explain and predict phenomena using this understanding. Science as a Human Endeavour recognises the changeable nature of science in the light of new evidence, the influence science has on society and society on it, the role of ethics and the social implications of science. It also recognises "that science advances through the contributions of many different people from different cultures" (ACARA, n. d.-b, para. 9). Science Inquiry Skills considers how evidence based arguments are constructed through predictions, hypothesis and investigation.

In Queensland, schools are assisted in implementation of educational policy, initiatives and curriculum by the Department of Education and Training (DET) and its statutory body, the Queensland Curriculum and Assessment Authority (QCAA). Both DET and QCAA provide advice and resources for the implementation of the Australian Curriculum. Prior to the Australian Curriculum

and the CCPs, Queensland schools had been required to embed Aboriginal and Torres Strait Islander perspectives in the Queensland curriculum. Both DET and QCAA provided advice and resources for this initiative. Embedding Aboriginal and Torres Strait Islander perspectives in schools was a key action in *The Queensland Government Reconciliation Action Plan* and the *Aboriginal and Torres Strait Islander Education Action Plan 2010-2014* (DET, n. d.). To this end, DET publishes the *Embedding Aboriginal and Torres Strait Islander Perspectives in Schools* (EATSIPS) guide which was revised every two years (DET, n. d.).

The EATSIPS initiative addresses the incorporation of Indigenous perspectives into school culture, curriculum and pedagogy. According to the EATSIPS guide, embedding of Indigenous perspectives enhances the educational experiences of Indigenous and non-Indigenous students:

> There is a call for educators and institutions to build bridges between the Indigenous and Western knowledge systems to achieve meaningful outcomes, for Indigenous students in particular but for all students in general. The challenge still remains: how does one build bridges between Western scientific and disciplinary knowledge and the Indigenous 'responsive, active eco-logical' knowledge that views 'language, land, and identity as interdependent in a unique way and constantly renewed and reconfigured' (Willimanson & Dalal, Christie cited in Klenowski 2008, p.11). (DET, n. d., p. 9)

DET suggest that in order to find a place where everyone's perspectives can meet, grow and learn, Bhahba's (2004) idea of a third cultural space is useful as a conceptual framework. The third cultural space is where Indigenous ways of knowing, being and doing overlap with Western ways, creating a space of innovation and creation.

Within the EATSIPS framework, curriculum and pedagogy is only one component of a whole school ethos. The other components include professional and personal accountabilities, community engagement and organisational environment. In curriculum terms, DET contend:

Aboriginal and Torres Strait Islander perspectives need to be presented to all students. *How* we teach these perspectives is based on an understanding of *why* we teach them… **By recognising that their role is 'the facilitator', as opposed to 'the expert', teachers can use this pedagogical approach to frame and support their development and understanding of Aboriginal and Torres Strait Islander issues.** (DET, n. d., p. 30)

It is also outlined that Indigenous perspectives are not considered to be embedded in curriculum unless "they are consistently and explicitly found within the intended curriculum and the pedagogies used in enactment" (DET, n. d., p. 30). In defining Aboriginal and Torres Strait Islander perspectives (the term Indigenous perspectives is also used synonymously) DET outline that perspectives are ways of seeing the world impacting on how we interact with the environment and how we perceive ourselves and others. Personal and family experiences, group and religious affiliations, linguistic understandings, media, text and visual representations and cultural values and beliefs influence them. They are not limited to one way of seeing the world as individual and collective identities contribute to perspectives. In terms of Indigenous perspectives DET recognise the localised nature of culture, the link between peoples and the land and the historical influences of past Australian policy and practice on Indigenous communities.

Affirming a commitment to embedding Aboriginal and Torres Strait Islander perspectives, the Queensland Curriculum and Assessment Authority (QCAA) released a statement in 2013 outlining their intended activities for the period 2013-2015 (QCAA, 2013). This document reflects the position on embedding perspectives from DET as outlined above and commits QCAA to continuing to ensure that Indigenous perspectives are embedded in all QCAA products and services, including curriculum development. The QCAA provides a range of support materials via their web site related to protocols, guidelines, resources and readings for embedding Indigenous perspectives. It is unclear how the curriculum element of EATSIPS relates to the Australian Curriculum as the

Aboriginal and Torres Strait Islander Histories and Cultures CCP takes a content rather than a perspective based approach to classroom implementation. Neither QCAA nor DET address this issue on their webpages.

Advice on implementing the CCPs was released by QCAA (while still operating as the Queensland Studies Authority) (Queensland Studies Authority, 2012). This advice was released in draft form after the data collection phase of this project but offers an insight into how QCAA view the CCPs. Figure 2 gives an exemplar of the Indigenous CCP in a year 9 science unit. The document gives no further explanation or resources to assist teachers in finding specific information to teach the unit or guidance on how to teach in a culturally appropriate manner. This exemplar shows that the CCP is not necessarily seen as the dominant element of a unit. The CCP is only included in one question that shapes the inquiry. It also shows a more content-based approach rather than the perspectives based approach outlined in EATSIPS.

Table 4: Year 9 Science

Year 9 Science: *Waves and particles*
www.qsa.qld.edu.au/13658.html#overview

Unit outline (p.1)

Students explore the atomic and wave models, developing understanding through targeted activities. The atomic and wave models build on students' understanding of the particle model explored in Year 8, demonstrating how models are developed over time through the process of scientific inquiry. This unit has three overarching aims — that students understand:

- phenomena that can only be observed indirectly can be described and explained by scientific models and theories
- models and theories are refined over time through observation, hypothesis and experimentation
- advances in technology can lead to modifications in the modelling used to describe phenomena.

Questions that shape the inquiry:

- How does energy get transferred by waves?
- Can a model used to explain mechanical waves work for electromagnetic waves?
- How does sound and light energy get transferred by waves and in what ways are they similar and how are they different?
- How do technologies (e.g. mobile phones and medical devices) make use of electromagnetic radiation and radioactive decay?
- Are claims in the media that mobile phones are not safe to use justified?
- What fundamental principles explain how Aboriginal and Torres Strait Islander traditional hunting tools and musical instruments work?
- How do scientists determine the structure of something they cannot see?

Aboriginal and Torres Strait Islander histories and cultures priority

Organising idea		Using the organising ideas for teaching and learning
OI.3	Aboriginal and Torres Strait Islander Peoples have unique belief systems and are spiritually connected to the land, sea, sky and waterways.	Students have opportunities to learn about how Aboriginal peoples and Torres Strait Islander peoples describe and explain a variety of phenomena.
OI.5	Aboriginal and Torres Strait Islander Peoples' ways of life are uniquely expressed through ways of being, knowing, thinking and doing.	By studying physical phenomena in this unit, students have opportunities to learn about the ways Aboriginal peoples and Torres Strait Islander peoples: • think about and understand the natural world • act on and express these understandings.

Figure 2: Year 9 Science exemplar including Indigenous CCP (QSA, 2012)

Through this history of policy around implementing Indigenous ways of knowing in the curriculum, there has been a focus on the 'why' of the inclusion. The rhetoric of the importance of including a concern for reconciliation through education has been present in Queensland schooling for quite some time. The impetus provided by a new national level curriculum has given renewed focus and framing to ideas around Indigenous perspectives and content in education. However, at the time of the commencement of the project, little support was provided for teachers in schools to get the job done. As Nakata (2011) points

out, teachers know the gaps in these curriculum documents and many of their questions around implementation remain from past curriculum approaches.

By undertaking research into how teachers experience engaging with unfamiliar content and knowledge at a time of curriculum upheaval, it was hoped to provide some clarification of what is important for participants to gain confidence and understanding around curriculum implementation. It was fortuitous that I was able to conduct this work at a time when teachers were already engaging anew with questions around how to include Indigenous ways of knowing and content in their teaching. The timing enabled interactions and questions to come to the fore that may have otherwise been silenced.

Conclusion

It is with an understanding of the theoretical framework and the educational context that the project proceeded from conceptualisation to implementation and analysis. However, it is necessary to frame how this project sits within a wider educational research field and consider what published knowledge is pertinent to making sense of the project. Chapter 3 presents a path through relevant literature guided by the understandings presented in this chapter.

Chapter 3: Literature review

Education is an act of love, and thus an act of courage. It cannot fear the analysis of reality or, under pain of revealing itself as a farce, avoid creative discussion.

(Freire, 1989a, p. 33)

Introduction

Two broad areas of literature were considered to be important to this research. Firstly, multifaceted literature around teachers and epistemology, to provide a basis for understanding the processes teachers may engage with when considering unfamiliar knowledge systems. Secondly, it was important to situate the project in terms of literature around the purposes of Indigenous knowledges in education broadly and science education specifically. Both of these areas offered substantial fields of work to consider.

Teachers' engagement with curriculum necessarily concerns the knowledge/s contained within them. Whenever people work with knowledge, their epistemologies influence their responses and understandings. Within the context of this research, teachers were required to engage with knowledges and epistemologies they were not familiar with. As such this review considers epistemology from a broad perspective, incorporating psychology, scientific and critical understandings.

The review also considers the opportunities that the inclusion of Indigenous knowledges has for creative discussion and the enactment of critical pedagogy in education. The epistemological challenges for teachers that come with these, as well as the potential benefits for themselves and students are profound. However, as Semali and Kincheloe (1999) suggest, educators can seemingly be "on dangerous ground" (p. 3) when they choose to engage with diverse ways of knowing in the classroom. The nature of this engagement in the science

classroom is considered along with the beliefs and attitudes of teachers who are ultimately responsible for such implementations.

Education that includes Indigenous knowledges and ways of knowing has been recognised in the literature as contributing to the success of Indigenous students (Aikenhead & Michell, 2011; D. Foley, 2003). I acknowledge the fundamental importance of Indigenous content and ways of knowing for Indigenous students in educational settings. However, the focus of the research project, and therefore the literature discussed here is the benefits of Indigenous knowledges in curricula for all students.

Section 1 – Epistemology, curriculum and pedagogy

Literature on epistemology is multifaceted and emerges in an educational context from several theoretical perspectives. While these perspectives might seem incommensurable, for example critical and psychological theories, they contribute to a broad understanding of the epistemological processes occurring in classrooms for teachers. When considering bodies of literature from psychological, scientific and critical approaches, it is apparent that the approaches to understanding the phenomenon vary greatly. For example, psychological and scientific epistemological studies attempt to measure and categorise epistemology, while critical studies would eschew these approaches in favour of situated, qualitative understandings.

In order to consider how teachers engage with unfamiliar knowledges, each perspective is considered in turn. A post formal approach, as suggested by Kincheloe and Steinberg (2011), originally postulated for considering cognition, is suggested as lens through which teachers' epistemology can be viewed. This lens allows the diverse perspectives to be brought together to consider the

similarities apparent across the theoretical approaches. Figure 3 summarises the structure of this section of the literature review.
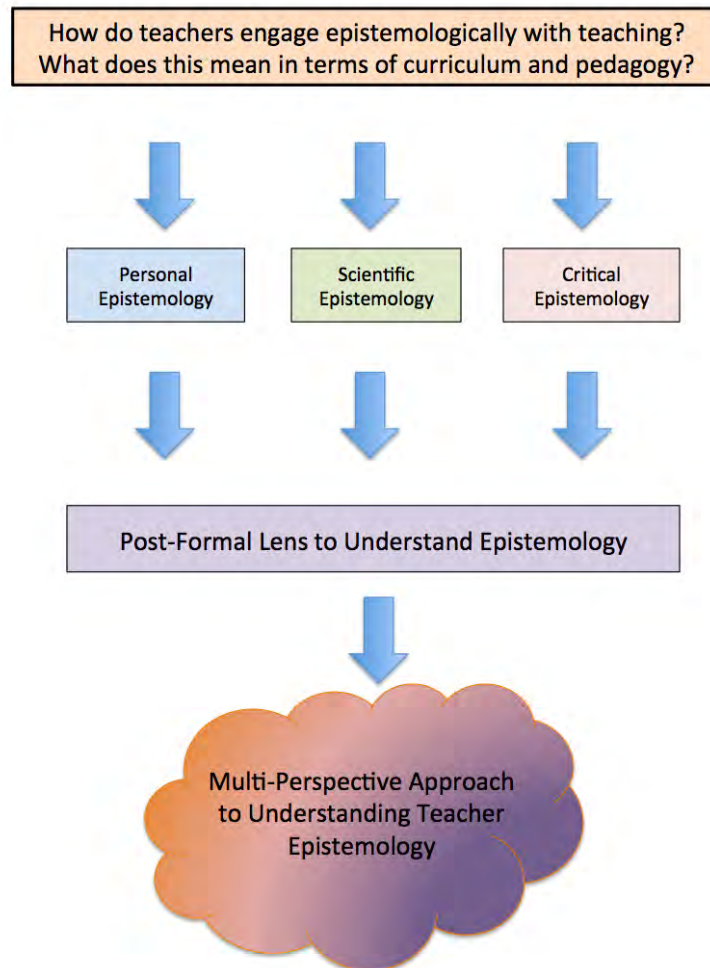
Figure 3: Framing of Section 1 – Epistemology, Curriculum and Pedagogy

Personal epistemologies

Considering how teachers' epistemologies influence their approaches to curriculum and pedagogy in the classroom is central to understanding how teachers may engage with curriculum initiatives that contain unfamiliar knowledge and epistemologies. A general definition of epistemology offered by Schraw and Olafson (2003), describes it as "*the study of knowledge and knowledge acquisition*" (p. 180).   There is a recent and growing body of

psychology and educational psychology literature that quantitatively and qualitatively analyses and describes teachers' personal epistemological stances and relates these to how they teach in the classroom (Brownlee, 2001; Schraw, Olafson & Vander Veldt, 2011). Where teachers are positioned epistemologically relates not only to their perspectives on what knowledge 'is', but potentially impacts their responses to the Australian Curriculum, Indigenous knowledges in science and their pedagogical decision making in the classroom.

How epistemologies relate to teaching has been recognised as an emerging field of significant importance by some authors (Bendixen & Corkill, 2011; Brownlee, Schraw, & Berthelsen, 2011). Brownlee et al. (2011) highlight that the terms *personal epistemology, epistemological beliefs*, *epistemological world view*, and *epistemological stances* are often used interchangeably to describe a set of beliefs about knowledge and knowledge justification. Categories of epistemological beliefs are commonly defined by individuals' responses to the certainty of knowledge in terms of the possibility of knowing 'absolute truths'. Brownlee (2001) considers Perry (1970) to be the first to describe and categorise personal epistemological beliefs. The four main epistemological positions identified in Perry's work were dualism, multiplism, relativism and commitment. Dualism relates to where individuals hold a set of beliefs that knowledge is comprised of absolute truths and can be transmitted by experts. Multiplism allows individuals to believe in some absolute truths but also to acknowledge that some things are not known with any certainty. In other words, personal opinion and absolute truths combine. Relativism shifts from the belief in certainty of knowledge to a belief that knowledge is personally constructed and that truth is relative to individuals' personal interpretations of experience. Commitment still features relativistic thinking but some beliefs are given more value than others and commitment to these beliefs takes place in a flexible manner.

Research on the epistemological beliefs of students and their impact on learning preceded work on teachers' epistemologies and implications for pedagogy. Schommer (1990) pioneered work with students and considered the impact of beliefs on comprehension, finding that personal epistemology influenced

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comprehension but comprehension was also influenced by factors such as home and educational background. Also considering students' epistemological beliefs, Hofer and Pintrich (1997) identified the importance of coming to some consensus as to the construct of epistemological beliefs and thinking. They flagged the possibility of similarities between constructivism at an individual level and constructivist sociocultural approaches to knowledge building in specific disciplines.

Turning the focus of epistemological studies from students to teachers has only occurred since the late 1990s (Schraw & Olafson, 2008). In an attempt to integrate literature on teachers' personal epistemologies from education, educational psychology and psychology fields, Schraw and Olafson (2003) produced an extensive review that contends that, in almost all of the writings they considered, a three category system of epistemology is endorsed. Drawing on a large body of literature, Schaw and Olafson define the epistemological positions of realist, contextualist and relativist. Similar to Perry's (1970) classification for students, these positions relate to the certainty of knowledge but are described in relation to how teachers approach classroom instruction. Realist teachers, working from the position of knowledge as absolute truth, actively teach students who are viewed as the passive recipients of knowledge. Contextualists believe in the co-construction of knowledge between teacher and student and serve as facilitators in the classroom. Relativists see knowledge as being constructed by each student from a unique knowledge base that is different but equal to other learners' knowledge. Teachers with relativist epistemologies emphasise a classroom environment that denies the primacy of teachers' knowledge and allows students to learn and think independently.

Several assumptions underlie the consideration of epistemological beliefs in Schraw and Olafson's (2003) categorisation of positions. Firstly, teachers are consistent in their beliefs and can be characterised by only one of the three positions at any particular point in time. Secondly, that these positions are consistent across academic domains; that is they are domain general beliefs rather than domain specific beliefs. Thirdly, that beliefs may be either tacit or

explicit, with the potential for beliefs to influence teaching practice becoming more likely as they become more explicit as this allows for reflection and change. Fourthly, different epistemological positions will result in different teaching practice. Lastly, epistemological positions develop over time and changes occur slowly through cognitive disequilibrium.

While Schraw and Olafson (2003) drew these assumptions from a wide range of literature, there is some contention as to their applicability particularly, as Brownlee (2001) suggests, in terms of the generalisability of positions across academic domains. If positions are generalisable, a teachers' personal epistemological positions in relation to the nature of knowledge should be reflected in their scientific epistemology. However, Kang and Wallace (2005) propose that the expression of this direct relationship may be disrupted by other practical considerations such as instructional goals that are linked to curriculum, and classroom management.

Much of the research on the domain specificity of epistemological beliefs has been conducted with students rather than teachers. Hofer (2000) found that truth was more likely to been seen as attainable by experts in the discipline of science compared to psychology. Hofer's study showed that disciplinary epistemological beliefs differed, contradicting previous research that suggested that epistemological development is domain general and disciplinary differences are not usually apparent. However, she still suggests there is "an underlying dimensionality to epistemological beliefs that cuts across disciplinary domains" (p. 400).

The context of the knowledge being considered may also impact students' views on the certainty of knowledge. Buelh, Alexander and Murphy (2002) propose, "while students may profess beliefs about the ambiguity of knowledge generally, they may also consider schooled knowledge to be rather certain" (p. 416). The structure of domains may influence student beliefs. According to Muis, Bendixen and Hearle (2006), well-structured domains that have agreed-upon solutions for

problems, such as science, compared to ill-structured domains such as history and literature may be associated with different epistemological positions.

How teachers view knowledge influences their teaching practice in relation to curriculum and pedagogy. Teaching practice is governed by the mandated curriculum as well as the pedagogical strategies teachers employ. Schraw and Olfason (2003) describe pedagogy as encompassing teaching and instructional practices, the role of the teacher, teaching style, the ways the classroom is managed and assessment strategies. As such, pedagogy is the manifestation of the curriculum in the classroom.

The level of sophistication of teachers' epistemological beliefs influences their pedagogical responses to curriculum. Olafson, Schraw, and Vander Veldt (2010) assert that more sophisticated epistemological beliefs usually result in teachers endorsing more student-centred instructional practices that emphasise critical reasoning. The converse of this is that less sophisticated beliefs lead to a sharper focus on traditional curriculum, student testing and mastery of basic concepts. It is likely that to combine potentially disparate epistemologies, such as scientific and Indigenous epistemologies, sophisticated personal epistemologies are necessary. If we consider Schraw and Olafson's (2003) epistemological positions of realist, contextualist and relativist the relationship between epistemological positioning and curriculum and pedagogy can be identified. From a realist position, curriculum is seen as the main vehicle in assisting students to acquire knowledge. Realist teachers see the curriculum as what experts consider as essential knowledge for students. Pedagogical approaches that emphasise knowledge transmission are favoured, including direct instruction from a textbook. Contextualist teachers believe in student centred curriculum, and use pedagogical approaches that reflect this, for example, problem based inquiry activities utilising multiple sources of information. Essential knowledge and skills outlined in the curriculum are seen as a guide to student construction of knowledge in meaningful ways that allow for knowledge to be applied in the real world. Learning is group-based and mediated by peers with the teacher, instead of being direct instruction based. Relativist teachers do not favour 'one size fits

all' curricula and curriculum choices are guided by student development and social reform. Students are encouraged to construct knowledge about themselves and the world and ask questions about power and justice. In support of this, Lidar, Lundqvist and Ostman (2006) found that teachers with more sophisticated personal epistemologies created more complex tasks designed to promote deeper learning and reflection in students. In addition, Bendixen and Corkill (2011) posit that if teachers believe in the certainty of knowledge, they may be less amenable to new and/or contradictory ideas which may impede conceptual change in teaching.

The consistency of teachers' espoused epistemological beliefs and their teaching practice is sometimes questioned. Olafson et al. (2010) affirm that it is not uncommon to find differences between teachers' espoused epistemological beliefs and their teaching practice in the classroom. Interestingly, Schraw and Olafson (2003) found that one influence on differences between beliefs and enactment came from teachers with more sophisticated epistemological beliefs feeling forced to teach a core body of knowledge as set out by the curriculum. In other words, curriculum pressure resulted in teacher centred pedagogy. Several limitations to enacting espoused epistemological beliefs have been identified in the literature, including limited classroom space and resources, behavioural management issues (Olafson et al., 2010) and curriculum enactment documents (such as curriculum frameworks) provided by the school district (Schraw & Olafson, 2003). According to Schraw and Olafson current educational policies mandating curriculum and student testing can impose time limitations on teachers' practice. This may then result in teachers not feeling free to teach as they would like to or in ways they believe are most effective.

Several factors are identified as limiting teachers' abilities to enact their preferred pedagogies. Schraw and Olafson contend that mandated curriculum frameworks provide a safety net for teachers in terms of curricular decisions and accountability, thus limiting teachers' pedagogical autonomy. Other additional pressures, such as a lack of teaching experience, administrative obstacles and a lack of professional culture in a school, result in teachers adapting a 'survival

mode' of teaching. In this way, compliance to a curriculum framework and mandated testing limits both effective practice and the implementation of teachers' espoused epistemological views. Similarly, Olafson et al. (2010) argue that factors such as teachers' age may be important. They suggest that older teachers may recognise a commitment to an ideological position may be possible in the face of barriers to ideal practice.

Schraw, Brownlea and Berthelsen (2011) suggest that future research is needed to develop an integrated theory that accounts for the development and manifestations of personal epistemology. Building on the work of earlier researchers, more exploration of factors influencing teachers' epistemologies and the impacts on their teaching are needed. This is a relatively young field and literature and theories are still developing.

Scientific epistemologies

From a personal epistemological standpoint, authors such as Brownlee (2001) question if epistemological worldviews are generalisable across academic domains. Within a school context, Lee and Tsai (2011) contend that beliefs about the nature of knowledge and knowing may be domain specific. Literature considering the relationship between science teachers' personal and scientific epistemologies is lacking. In addition to domain specificity, teachers' approaches to teaching particular school subjects may be influenced by the conceptions of teaching that they hold, so, for example, a particular teacher may have approaches to teaching science that are different from their approaches to teaching in general. Teachers' engagement with Indigenous ways of knowing in the science classroom may be influenced by their domain specific scientific epistemologies.

In order to consider scientific epistemologies, it is first necessary to engage with diverse ideas around what science 'is'. As highlighted in Chapter 2, Cobern and Loving (2001) attempt to define a 'Standard Account of Science' from their

epistemological perspective. These authors contend that science is a "naturalistic, material explanatory system used to account for natural phenomena that ideally must be objectively and empirically testable" (p. 58). Contained within this statement are the ideas that science describes nature in a way that is empirically testable, that is objective, and provides a systematic explanation of natural phenomena. Corben and Loving go on to further define science as *"grounded in metaphysical commitments about the way the world 'really is'"* (p. 60) thus linking epistemological to ontological perspectives. This statement acknowledges science's presupposition of the possibility of knowledge about nature and the existence of order and conformity in nature, as well as the essential premise of cause and effect. In conjunction with these points, Corben and Loving acknowledge the role of the scientific community in determining what science 'is' and contend that "what ultimately qualifies as science is determined by consensus within the scientific community" (p. 60).

Adding to this definition, Rosenberg (2006) describes an approach to understanding scientific theories as widely accepted laws, methods, applications and foundations that have been formulated and can apply to situations other than those in which they were derived. That is, scientific theories are universally applied, and operate independently from human thought. As Matthews (1994) points out, a universalist view can recognise that there may be some cultural considerations that influence science; however, these do not determine the truth claims of science. For example, culture, gender, race, ethnicity or sexual orientation of the knower is irrelevant, as the knower and the known are separated (Stanley & Brickhouse, 2001). Working in this way, science constructs theories and the behaviour of the natural world is seen as the ultimate proof of these. Stanley and Brickhouse state, "WMS [Western Modern Science] is conventionally described as a universal mode of reasoning that can transcend the effects of cultural mediation and material practices when it is employed to understand the natural world" (p. 43).

Corben and Loving's (2001) presentation of the 'Standard Account of Science' (also see Chapter 2) is one that provides a basis for the operation of the scientific

community, science in educational institutions and in the public domain. It represents a view of science that is part of the public consciousness and school curricula. However, not all authors writing in the area accept the Standard Account and aspects of the underlying epistemology of this construction of science are challenged (Kincheloe, 2010; Stanley & Brickhouse, 2001).

Universality is assumed in many definitions of science, including Cobern and Loving's (2001) Standard Account, however the claim of universality is often contested. Universality can be seen as an epistemological position (Stanley & Brickhouse, 2001). Cobern and Loving state that "good science explanations will always be universal" (p.51). Stanley and Brickhouse (2001) advance three assumptions upon which they contend that the universalist case rests; that reality is concrete and exists irrespective of what humans know or think about it; that there is order and structure to reality that exists across time and place; and that the structure of reality is knowable and reliable knowledge about the natural world is the product of scientific investigation (p. 37). Stanley and Brickhouse consider that those holding a universalist epistemology may acknowledge that people produce social constructions of scientific knowledge but that these are irrelevant because social knowledge cannot be imposed on reality. They oppose the universalist view of science contending that science is "local and multiple" and argue that the "content of the sciences is shaped by culturally different forms and social organization of research" (p.39). This is a position that Cobern and Loving reject. They question whether the problem multiculturalists such as Stanley and Brickhouse have with the universalist account is more about the intellectual exclusiveness of the Standard Account, rather than its universality. They argue that it is this exclusivity that leads to marginalisation of other ways of knowing rather than universality per se.

Debates around the universality of science connect to ontologocial and epistemological positions. Cobern and Loving (2008) understand the debates around universality and truth as exercises in ontological realism. That is, epistemological positions that reject the universality and truth claims of science are related to ontological positions that posit that it is not possible to know the

actual nature of reality. This means that each individual constructs their understanding of what is real from their own ontological and epistemological position. This leads to a rejection of a belief in science as universal and about how things 'really are'. Based on this understanding Corben and Loving advance a description of the ontological and epistemological positions of science summarised in Table 1.

Table 1: Ontological and epistemological positions of science (Cobern and Loving, 2008)

Ontological and Epistemological position	Defining characteristics
1. Positivism	• Rational, realist • Logical empiricism • Scientism • Objectivism • One true scientific method
2. Critical Realism	• Realist – based on ontological reality • Knowledge has verisimilitude with the real world • Some elements of construction of knowledge but limits placed on knowledge by external world
3. Philosophical Multiculturalism	• Relativistic • All knowledge local and culturally situated • Belief in ontological realism – different people have different ways of constructing reality
4. Radical Constructivism	• Anti-realist • Radical constructivism • WMS not about what is really real.

The ontological and epistemological positioning of science can be related to what knowledge is considered as legitimate by dominant society (Aronowitz, 1988). Drawing on Nadeau and Désautels (1984), Cobern and Loving (2008) situate positivism as realist and rational, arguing that this position is where the "myth of scientism" can exist that gives scientific knowledge "unquestioned epistemic privilege" (p. 427). An alternative position is that of philosophical multiculturalism and Cobern and Loving recognise Stanley and Brickhouse (2001) as holding this ontological and epistemological position (similar positions

are stated by Ogawa, 1995; Snively & Corsiglia, 2001). Rejecting universal knowledge and recognising knowledge as local and situated suggests an epistemological realism in which people have many ways of constructing reality. Stanley and Brickhouse contend that:

1) Our ability to understand nature is constrained by the limits of human cognitive abilities;

2) The observer is part of the reality that is observed, thus social construction plays a role in the scientific account of physical reality;

3) We cannot determine if reality is either uniform or invariant; reality may best be described as flux; and

4) We can, however, make the case for the disunity of science (Harding, 1998), since the cognitive content of the sciences is shaped by culturally different forms and social organisation of research. (p. 39)

Cobern and Loving (2008) describe their own position as holding an epistemology of critical realism. This combines a universalist epistemology with an ontological realism, but it recognises that "knowledge of reality is not like a photograph, but more like representational art" (p. 441). They see the relativist multiculturalists' position as coming from a "rejection of epistemological universalism grounded in an instrumentalist/utilitarian rejection of epistemological realism" (p. 436).

The differing ontological and epistemological positions described here have the potential to greatly influence the mode of inclusion of Indigenous knowledges in science education. A critical realist epistemology that holds to the universalism of science does not deny the importance of other ways of knowing but places them outside of science, albeit with equal status. A multiculturalist epistemology recognises the existence of different ways of knowing nature as different forms of science, also recognising these multiple understandings as equally important.

Critical epistemology and pedagogy

Engagement with Indigenous knowledges in science education is potentially a complex epistemological process that transcends specifically scientific or personal epistemological understandings. In order to capture the complexities of classrooms, Kincheloe (2006) suggests that considering only one research paradigm or discipline is not adequate to the task. He contends that knowledge about teachers and teaching that is produced through reductionist scientific methods must always be viewed in light of the unique circumstances in which it was produced and not taken to be universal. Kincheloe's position informs critical epistemological and pedagogical approaches that draw on critical theoretical perspectives.

Representing a changing and evolving tradition, Kincheloe (2008) contends that critical theoretical perspectives have been influenced by the 'post-discourses', namely, postmodernism, feminism and post-structuralism. In the view of Muis et al. (2006), postmodernist perspectives reject the presentation of knowledge as final and binding for all times, people and places. Rather, they contain multiple positions that share an understanding of the plasticity and constant change of reality and knowledge, the valuing of concrete experience over abstract principles and a belief that no single *a priori* thought system should dominate belief or investigation. Following this, Kincheloe (2008) holds that critical perspectives recognise that individuals' views of themselves and the world are heavily influenced by social and historical forces. As such, McLaren (2007) suggests that critical theory assists in interpreting, understanding and transforming every day experiences through recognising this contextuality.

Defining a critical epistemology is not easy to do and is often not specifically interrogated in the literature. Kincheloe's (e.g., 2004b, 2007, 2009, 2010) body of work on critical epistemology stands out as the most specific writing on the topic, in particular his 2010 book *Knowledge and Critical Pedagogy*. The tensions between critical positions and Western science are often discussed in Kincheloe's work (Kincheloe, 2004b, 2007; Kincheloe & Tobin, 2009; Kincheloe

& Steinberg, 2008; Semali & Kincheloe, 1999). However he acknowledges that holding a critical epistemology does not mean the rejection of all empirical science but it allows scientific ways to be only one perspective on reality (see Kincheloe, 2010). In line with critical theoretical positions, "a critical complex epistemology assumes that the mind creates rather than reflects, and the nature of this creation cannot be separated from the surrounding social world" (Kincheloe, 2010, p. 28).

The core of a critical epistemology is the recognition and understanding of how knowledge is constructed through historic and social influences. As Kincheloe (2010) posits, the critical position recognises that scientific knowledge assert its epistemological dominance within society, through asserting the power to claim objectivity and neutrality. Within a school setting, Kincheloe contends that it is necessary to ask questions about what knowledges are considered important and have, therefore, become part of the curriculum. Deploying a critical epistemology in this context requires interrogation of the nature of assumptions about knowledge and their everyday impact on teaching practice. Where a critical epistemological approach is taken, teaching becomes an epistemological act before it is anything else and multiple knowledge domains are recognised as appropriate bases for education (Kincheloe, 2004b).

When curriculum is engaged from a critical epistemic position, the political and contested nature of the knowledges it contains become visible. Kincheloe (2010) asks "how did this society - or at least the dominant power bloc in this society – come to promote this body of knowledge as the official curriculum?" (p. 40). He understands the term 'political' within the broader context of society as related to the way that power is distributed among social groups and contests that "all educational acts involve power" (p. 276). Through epistemological analysis and self-reflection on the nature and construction of their consciousness, teachers necessarily adopt a political role. The role of the teacher as transmitter of pre-arranged facts is politicised.

Contestation of the political nature of curriculum is inherent to a critical epistemological approach. Kincheloe, Slattery and Steinberg (2000) see the knowledge included in curriculum as a political issue because the decisions involve power dynamics related to whose heritage or considerations are of worth. Historically, Western curriculum development has erased any epistemic ways of knowing from those on the colonised side of the coloniser/colonised divide (Kincheloe, 2010). A critical epistemological approach requires teachers to ask the questions Apple (2004) poses about whose knowledge is accepted and taught in the curriculum (see Chapter 2), but to also interrogate their personal relationships to this knowledge, in order to understand their own positionality to be able to engage pedagogically in the classroom.

The pedagogical implications of a critical epistemology for teaching practice are profound. In order to enact a critical epistemology of practice, Kincheloe (2010) recognises that there must first be a rich, nuanced, historically grounded understanding of the self. This type of self-reflection allows for an examination of how practice is shaped by our own, and others', socio-cultural conditions. This position embraces the complexity of the nature of being in the world, rather than seeking to reduce this complexity to its constitute parts. The impact of this type of self-analysis for teachers is inevitable social and pedagogical transformation through thinking in new ways.

Through employing a critical pedagogy, based on a critical complex epistemology, teachers are able to conceive knowledge as culturally embedded and employ constructivist sense making to assist students to "build for themselves an epistemological infrastructure for interpreting the phenomena they confront" (Kincheloe, 2010, p. 29). Moving beyond personal epistemological classifications, teachers may view the intersection of disciplinary information and students' understandings and lived experiences as opportunities to create learning experiences where students can uncover new talents. This view of personal knowledge construction presages pedagogical change (Kincheloe & Steinberg, 2011).

Using a post-formal lens to understand epistemology

The perspectives on epistemology and its relationship to curriculum and teachers' pedagogy presented so far are theoretically diverse. The view of a critical epistemology seems quite far theoretically from the psychological perspective of personal epistemology or the analysis of scientific epistemologies. However, it is necessary to engage with each of these perspectives and to have these disparate disciplinary views on epistemology speak to each other, in order to understand the complexities involved in engaging with multiple ways of knowing in the classroom.

Post-formalism, as theorised by Kincheloe (2007), is proposed as a way to move between discourses based on the empirical cognitive domain and critical viewpoints of theory and practice in education. Further theorised by Kincheloe and Steinberg (2011), post-formalism derives its name from an effort to move beyond Jean Piaget's highest level of cognition, formal thinking. Post-formalism initiates a dialogue between critical theory and postmodernism which "is concerned with the expansion of self-awareness and consciousness, never certain of emancipation's definition, and perpetually reconceptualising the system of meaning" (p.55). Piaget's formal thinking implies an acceptance of a Cartesian-Baconian-Newtonian mechanistic worldview which Kincheloe (2007) sees as Eurocentric and mono-cultural. Formal operational thinking accepts "an objectified, unpoliticized way of knowing that breaks a social or educational system down into its basic parts in order to understand how it works" (Kincheloe & Steinberg, 2011, p. 54).

The post-formalist position is described as subjective, celebrating the connection between the knower and the known. It considers ill-defined and ill-structured problems, resituates cognitive theory as critical discourse, recognises reason as socially mediated and is committed to critical pedagogy and notions of social justice (Kincheloe, 2008). Post-formal thinking exceeds Piaget's formal thinking by expanding the notion of critical thinking that embraces multiple ways of knowing, like women's knowledge and Indigenous knowledges (Kincheloe et al.,

2000). This rejects the *Grand Narrative* of intelligence that excludes the non-White, poor and feminine (Kincheloe & Steinberg, 2011). Through teachers expanding their own cognitive thinking, they are able to bring these more sophisticated notions of critical thinking and pedagogy to the classroom.

Within the post-formal frame, Kincheloe (2008) does not completely reject the entire enterprise of empirical research but he does seek to move it beyond the tenets of positivism that Kincheloe and Tobin (2009) identify as so embedded in educational thinking that they are often invisible. A positivist epistemological position that sees 'objective' knowledge as the only 'true' knowledge (Kincheloe, 2006) denies the complexities of classrooms. The post-formalist position "grapples with purpose, devoting attention to issues of human dignity, freedom, authority, and social responsibility" (Kincheloe & Steinberg, 2011, p. 55).

Post-formalism offers a theoretical frame through with personal epistemological positions can be built on to include more critical approaches. Personal epistemologies, including epistemological beliefs, epistemological worldviews and epistemological stances are forms of cognition about epistemic matters (Chinn, Buckland, & Samarapungavan, 2011). The post-formal position would likely question the field of personal epistemology due to its positivist nature, contending that it is limited in its understanding to a particular ethnocentric position. The epistemological positions described by personal epistemologies and concepts in critical theory and pedagogy can be considered together to broaden contextual, socio-cultural and political understandings of teachers' epistemologies.

Returning to Schraw and Olafson's (2003) description of teachers' personal epistemologies and related pedagogies, comparisons can be made with critical theoretical positions. If epistemological approaches are not domain specific, realist teachers who believe that students are passive recipients of certain knowledge may also hold positivist (in scientific terms) epistemologies and deploy pedagogies that could be described as 'banking models' of education (in critical terms). In Freire's (2009) critical sense of education as narrative, the

teacher's "task is to 'fill' the students with the contents of his narration- contents which are detached from reality, disconnected from the totality that engendered them and could give them significance" (p. 71). This is the mechanism through which education becomes "an act of depositing, in which the students are the depositories and the teacher is the depositor" (p. 72). As Kinchelole and Steinberg (2011) suggest, if knowledge is viewed as external to people, the role the teacher takes emphasises the retention of independent pieces of information, inserted into the minds of students. In this way, realist teachers may deploy banking pedagogies.

Pedagogies resulting from a contextualist epistemological position may start to link with Frerian notions of generative themes in a pedagogical sense. If contextualist teachers believe in the co-construction of knowledge and consider their teaching role as that of a facilitator (Schraw & Olafson, 2003), one way this may manifest in the classroom is through problem posing. Where the 'banking model' of education "resists dialogue; problem-posing education regards dialogue as indispensable to the act of cognition which unveils reality" (Freire, 2009, p. 83). The contextualist epistemological position seems less likely to link with positivist scientific epistemologies, as it allows for exploration of more than one approach to scientific knowledge. Sophisticated scientific epistemologies are more likely to promote contextualist pedagogical approaches.

Moving from a contextualist to a relativist epistemology may involve deploying a pedagogy based on generative themes. Freire (2009) suggests that generative themes allow the consideration of complex ideas, values, concepts and hopes that impede people's full humanisation. By understanding these themes as influenced by the past, present and future, one can move beyond the current limit-situations that preserve the status quo (Freire, 2009). Consideration of themes becomes generative as "they contain the possibility of un-folding into again as many themes, which in their turn call for new tasks to be fulfilled" (Freire, 2009, p. 102). A relativist epistemology that considers students each create their own knowledge from a unique but equal base may capture the social change element of Freire's generative themes. A philosophical multiculturalist

scientific epistemology may also connect to the consideration of students' knowledge positions as local and culturally based. Schraw and Olafson's (2003) description of relativist teachers being guided by student development and social reform and encouragement of students to ask questions about their world and power and justice seems to connect to Freirean notions of praxis. Freire (2009) described praxis as the action of people upon their world in order to change it.

The links described between personal, scientific and critical epistemologies are derived from an analysis of the literature available around these perspectives. The use of post-formalism to draw these disparate theoretical positions together provides a way of considering teachers engagement with classroom and curricular epistemologies they may not be familiar with.

Interactions between epistemology, curriculum and pedagogy are only part of the considerations necessary to understand the complexities of science education inclusive of Indigenous knowledges. Working from the post-formal critical position, issues of knowledge and power also need to be considered. The second part of this literature review focuses on some of the complexities surrounding Indigenous knowledges in the curriculum in general and specifically within science education. The review concludes with recognition that teachers' attitudes and beliefs to the inclusion of the CCP are important, as they are on the front line of such curriculum reform.

Section 2 – Indigenous knowledges, power and school science

The potential for the study of Indigenous knowledges in education lies in openness to different epistemological ways of knowing that lead to transformative pedagogies in the classroom. Section 2 of this review considers the reasons why Indigenous knowledges should be included in formal educational contexts and how this might be important within the specific context of school based science education. These issues are contextualised through recognising the importance of Indigenous people's interests in the educational process. The section also recognises the power differentials between Indigenous knowledges, and science within educational contexts.

Teachers are responsible for the translation of any curriculum initiative to the classroom. As such, this section considers literature on the theoretical considerations for teachers of science education inclusive of Indigenous knowledges. Approaches to this type of science education are also considered. National and international literature around the attitudes and beliefs of teachers about the inclusion is explored. Figure 4 summarises the structure of Section 2 of the literature review.
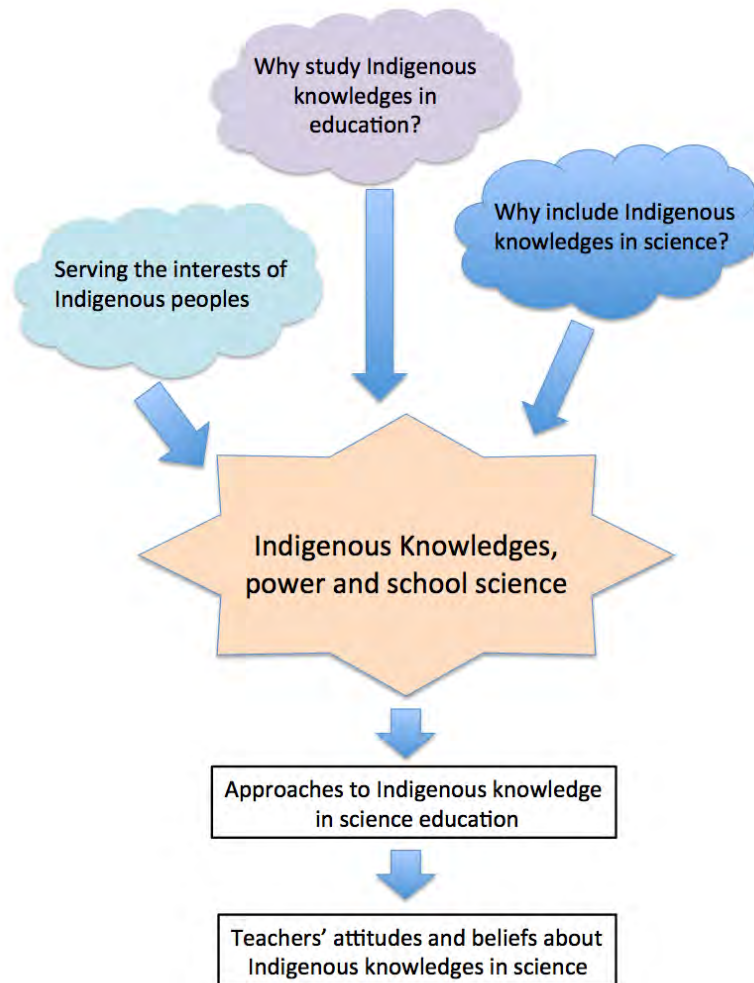
Figure 4: Literature review section 2 - Indigenous knowledges, power and school science

Why study Indigenous knowledges?

In order to provide a rationale for the importance of the Cross-Curriculum Priority (CCP) in science education, specific consideration of the benefits and complexities of studying Indigenous knowledges need to be discussed. Working from the theoretical framework outlined in Chapter 2, aspects of knowledge construction and privileging in the Western academy, the transformative power of Indigenous knowledges and the potential benefits of educational practices derived from mulitilogical perspectives are all important considerations to this research work.

In the opening pages of Semali and Kincheloe's (1999) edited volume, *What is Indigenous Knowledge?*, the authors acknowledge the contested and complex nature of social, cultural and political contexts surrounding Indigenous knowledges in the academy. Often, Indigenous knowledges have been represented as "primitive, wild, the natural" (p.3) and viewed with condescension by Western observers. Despite recognition that the study of Indigenous knowledges can place academics "on dangerous terrain" Semali and Kincheloe state that "we perceive the benefits of the study of Indigenous knowledge sufficiently powerful to merit the risk" (p. 3). The authors see the usefulness of Indigenous knowledges in providing multi-dimensional intellectual evocation that challenges and encourages interaction between Indigenous and Western epistemologies for the purpose of finding new methods to produce knowledge.

In order to progress to the possibilities that Indigenous knowledges hold in educational settings, it is first necessary to understand and acknowledge a past which has presented "particular hegemonic ways of knowledge production, validation, and dissemination and also given currency and legitimacy for certain bodies and practices" (Sefa Dei, 2011, p. 1). Understanding knowledge as hegemonic places the ideal representations of privileged groups of society as the natural political or social order accepted by the masses (Orlowski, 2011). With the privileging of Eurocentric understandings within disciplines such as science, a power imbalance is set up with other ways of knowing. The cultural imperialism that results from this construction of Western knowledge allows the marginalisation of different cultures' ways of understanding.

As Semali and Kincheloe (1999) point out, "Culture A certainly gains an element of domination over Cultures B and C if it can represent its knowledge as transcendent truth and Cultures B and C's knowledge as 'superstition'" (p.18). This leads to the idea that scientific worldviews cannot be judged by other worldviews, but other worldviews can and should be judged by science (Nandy, 1992). Langdon (2009) sees the knowledge imperialism that has been linked to colonialism as a legacy of violence that needs to be confronted in modern times if

Indigenous knowledges are to be worked with and learnt from. Within science education, Western science is taught at the expense of Indigenous knowledges and this "precipitates charges of epistemological hegemony and cultural imperialism" (Snively & Corsiglia, 2001, p. 7).

The subjugation of Indigenous knowledges is intimately related to colonialism. The ability to decide what knowledge is legitimate and impose Western ways of knowing on Indigenous populations is one carefully selected mechanism employed by dominant groups to subordinate Indigenous populations (Kanu, 2011b). In Australia and many other colonised countries, national policies of colonising governments were initially linked to Christianising agendas that sought to eradicate what were seen as primitive cultures and replace them with European ways of life (Burridge & Chodkiewicz, 2012). Knowledge that underpinned everyday life in Indigenous peoples' contexts was generally considered an obstacle to progress towards civilisation (Nakata, 2008).

Australian policies from the 1800s to the 1960s have been categorised in three periods: the Mission period, which saw churches run schools to teach basic (English) literacy, work skills and the Christian religion; the Protection period, where Aboriginal peoples were segregated onto government run reserves and stations, with the government having control over all aspects of life; and the Assimilation period, which aimed to absorb Indigenous peoples into the general population with all people living Western lifestyles (Burridge & Chodkiewicz, 2012). Forcible separation of Indigenous children from their parents was a hallmark of all of these policy periods. The trauma associated with children being removed from their parents and communities resonates within Australian society still, with inter-generational impacts in areas such as parenting, violence, depression and mental illness (Commonwealth of Australia, 1997). Through severing cultural and knowledge connections between Indigenous peoples and their lands, families and children, and communities and individuals, and imposing Western values, religion and knowledge through formal education, Indigenous knowledges are devalued, subjugated and destroyed (Adyanga Akena, 2012).

Formal education plays a pivotal role in the promotion and validation of the knowledge of dominant groups as official knowledge for all students (Kanu, 2011b). The power of this type of colonizing knowledge is its constant normative position within 'state apparatuses' and its simultaneous uptake as the idealised body of knowledge (Sefa Dei & Simmons, 2009). As Apple (2004) reminds us:

> educational institutions provide one of the major mechanisms through which power is maintained and challenged... education is also a site of conflict about the kind of knowledge that is and should be taught, about whose knowledge is "official" and about who has the right to decide both what is to be taught and how teaching and learning are to be evaluated. (p. vii)

As such, teachers and schools need to be aware of the richness and transformative potential of teaching marginalised knowledges and ways of knowing in order to make the most of systemic change.

The richness of Indigenous knowledge systems lies in their ability to address everyday challenges of human survival (Sefa Dei, 2011), interrelate knowledge, cultural beliefs and history to enhance lives (Semali & Kincheloe, 1999), while making no claims to universality that attempt to validate other ways of knowing (Kincheloe & Steinberg, 2008). Such knowledge systems are dynamic and undergoing constant renegotiation as people and communities exist in complex relations with land, culture and society (Sefa Dei, 2008). The ever-changing trends of modernity and post-modernity have influenced Indigenous knowledge systems to evolve in line with contemporary challenges (Sefa Dei, 2011). Sefa Dei (2011) describes where in Indigenous communities such knowledges are found:

> in their story forms, songs, myths and mythologies, fables, tales, folklore, riffles, and parables. They can be found in other forms of material culture, such as symbolic ornaments and body wear, and the meanings encoded in cultural artefacts. They can also be found in the local cultural resource knowledges and practices associated with traditional

pharmacology/plant medicine, farming technologies and agricultural methods, environmental management, soils and vegetation classification, arts and crafts, cultural norms, belief systems, social organisation of families and kin groups, cultural festivals, and cultural products (e.g., weaving, pottery, poetry, folklore, music, as well as ornaments creatively fashioned from Indigenous materials). (p.6)[2]

Foley (2003) describes Australian Aboriginal philosophy, intimately related to epistemology and knowledge, as "the triangulation of the Physical, the Human and the Sacred worlds" (p. 47). The base of the physical world is the land, which is seen as 'mother' and to which the people belong. Foley recognises the intimate relationship that Aboriginal people have with the land as integral to food, culture, spirit and identity. The human world encompasses knowledge, social relationships, ceremonies and people's capacity to change. The spiritual world is not solely metaphysical, but encompasses healing, lore, law and care for Country. These worlds are inextricably linked, demonstrating the interconnectedness that is integral to many Indigenous knowledge systems worldwide (Semali & Kincheloe, 1999).

It is in this interconnection between the physical, spiritual and human that possible incompatibilities between Indigenous knowledges and Western science arise. The central role of Cartesian dualism in science allows for the separation of the knower and the known and the separation of humans from nature, leading to the possibility of observing objective reality (Semali & Kincheloe, 1999). This allows for science's internally endorsed validation system – if science is objective and logical, how can it be wrong? Nandy (1992) describes this as a reduction of reality to that which is accessible to Western science, because from an Indigenous perspective it negates the possibility of unobservable spiritual and metaphysical forces. Nandy also contends that, through dualism and objectivism, Western science can become a system of domination that is endorsed by the

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[2] Some longer direct quotes have been used in this section. These are generally from Indigenous authors whose voices I have chosen to privilege over my own paraphrasing of their explanations. Where the authors are non-Indigenous, they are recognised as leading scholars in their field who are accepted as having authority to speak on the issue.

general public because of its objectivity and people's media and educational socialisation into accepting its authority or power.

Through such analysis and engagement with Indigenous knowledge systems it can be seen that knowledge production is not a neutral project. As Sefa Dei (2011) contends:

> every process of knowledge creation, validation, and dissemination is about the embodiment of politics... An important academic goal is to understand the on-going contestations in knowledge in the search to engage everyday social practice and experiences as well as the social barriers and approaches to peaceful human coexistence. There is a need for new, counter/alternative and multiple knowledge forms in diverse social sites to provide critical understandings to individual and collective political action. (p. 2)

As such, recognition of the social and historical constructions of knowledge, the power differentials at play in knowledge construction and the potential for an anti-racist discursive framework can be found in local, national and global struggles for equity and justice (Sefa Dei, 2000b).

Study incorporating Indigenous knowledges allows for the epistemological interrogation of knowledge production. In science education and research, it may "shake the Western scientific faith in Cartesian-Newtonian epistemological foundation as well as the certainty and ethnocentrism that often accompany it" (Semali & Kincheloe, 1999, p. 137). Kincheloe and Steinberg (2008) see the opportunity to challenge the academy and its 'normal science' to ask questions about the "globalised imperial future that faces all peoples of the planet at this historical juncture" (p. 136). Sefa Dei (2000a) describes his learning objective in studying Indigenous knowledges as "to develop a critical epistemology to account for the production and validation of critical knowledge for decolonisation purposes" (p. 113). Aligning with the theoretical framework and critical intent of this project, Semali and Kincheloe (1999) raise the possibility that "Westerners of diverse belief structures and vocational backgrounds may

experience a fundamental transformation of both outlook and identity, resulting in a much more reflective and progressive consciousness" (p. 137). Further, these authors link the introduction of Indigenous knowledges to an educational reform that is part of a socio-political struggle that promotes a reconceptualisation of science, and struggles for justice and environmental protection. This then allows for a transformative impact on critical consciousness that encounters the possibility that the de/legitimation of knowledge is "more a socio-political process than an exercise of a universal form of disinterested abstract reasoning" (p. 16).

The type of progressive consciousness that Semali and Kincheloe (1999), Sefa Dei (2000a) and Kinchelole and Steinberg (2008) strive for through the study of Indigenous knowledges represents what Freire (1989a) described as "*Conscientização* [which] signifies the *development* of the awakening of critical awareness" (p. 15). *Conscientização* (or conscientisation), the development of a critical consciousness, does not occur automatically in education. It requires "an active, dialogical education program concerned with social and political responsibility" (p. 15) and must take place for teacher and student through "intervention in and interrogation with his own context" (p. 15). Since the 1970s, Freire's body of work has influenced educators to recognise the ways in which education can be an important vehicle for the political formation of citizens within a democratic society (Darder, 2015). Education as a practice of liberation and humanisation requires people's reflection and action upon the world, that is, praxis. While critical consciousness is a necessary first step, "liberation cannot exist within men's consciousness, isolated from the world; it exists in the praxis of men in history which requires a critical awareness of the relation it implies between consciousness and the world" (Freire, 1970, p. 3). For teachers, critical consciousness allows the fundamental realisation that we live in an unequal world leading to a teaching praxis that requires emancipatory pedagogy with the explicit aim of the establishment of a more harmonious and peaceful society (Darder, 2015).

Drawing on his experience with Kaupapa Māori (Māori philosophy, worldview, and cultural principles) education, G. H. Smith (1999) suggests a framework of humanisation through conscientisation, resistance and transformative praxis which transcends a linear model. Instead of conscientisation leading to resistance and then to transformative praxis, all components are considered important and all can be held simultaneously, standing dialectical relation to one another. In this way G. H. Smith contends that individuals do not enter the transforming cycle - they are always in it. In terms of teachers and Indigenous knowledges, this may mean that encountering points of resistance in science education may lead to conscientisation and transformative praxis. Or, their own transformative praxis may lead to resistance and conscientisation. Within these processes, the notion of a critical ontology, where new levels of consciousness and 'ways of being' are achieved through understanding how political, religious, gender and racial positions are shaped by dominant cultural positions (Kincheloe, 2009) may be integral. Epistemologically, Kanu (2011b) argues that we are all what we know in terms of our own epistemologies, philosophies and values, but that we are also what we do not know of others' positions in these areas. She states, "Refusal to access the knowledge and wisdom of others produces self fragmentation in us. A fragmented self lacks full access both to itself and to the world, thereby impairing capacity for action" (p. 15).

The benefits to education, teachers and students of curriculum inclusive of Indigenous knowledges and ways of knowing are multifaceted and numerous. Current educational issues such as questions of integration, whole child education, multiple intelligence based instruction, environmental education, and holistic pedagogy are all assisted through the consideration of Indigenous knowledges in the classroom (Sefa Dei, 2011). Using Indigenous perspectives such as "indigenous conceptions of the learner who never walks alone, and who is indeed accountable to the world around her (including the environment)" (Sefa Dei, 2011, p. 9), and 'learning as community' considering learners' rights and responsibilities and learning as a cooperative and collaborative undertaking (Sefa Dei, 2008) enriches pedagogy for all students. Non-Indigenous students benefit from learning Indigenous knowledge, through experiencing different

perspectives on the natural world, which enhances their creative problem solving capabilities. If students move into professional scientific careers they may be more well-rounded and reflective scientists, engineers, resource managers or health professionals (Aikenhead & Michell, 2011).

While embracing the power to transform and enrich experiences for teachers and students, there must be recognition, especially from non-Indigenous teachers and administrators, that the interests of Indigenous peoples, communities and cultures must be maintained. From an Indigenous perspective "indigenous knowledges represent essentially a "speaking back" to the production, categorisation and positions of cultures, identities and histories... indigenous knowledges are about resistance, refusal and transformation (for indigenous peoples)" (Sefa Dei, 2008, p. 6). Within the context of Indigenous knowledges in science and science education, an important first step is to recognise science's historical relationship with the 'Other'.

Why include Indigenous knowledges in science?

Although science can be seen as externalised knowledge (see Theoretical Framework in Chapter 2), it also has a history of attempting to describe society in universal and objective terms. In this, Western science's perceived neutrality has been used to justify marginalisation and oppression of non-Western races and those who exist on the fringes of capitalist society. Claeys (2000) describes the evolution of Social Darwinism and suggests that the crucial shift in the application of the 'survival of the fittest' from the natural to the social world came when Darwin accepted the definition of 'fitness' in the human species as 'intelligence' and expressed the hope that "the optimal outcome of human natural selection would be the triumph of 'the intellectual and moral' races over the 'lower and more degraded ones'" (p. 237). The presumption here is that the 'civilised races' would encroach upon and replace the savage 'lower races'. Here we see the justification of the colonial project and the past policies and practices related to 'civilising and Christianising'. Social Darwinism applied a linguistic

framework of Darwin's biological theories to describe the world as experienced by White settlers and to justify the policies and practices of racial oppression against Australia's Indigenous peoples (Dafler, 2005). In order to maintain race as a categorical division in the same way as Darwin used 'species', Caleys (2000) suggests that race was constructed as a general classification directly attached to skin colour and wed to the ideas of a racial hierarchy and supremacy based on the notions of an intellectual 'fitness'.

The Enlightenment period provided a rational conceptual basis around which civilisation and savagery could be delineated (Semali & Kincheloe, 1999) and through 'scientific advances' such as Social Darwinism a specific image of science as being analogous with Whiteness became apparent. When combined with Cartesian-Newtonian epistemology and Baconian domination of nature, Semali and Kincheloe suggest "as a scientific construct whiteness privileges mind over body, intellectual over experiential ways of knowing, mental abstractions over passion, bodily sensations, and tactile understanding" (p. 30).

The history of scientific knowledge production *about* Indigenous peoples has served to rationalise an array of liberal capitalistic practices worldwide (Nakata, 2008). Early anthropological documentation of Indigenous peoples used extensive field data to describe the physical mental and social characteristics of Indigenous peoples on a comparative basis to people in Western communities (Nakata, 1998, 2002, 2008). Nakata contends that the methods used are an excellent example of the cultural embeddedness of science and how knowledge achieves legitimacy and authority at the expense of other knowledge systems (Nakata, 2002). There has been a shifting basis of inquiry about Indigenous peoples but "all knowledge production about Indigenous people still works within a wider set of social relations that rationalise, justify and work to operationalise a complicated apparatus of bureaucratic, managerial and disciplinary actions that continue to confine the lives of Indigenous people" (Nakata, 2008, p. 189).

While Indigenous knowledge systems are increasingly acknowledged in scientific areas of study, especially in regard to sustainable development practices, Nakata (2002) suggests that "the Indigenous knowledge enterprise seems to have everything and nothing to do with us [Indigenous peoples]" (p. 2). Western scientists claiming value in Indigenous knowledges can also tacitly decontextualise and relegate it to a lower order of knowledge (Semali & Kincheloe, 1999). By labelling Indigenous knowledge systems as "ethno-science" such as, ethnobotany, ethnopharmacology, ethnomedicine and so on, Semali and Kincheloe argue that Indigenous ways of knowing are situated as culturally grounded, while Western science is represented as transcultural or universal. In addition, categorising Indigenous knowledges in Western scientific terms "is to inadvertently fragment knowledge systems in ways that subvert the holism of indigenous ways of understanding the world" (p. 21). The documentation and storage of Indigenous knowledges in databases located within academic institutions (for example, gene banks and electronic networks), from an Indigenous standpoint can look similar to former colonial enterprises that "co-opted land, resources and labour in the interest of their own prosperity through trade and value adding" (Nakata, 2002, p. 2).

However, Indigenous knowledges and science do not have to sit in opposition and can be seen as complementary rather than separate realities (Aikenhead & Michell, 2011). In seminal work, Agrawal (1995) argues that to commit to a dichotomy between Indigenous knowledge and science is to reproduce the dilemmas of earlier debates, where anthropologists such as Malinowski were able to relegate Indigenous knowledges to primitive status through showing their distance from Western scientific knowledge. Nakata (2008) stresses that it is important to understand what happens to Indigenous knowledges when they are conceptualised simplistically and opportunistically from the "standpoint of scientific paradigms as everything that is 'not science'" (p.191). Aikenhead and Mitchell (2011) offer a way of understanding the two systems as differing primarily in terms of knowing and experiencing nature: "this cultural difference may be expressed as follows: the way scientists *see* the world can clash with the way Indigenous Elders *inhabit* the world" (p. 8). With these considerations,

Nakata's (2002) notion of the cultural interface (see Theoretical Framework in Chapter 2) becomes a useful way of conceptualising the interactions between Indigenous and Western systems of knowledge:

> This notion of the Cultural Interface as a place of constant tension and negotiation of different interests and systems of knowledge means that both must be reflected on and interrogated. It is not simply about opposing the knowledges and discourse that compete and conflict with traditional ones. It is also about seeing what conditions the convergence of all these and of examining and interrogating all knowledge and practices associated with issues so that we take a responsible but self-interested [from an Indigenous standpoint] course in relation to our future practice. (p. 286)

Serving the interests of Indigenous peoples

The title of this thesis, *Whose Knowledge: Science Education, Indigenous Knowledges and Teacher Praxis*, represents acknowledgment of not only the contestation of knowledge production described so far in this review, but a recognition of the rights of Indigenous peoples to have Indigenous knowledges recognised and Indigenous interests served through formal school based education for all. This research was formed and conducted with de-colonising intent. That is, understanding the underlying social and historical constructs of Western scholarship as part of the larger intent to make material differences in the lives of Indigenous peoples (L. T. Smith, 1999). This links to the process of reconciliation which peak body Reconciliation Australia (n. d.) describe as "about building better relationships between the wider Australian community and Aboriginal and Torres Strait Islander peoples for the benefit of all Australians". The project was conducted with the understanding that science education that considers Indigenous knowledges can make tangible contributions to Indigenous sovereignty movements locally and internationally (Aikenhead & Michell, 2011).

While negotiating the complexities of working with Indigenous knowledges in academic settings, non-Indigenous teachers and researchers must not only avoid essentialism and romanticisation of Indigenous knowledges, peoples and cultures, but must also ensure their attempts at facilitation do not turn into further marginalisation (Kincheloe & Steinberg, 2008). As alluded to by Nakata (2008), there are still ways in which Western knowledges and ways of being act neo-colonially to intervene and confine Indigenous lives. Through government, state and institutional denial of the historical formation of marginalising conditions these conditions are perpetuated (L. T. Smith, 1999). At times, Western scholars unwittingly participate in the Western hegemonic process; the difference between celebration of Indigenous knowledges and their appropriation needs to be carefully considered (Kincheloe & Steinberg, 2008).

Current interest in Indigenous knowledges comes at an historical moment when Indigenous peoples are better positioned in terms of the legal-political issues of rights, sovereignty and self-determination to assert their intellectual property and proprietary rights (Nakata, 2008). Indigenous people are, of course, best positioned to make decisions surrounding the use and withholding of Indigenous knowledges. The different collective rights, interests and rules regarding secret and sacredness means that requirements for protecting Indigenous knowledges differ from those found in Western institutions (Nakata, 2008). Nakata argues that:

> in best practice circumstances, the transferring and/or integration of Indigenous knowledge across knowledge domains provides due recognition and legal protection to those aspects and innovations of knowledge that are indigenous in origin. In worst practice, of course, global interest in indigenous knowledge threatens its integrity and exploits it on and even greater scale. (Nakata, 2008, p. 190)

In terms of the place of Indigenous knowledges in learning institutions, Sefa Dei (2011) calls for new non-hierarchical spaces of knowing, not simply decolonised spaces. He argues that we cannot ask hegemonic or dominant spaces to simply 'make room', but the politics of decentring learning spaces and dominant

knowledge require new ways of creating spaces for a centricity of multiple knowledge systems to contend with asymmetrical power relations. As Nakata (2002) recognises, knowledge recovery led by Indigenous communities would not look the same as that led by Western concerns. Indigenous knowledges must be meaningfully included in the academy without being trivialised (Sefa Dei, 2011).

Indigenous knowledges in science education

Increasingly the culturing of knowledges within science education is being recognised (Chigeza, 2007; Lewis & Aikenhead, 2001; Roth, 2009b). Drawing on Phelan et al.'s (1991) definition of culture, Aikenhead (1996) categorises canonical scientific knowledge as cultural "beliefs" and recognises science as "itself a subculture of Western or Euro-American culture" (p. 9). If science is recognised as a sub-culture, learning science can be viewed as cultural acquisition. Aikenhead argues that, as a sub-culture, science exhibits a well-defined system of symbols and meanings that have their origins in a Western male history. The project of acquisition of the sub-culture of science may necessitate a cultural 'border-crossing' (Aikenhead & Jegede, 1999). For people from non-Western cultures, making the crossing into Western science requires assimilation that can marginalise or replace their own world-view. Similarly, as Aikenhead (1996, 1998) notes, those of a Western background are also required to cross cultural borders between their life-world and the world of science.

Treating science as a cultural enterprise represents a radical shift in thinking for some science educators (Aikenhead, 1996). Aikenhead's argument for the cultural nature of science is succinct: "Science does have norms, values, beliefs, expectations, and conventional actions that are generally shared in various ways by communities of scientists. Hence, science satisfies the definition of culture established by Phelan et al. (1991)" (p. 9). School science, Aikenhead contends, is a sub-culture which expects students to acquire these norms and values and make them part of their world to varying degrees. He recognises, however, that

"unfortunately, the 'taught' science curriculum, more often than not, provides students with a stereotype image of science: socially sterile, authoritarian, non-humanistic, positivistic, and absolute truth" (p.10). This form of scientism acts like a hidden curriculum, emphasising the need for students to think like scientists (Aikenhead, 2001). The goal of science education's cultural transmission runs into ethical problems when Western culture in the form of science is forced upon students who do not share its system of meanings resulting in not enculturation but assimilation and a form of cultural imperialism (Aikenhead, 1996). This does not deny that border crossings are also necessary for many Western students who identify with sub-cultures that are non-masculine, humanities orientated and non-Cartesian.

Aikenhead's (2001) position is particularly salient to the context of this project because when students reject the assimilation into the Western culture of science, they become alienated from science, which is a major global influence on their lives. As outlined previously, the Australian Curriculum has been designed with just such global influences in mind in terms of what students should know and be able to do. When students do not attain the cultural capital associated with scientific understanding they are limited in their ability to participate effectively in Western society (Aikenhead, 2001). Often in the case of Indigenous students (or other marginalised groups) this perpetuates a 'discourse of deficit' around educational achievement. However, in a global world where the Internet makes location an abstract concept, bringing local knowledge into curriculum brings with it challenges in politics, history, language, economics and ethics (McKinley, 2005).

In order to mediate possible cultural alienation, a cross-cultural school science that does not accept the hegemony of Eurocentrism but seeks ethical, social, ecological and economic rewards for all students is suggested (Aikenhead & Lima, 2009). In countries with a history of colonisation, recognising Indigenous knowledge as foundational to understanding nature and bringing these knowledges into the classroom allows teachers to build bridges between Western science and local Indigenous culture (Aikenhead & Lima, 2009).

Curriculum of this nature allows both Indigenous and non-Indigenous students to 'walk in both worlds':

> By walking in both worlds or by two-eyed seeing, Indigenous students gain cultural capital essential for accessing power as citizens in a Eurocentric dominated world (e.g., the capability to appropriate knowledge from Eurocentric science and technology, as needed) while maintaining their roots in an Indigenous wisdom tradition. For non-Indigenous students, cross-cultural school science can nurture a richer understanding of the physical world. Their Eurocentric dominated world is an impoverished mono-cultural world that stifles diversity. By learning to walk in both worlds or by two-eyed seeing, non-Indigenous students gain insight into their own culturally constructed Eurocentric world, and they can gain access to Indigenous cultural capital essential for wisdom-in-action for their country's sustainable growth (Aikenhead & Lima, 2009, n. p.).

Snively and Corsiglia (2001) identify the cultural imperialism inherent in the imposition of purely Western science education. They assert that non-Western and cultural minority students may be forced to accept Western values and assumptions about political, social, economic and ethical priorities. Conversely, mainstream students can be denied the important values, assumptions and information embedded in other cultural perspectives.

Whilst there are many authors arguing that the inclusion of Indigenous knowledges in science education is important there are several different schools of thought about how Indigenous knowledges should be placed within science. A multicultural approach favoured by Stanley and Brickhouse (1994) rejects the universalist view of science and acknowledges the role of social construction in science. These authors suggest strategies, such as the use of cross-cultural case studies, to help students understand other cultural views of science and make visible some of the basic tenets and assumptions of Western science (Stanley & Brickhouse, 2001). This approach is also suggested by Snively and Corsiglia (2001) who also hold a more relativist, contextual and historicist view of science.

Ogawa (1995), suggests a multiscience rather than a multicultural approach, to recognise the existence of the various types of science including personal science, Indigenous Science and Western science. Other authors, while supporting 'culturally-sensitive' science education, contest the definition of Indigenous knowledge systems as 'Native Science' or 'Indigenous Science' (El-Hani & de Ferreira Bandeira, 2008).

An important question asked by Snivley and Corsiglia (2001) in regard to the purposes of Indigenous knowledges in science education is:

> Should we develop a teaching approach that merely develops an appreciation for TEK [Traditional Ecological Knowledge] and IK [Indigenous Knowledge], or one that goes further into the implications of racism, history, and definitions, and attempts to deconstruct old prejudices? (p. 24).

These authors suggest a model of science education where different perspectives of the world are considered, as are the areas where they overlap and reinforce each other. A dialogic approach allows for discussion of the similarities and differences of the knowledges and identifies areas where Indigenous knowledge helps fill in the gaps in Western scientific knowledge and vice versa. In this way critical questions such as "what are the origins and consequences of our practice of viewing Western science as superior to other forms of knowing? Where did we get the idea that Western science is the only 'true' science? What are the consequences?" (Snivley and Corsiglia, 2001, p. 28) may be engaged. This type of critical pedagogical practice allows students to see more than one worldview but it also needs to address changing deep-seated views of cultural difference and issues of power (McKinley, 2005).

Approaches to science education inclusive of multiple perspectives have been categorised into three models (Chigeza, 2007): firstly a cross-cultural perspective that employs a method of considering problems from a scientific and from an Indigenous perspective; secondly, a multi-cultural perspective where different ways of understanding what science is and how it works are explored,

making explicit cultural border crossings by highlighting different worldviews; thirdly, a pluralistic approach which considers knowledge systems on different terms, seeing Western science as a 'gate-keeper' and comparing other ways of knowing to it. A pluralist approach recognises multiple sciences constructed in different cultural contexts from the understanding that science is "a rational, empirical way of describing of explaining nature" (Aikenhead & Lima, 2009, n. p.). The pluralistic approach most closely aligns with Kincheloe and Steinberg's (2008) concept of multilogicality. Multiple perspectives and vantage points allow for increased understanding of the complexity of science. Through a multilogical perspective, different interpretations and realities help to extend students' cognitive abilities as they come to see disciplinary knowledge from as many frames of reference as possible.

Whatever approach is taken to integrating Indigenous knowledges and science in education, there is a challenge to move beyond the scientism that is commonly held by teachers and attempts to enculturate all students into the value system of Western science (Aikenhead, 2001). This requires both teachers and students to be able to critically consider the epistemological and ontological bases for understanding science. Drawing on van der Plaat (1995), Aikenhead (2001) suggests that "reading between the lines of privileged discourse to infer what ontology has been culturally constructed by that discourse and to understand that ontology in terms of its relationship to one's own culturally determined ontology" (p. 339) is a literacy very much needed by Indigenous students in order to make sense of science. This may also be necessary in order for teachers to negotiate an understanding of what Western science is and to open a conceptual space for the inclusion of Indigenous knowledges.

In order for this conceptual space to work towards addressing power imbalances between non-Indigenous and Indigenous Australians, teachers need to deploy a pedagogy that values and understands Indigenous knowledges. Giroux (2005) suggests a 'border pedagogy' that allows engagement with the "borderlands in which diverse cultural resources allow for the fashioning of new identities within existing configurations of power" (p. 20). So while teachers are assisting

students and themselves to cross Aikenhead's borders into the sub-culture of science, Giroux's border crossings in order to "understand otherness in its own terms" (p. 20), become relevant to cross-cultural curriculum and education as a tool of reconciliation. In the Australian context, there is potential for this type of pedagogy to aid in reconciliation, but in order for this to occur, Indigenous knowledges must be included as part of dominant culture, approached in a non-tokenistic way and not dismissed as primitivism (Michie, 2002).

Teachers' attitudes and beliefs

While the benefits of Indigenous knowledge in science education are clearly demonstrable, it is the task of each individual teacher in each classroom to implement curriculum initiatives. The complexities around epistemological and ontological differences mean that, "we cannot just 'do' indigenous knowledge in the curriculum" (Nakata, 2008, p. 189). The vast majority of teachers who are required to engage with the *Aboriginal and Torres Strait Islander Histories and Cultures* CCP identify as non-Indigenous, making it difficult for them to see Indigenous knowledge outside of the coloniser interface (Nakata, 2008).

In the Australian context, some authors have reported on work conducted with teachers and schools around the incorporation of Indigenous, or specifically Aboriginal, perspectives or cultural knowledge (Burridge, Whalan, & Vaughn, 2012; Harrison & Greenfield, 2011). These discussions often focus on a whole school level and consider how quality teaching can be promoted through engagement with local Aboriginal communities to improve educational outcomes for both Indigenous and non-Indigenous students.

Nakata's 2011 paper lists questions and concerns that teachers and schools had surrounding the Australian Curriculum initiative. These included issues such as "what does the inclusion of Indigenous perspectives look like and how do teachers embed these in meaningful ways?" and "how can non-Indigenous teachers do this when they have their biases and may already be challenged in

this area?" (p. 2). As Nakata points out, these are not new questions, but they are challenges that remain from past curricular approaches.

Harrison and Greenfield (2011) reported on a project looking at how schools incorporate Aboriginal perspectives. They noted that teachers "lament that they do not possess the knowledge to teach about Aboriginal Australia" (p. 74). Michie (2002) recognised that teachers "do not have much knowledge about Indigenous science" (p. 39) and identified a lack of resources and access to professional development as problematic. Also identified has been confusion surrounding what constitutes Aboriginal cultural knowledge (Burridge, Chodkiewicz, & Whalan, 2012), and the differences between Aboriginal perspectives and Aboriginal knowledge (Harrison & Greenfield, 2011).

Teachers are also reportedly hesitant about incorporating Aboriginal content when they feel like they do not have the expertise to do this in an authentic way (Quince, 2012). In a school of largely Indigenous students, Yunkaporta and McGinty (2009) found that non-Indigenous teachers avoided Aboriginal perspectives as they felt uncomfortable and were "fearful of overstepping" (p. 63). Burridge and Evans (2012a) showed that participation in an action learning based professional development increased teacher inclusion of Aboriginal cultural knowledge in their teaching. Teachers were reassured through the professional development process that "Aboriginal cultural knowledge could form part of the mainstream curriculum" (Burridge & Evans, 2012a, p. 67). In that project, teachers recognised the challenges of being time poor and struggled to sustain the project in amongst the usual pressures of a school day. However, while time constraints were recognised as a challenge and participation in the project was perceived as an increase in workload, these issues were not seen as a deterrent to undertaking the project. In light of this, Burridge and Evans highlighted the need for teacher professional development work to be adequately resourced, including funding provisions for staff relief to allow participation.

The issues of teachers overcoming their own biases might be intensified in canonical subject areas such as science. Specifically considering secondary science teachers and Heads of Departments (HoDs) of Science, Baynes and Austin (2012) report on the initial reactions to the proposed Indigenous cross-curriculum perspective in the draft Australian Curriculum documents. HoD reactions were generally pessimistic, asking questions such as "Is this really science?" (p. 61). This study suggested HoDs thought that teacher apathy and a lack of knowledge would be challenges. Teachers offered positive responses in the face of the HoDs' attitudes, overcoming their initial concerns around epistemology and lack of knowledge to produce beneficial outcomes for students.

In the Canadian context, Kanu (2005, 2011a) offers in-depth, critical discussions on integrating Canadian Aboriginal perspectives into the school curriculum. Kanu's (2012) book devotes a chapter to teachers' perceptions of integration and starts with the observation that "an important dimension… that has rarely been addressed in previous research is the voices of teachers on this issue" (p. 165). From data collected through ethnographic work, she outlines the reasons the teachers in the study believed that the integration of Aboriginal knowledge and perspectives were critical. The reasons cited were: the need to learn from Aboriginal peoples; providing culturally relevant curriculum to all students; improving the images and perceptions Aboriginal students have of themselves; limiting the economic implications of school dropout of Aboriginal students; representation of all Canadian peoples and benefits to Aboriginal; and non-Aboriginal students through learning about Aboriginal cultural heritage and history (pp. 169-171).

Like the Australian authors Quince (2012) and Yunkaprota and McGinty (2009), Kanu (2012) reports that teachers perceived their own lack of knowledge about Aboriginal culture and issues and a resultant lack of confidence as challenging to integration. Kanu goes on to also identify the exclusion of teachers from educational system level discussions about integration, a lack of resources, racist attitudes, lack of support from school administrators and incompatibility

between school structures and some Aboriginal cultural values also impeding meaningful integration. Aikenhead (1999) identified conceptual, pedagogical, ideological, psychological and practical barriers from the perspectives of teachers to accommodating both Western and Aboriginal (in the Canadian context) cultures in the science classroom.

An important consideration in challenging current curriculum practices is teacher identity. Kanu (2011a) suggests that teacher identities are under negotiation as they attempt to carry out reforms that challenge the constructed social norms that have historically functioned to protect the dominant culture's linguistic and cultural rights. Melville and Bertley (2013) recognise the pressure on science teachers to preserve the prestige and power of science as a discipline and therefore the importance of mandated curriculum change in teachers' sense of agency. A re-negotiation of the science curriculum to include Indigenous knowledges requires teachers to be comfortable challenging established notions of what science 'is', for classroom implementation. The mandated nature of current curriculum change may validate sympathetic teachers' beliefs and allow a greater sense of agency.

Conclusion

The inclusion of the Aboriginal and Torres Strait Islander Cross-Curriculum Priority in the Australian Curriculum presents an important opportunity to address different cultural perspectives in the science classroom. Through a critical pedagogical approach to this curriculum change, the nature of knowledge construction in Western and non-Western contexts can also be interrogated. Through such a multilogical approach, not only can Indigenous students cultural contexts be taken into consideration to assist in their success in Western based schooling, but also all students have the opportunity to develop a critical consciousness. Within science specifically, Indigenous knowledges may assist with improving cultural border crossings into what is considered an important discipline within schooling in a global context.

Teachers also may benefit in similar ways to students through the implementation of the CCP. In considering the curriculum initiative, teachers need to develop an understanding of Indigenous identity, peoples and cultures. This is not a small task, especially if they have been enculturated into the values and assumptions of Western science. Developing a critical praxis may entail the need to reform their professional identities, in order to feel comfortable with the curriculum initiative.

The following chapter describes the epistemological theoretical and practical aspects of the methodology chosen and the Participatory Action Research (PAR) method used. The chapter draws on the theoretical framework and aspects of the literature review to frame the methodology and method. This review has provided the context for analysis in the remaining chapters in terms of the curriculum itself and the theoretical and practical considerations the teachers faced.

Chapter 4 - Methodology

What begins with the personal should end with the personal, not simply because of the symmetry, but because that is where questions of power and knowledge always end (Apple, 2000b, p. 13).

Introduction

The previous chapter outlined the literature considered relevant to this study. It is from this base that the methodology and method of the project were constructed. This chapter outlines my theoretical understanding of critical qualitative studies, Indigenous methodologies and how these two bodies of literature 'speak' to each other. The theoretical position created informed the chosen Participatory Action Research (PAR) method and how it was implemented. The relationship between the project's research problem, research questions, methodology and method can be seen in Figure 5. The metaphor of the Tree of Life has been used to frame the project and its methodology and method to acknowledge the importance of Indigenous perspectives to this research.
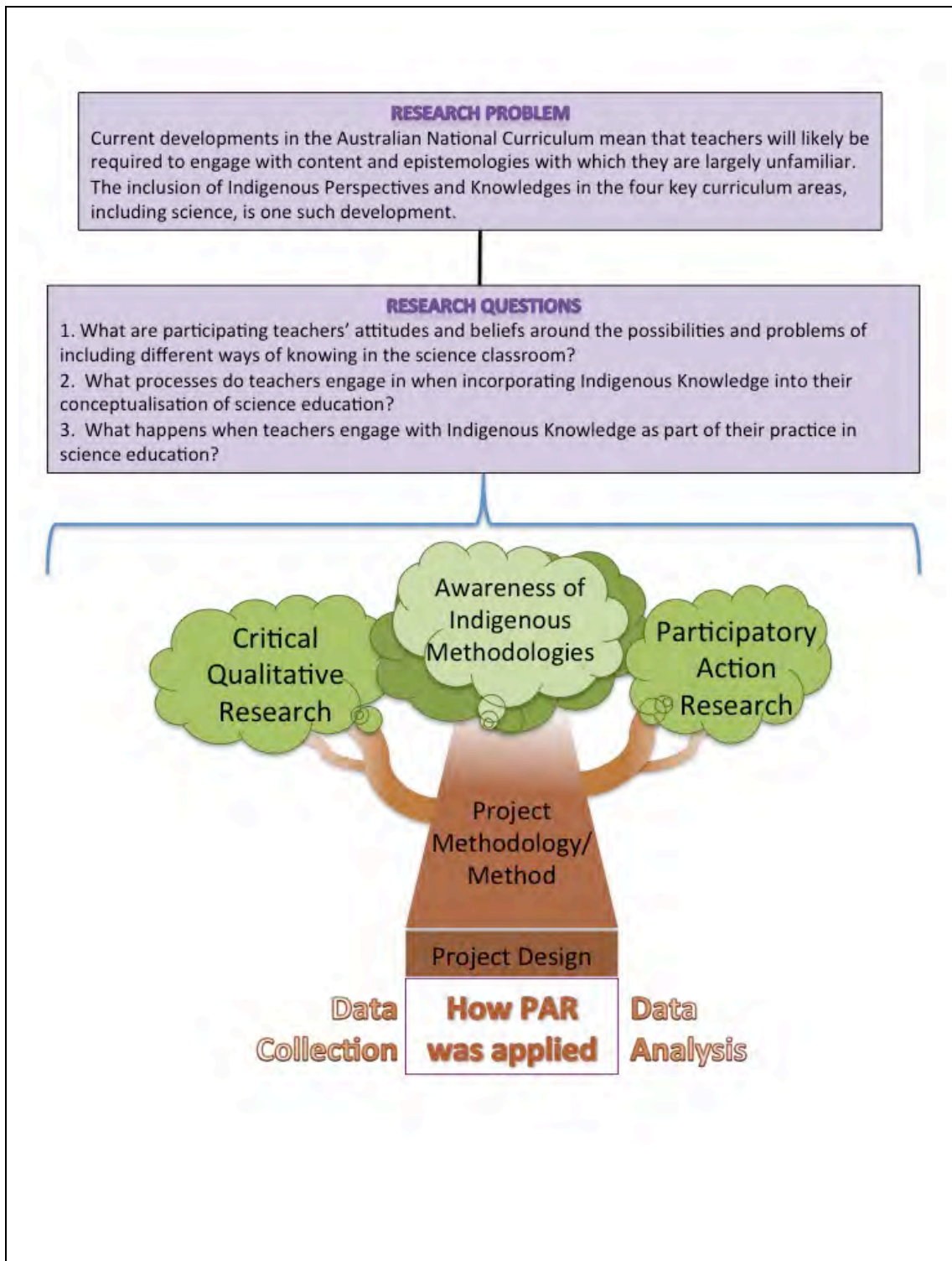
Figure 5: Research design components and their relationship

Critical qualitative research

In a project considering science education and educators, my decision to conduct the research qualitatively was both an obvious choice and a contradiction. Science has a long tradition of positivist, quantitative research based on a realist ontology and discovery of the 'Truth' (see Chapters 2 and 3). The scientific primacy placed on empirical, measurable, cause and effect data derides the idea of situated, interpretive, multiple realities as 'soft' research. This project however, was not about the science, it was about the teachers and their understandings, action and praxis surrounding the use of Indigenous ways of knowing in the classroom.

In considering the research problem posed, a qualitative approach was chosen to attempt to capture diverse and rich data. Qualitative techniques allowed me to record some of the lived experiences of these teachers while they were grappling epistemologically and politically with both the specifics and wider educational and societal issues surrounding their practice. The aim of data collection was the illumination of the processes of reviewing, understanding and implementing the Cross-Curriculum Priority (CCP) in the science classroom.

For me as a former science researcher, there was also something metaphorical and personal in choosing a completely qualitative approach. There was an inherent challenge to overcome ingrained scientific methodological thinking in order to produce a rigourous qualitative study. At times, the devil on my shoulder (dressed in a white lab coat) whispered in my ear that the data I was collecting was not 'hard' enough. "How would this apply in other contexts and how do I know that it is True?" it would ask. This internal struggle was a call for me to whole heartedly embrace the qualitative approach and felt reflective of the struggle by some of the project participants to make sense of Indigenous ways of knowing within a scientific frame. In a sense, there was a relearning of the idea of what research 'is', quite similar to the questions I was asking participants about their view of what science 'is'.

Essentially, this project deployed a critical qualitative research methodology for two reasons. Firstly, the research questions require data to be gathered that would not be easily measured using quantitative methodology. As the research method is inductive and emergent, it was not easy to anticipate what data would arise during the project and the use of qualitative techniques allowed the collection of data to evolve along with the organic development of the research process. Secondly, the choice of qualitative method reflects the rejection of a positivist scientific paradigm. Qualitative research is of the world of lived experience which cannot be easily defined through causal models (Denzin & Lincoln, 2005). This allows for the consideration of different epistemologies, rather than trying to fit conflicting ways of knowing into a scientific experimental paradigm.

To take a scientific research approach to a project such as this would have been to further reinforce the status quo in terms of what can be considered legitimate 'research' and be assimilated into what Apple (2000b) described as 'official knowledge'. As such, the research took a critical frame, contending that "positivist and post-positivist research reproduces only a certain kind of science, a science that silences too many voices" (Denzin & Lincoln, 2011a, p. 9).

In this project, the inherently political nature of all research was recognised and indeed embraced. Critical qualitative research works within the context of individuals to confront injustices and promote an emancipatory consciousness (Kincheloe, McLaren, & Steinberg, 2012). Far from the purported politically neutral stance of the natural sciences, I recognise this work as an inquiry project, but one that is also a "moral, allegorical, and therapeutic project" (Denzin & Lincoln, 2011b, p. xiii). Within this perspective, the inherently political nature of working with marginalised knowledges can be examined, explicated and valued. My epistemological position as the researcher and the methodological approach were united through methodology that considers multiple ways of knowing and individuals' political positioning.

As the researcher I decided to adopt an inductive, emergent project design. The idea of the researcher as an interpretive bricoleur was pivotal. In producing a bricolage, a pieced together set of representations fitted to a complex situation (Denzin & Lincoln, 2011a), the multiple voices and perspectives of all participants could be represented. This allowed a multilogical approach (Kincheloe & Steinberg, 2008) to the research design that linked with the epistemological multilogicality of the project as a whole. The bricolage methdology is cross-discliplinary in nature, allowing an approach to method that enhances mulitilogicality (Kincheloe et al., 2012) and fits within the post-formal frame (Kincheloe & Steinberg, 2011). Using the idea of bricoleur, I attempted to combine multiple data collection practices and emic representations from participants to add rigour, breadth complexity, richness and depth (Denzin & Lincoln, 2011a).

In combining the bricolage approach with a critical data analysis lens, I hoped that the politics and power relationships inherent in the study would be illuminated. Kincheloe (2004a) describes the task of the bricoleur as uncovering the artefacts of power and culture that influence a researcher's scholarship as well as scholarship in general. In his view, bricolage is an active research process, meaning that researchers have an agency that "rejects deterministic views of social reality that assume the effects of particular social, political, economic, and educational processes" (pp. 2-3). Within this project, the approach allowed a fluid research process that met the needs of the participants while providing methodological rigour. While a particular research method was chosen to structure the project, the bricolage approach meant that the manner in which it was adopted did not conform to one particular framework of how research must proceed. Data collection was viewed as an evolving process and was elastic to encompass many forms of information that became pertinent to the work.

Grand Narratives and *Little Stories*

The overall structure of the research and the presentation of this thesis have been constructed with Lyotard's (1984) idea of "incredulity toward metanarratives" (p. xxiv) in mind. Lyotard saw grand or metanarratives as the broad totalising metadiscourses that narrate the story of human history and guarantee the pragmatic acceptance of modern science and political processes (Fraser & Nicholson, 1994). While considering *Grand Narratives* as losing their credibility, Lyotard (1984) also recognised their popular appeal.

In many ways this research was constructed to speak back to the *Grand Narrative* of the Standard Account of Science (Cobern & Loving, 2001). This speaking back has been enacted through telling the *Little Stories* of teacher participation. Griffiths (2009) draws on Lyotard (1992) to highlight the importance of *Little Stories* that are told in specific contexts. Hughes and Mac Naughton (2000) argue that *Little Stories* (or *Little Narratives*) can be used to capture multiple understandings and generate new questions and new rules about alternative but equally valid ways to discuss an issue. As knowledge is seen as local and contextual within Indigenous systems (Chigeza, 2007), so too are my representations of the *Little Stories* (lived experiences) of the participants of the project. Capturing the *Little Stories* in relation to and juxtaposed against the *Grand Narratives* was an important methodological consideration.

As such, in selecting a method for investigating the research problem and questions, it was important for considerations of contextuality and lived experience to come to the fore (Denzin & Lincoln, 2011a). Equally, a way of considering the politics and portraying an openness to multiple perspectives was considered essential to align with the critical intent of the methodology and be respectful to Indigenous concerns. I considered that the reflexive nature of Participatory Action Research would allow the methodological rigour and flexibility to achieve these aims (W. Carr & Kemmis, 1986; McIntyre, 2008).

Participatory action research

As I wished to draw current science teachers into the project and work with them in their efforts to address the CCP in science teaching, a method based on collaboration was necessary. While adopting the bricolage approach, I worked broadly within a Participatory Action Research (PAR) method. The multilogical approach to understanding the research and the piecing together of representations of the complexities of the study were inherent in my approach to PAR.

The selection of PAR shows a concern for locating the project within the social and political landscape, seeking emancipatory outcomes and reflects a concern with praxis. Participatory Action Research is a cyclical research process of continual reflection and action involving collaboration between participants in the research (Griffiths, 2009). Participant groups complete cycles of questioning, reflecting, investigating, developing a plan and implementing as represented by McIntyre (2008) in Figure 6. The underlying tenets of PAR, as applied in this project are: a collective commitment to investigate an issue; a desire to engage in individual and collective action leading to a useful solution that benefits the people involved; and, the building of alliances between the researcher and the participants in the planning, implementation and dissemination of the research process (McIntyre, 2008).
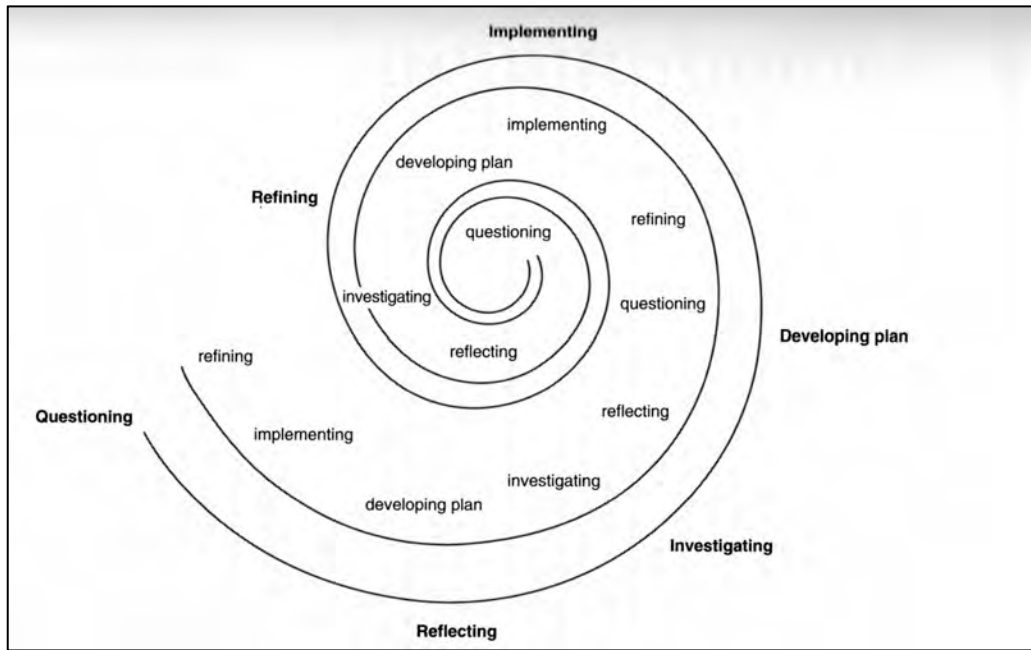
Figure 6: McIntyre's (2008) model of PAR

The method of this project draws from critical rather than technical framings of Participatory Action Research to consider the way knowledge is formalised and enacted through the implementation of innovative curriculum by teachers. Some practitioners of action research consider their methods to be more focused on the 'personal' or 'professional' development of educational practice (W. Carr & Kemmis, 2009) or technical, practical and emancipatory objectives (W. Carr & Kemmis, 1986). This research operated in Denzin and Lincoln's (2005) eighth moment of qualitative research with "a stance that is democratic, reciprocal, and reciprocating rather than objective and objectifying" (p. 1118) and makes clear its liberatory intentions. Critical theory has contributed to PAR through the examination of social, political and economic structures that influence the social participation of individuals and their practice (Kemmis, 2008; McIntyre, 2008). The idea of *conscientização* (Freire, 1989a, 2009), developing a critical consciousness, is inherent in the reflexive and social nature of the PAR process. The critical self-inquiry and reflection processes of PAR and the importance of these for effecting social change draw on Freire's work (Fals Borda & Rahman, 1991; Herr & Anderson, 2005; McIntyre, 2008).

This project drew on the strengths of PAR as a research method to ensure it was collaborative, interested in social interactions and emancipatory outcomes, reflexive, and connected theory and practice to collectively (re)create knowledge (Kemmis, 1981; Kemmis & McTaggart, 2005; McIntyre, 2008). This type of research aims for a genuine commitment to effecting change in the practices being investigated. This collaborative nature, emancipatory intent and interest in real and concrete practices made it an ideal method for investigating the project's research questions which were grounded in the changes in thinking and practice necessary for teachers as they implemented a new curriculum. The central features of PAR and bricolage offered an approach where:

> theoretical rigor is connected to social relevance, knowledge is subjected to critical scrutiny and engagement, and pedagogy is seen as a moral and political practice crucial to the production of capacities and skills necessary for students [or teachers] to both shape and participate in public life. (Giroux, 2001, p. xxvi)

PAR and Indigenous methodologies

As a non-Indigenous researcher working on a project engaging with Indigenous and Western ways of knowing and being, I considered it to be essential that the chosen method be deployed recognising the cultural sensitivities inherent in the topic. I was conscious of the power differentials between Indigenous knowledges and Western scientific knowledges as well as the potential for me as a White researcher to be seen as appropriating Indigenous ways of knowing. As Semali and Knicheloe (1999) warn, it is important that Western people do not speak and act for Indigenous people and that Indigenous people form allies outside their local communities.

This project was formed with a focus on relationships and collaborative thought, action and generation of knowledge. As Brydon-Miller, Kral, Maguire, Noffke, and Sabhlok (2011) highlight,

PAR is in keeping with Indigenous cosmologies where relationships are at the center, a form of research that is "evaluated by participant-driven criteria" (Denzin and Lincoln, 2008, p.11). It is a decolonizing of methods and of academia, a political stance in the redistribution of power with a focus on sharing and mutual respect. (p. 395)

As the researcher in this project, I was always conscious of these types of questions as critiques of my methodology from an Indigenous methodological standpoint. Indigenous methodologies can be described as research by and for Indigenous people. Writing from a Maori standpoint, L. T. Smith (1999) emphasises the importance of building trust in relationships within Indigenous methodologies. Important questions around the researcher's intent are highlighted such as, Who owns the research?, Who will benefit? and How will the results be disseminated? L. T. Smith sees these questions as part of the larger judgements that Indigenous communities make surrounding the researcher where questions such as – "Does he/she have a good heart?", "What baggage do they carry?" and "Can they actually do anything?" (p. 10) are equally important.

In the case of this project, Indigenous methodological stances informed the PAR process, in particular through my critical theory and critical pedagogy lens and engagement with the importance of reciprocity in relationships. There is an intersection between PAR and Indigenous methodologies in that both seek to critique the notion of the unproblematic creation of scientific knowledge. The frameworks employed by PAR can complement Indigenous methodologies through challenging the positivist scientific cornerstones of objectivism and neutrality (Evans, Hole, Berg, Hutchinson, & Sookraj, 2009).

The critical theoretical base for the project connects to Indigenous methodological approaches through the works of authors such as Freire (2009). Freire's development of counterhegemonic approaches to knowledge construction within oppressed communities, such as Indigenous communities, has informed many of the strategies practitioners use in PAR projects (McIntyre, 2008). Conscientization is also part of some Indigenous methodologies, for

example, L. T. Smith (1999) draws on Freire's thoughts around 'naming the world' and the power that this gives to hegemonic groups in knowledge claims to suggest the Indigenous project of *Naming* to (re)name the landscape with Indigenous names. Here the possibilities of synergies between Indigenous methodologies and PAR emerge; both are aiming for a critical consciousness in analysing the legitimacy and power of knowledge.

Another synergy between PAR and Indigenous methodologies enacted in this project lies in the ways the findings of studies are disseminated back to the people involved. Indigenous methodologies explicitly build in cultural protocols, values and behaviours as part of the research design with the final results to be disseminated back to people in culturally appropriate ways (L. T. Smith, 1999). In a similar way, it is the responsibility of a practitioner of PAR to report back to the participants of the project what and how findings are being reported and used (McIntyre, 2008).

The following sections in brown text are a way of highlighting my methodological thinking as a doctoral student and researcher in regard to Indigenous methodological perspectives related to this project.

Indigenous methodological perspectives

Through the process of my doctoral work I spent much time musing on the methodology of PAR and searching for a way of representing my work that could relate to both critical and Indigenous understandings. From the perspectives of both the critical tradition and Indigenous methodologies, the theme of interconnectedness was one that reoccurred throughout my reading of theoretical underpinnings. More than this, interconnectedness was a theme through the project itself, manifesting in unexpected and serendipitous ways. In an Australian Aboriginal understanding, it was explained to me by a Kamilaroi woman, that serendipity and intuition are intertwined ('Dianne', personal communication, September 1, 2011). If a person is 'on the right track', connected

to Country and listening to her or his intuition, serendipitous things will happen. This conversation led me to think of the fortunate and unexpected events that happened in the PAR journey as more than just mere co-incidence. Trying to represent my newfound understanding of the methodology in a scholarly way became difficult. I was searching for a way of representing ideas quite separate from White Western epistemology. As a White researcher, this was a particular challenge.

It was at this juncture (serendipitously perhaps) that I picked up my volume of *Native Science* (Cajete, 2000) and re-read some chapters. In this book, I found a Native American description of the Tree of Life. In the cyclical development of the teachings of the tree I found a parallel to the personal and professional development of myself as a researcher-participant and the teacher participants of my PAR project. The cycles within cycles, interconnectedness and growth of the Tree of Life drew together the purpose and critical intent of the project.

The Tree of Life

Figure 7: 17th-century depiction of the Tree of Life in Palace of Shaki Khans, Azerbiajan (Meniashvili, 2013)

The motif of the Tree of Life appears prominently in cultures from around the world. Figure 7 shows an ancient example from Azerbaijan. The symbol is usually understood as a representation of the interconnectedness of life and the spiritual and physical worlds (Cook, 1974). The Tree is a metaphor for cycles of renewal and dynamic creativity that has acquired a permanent significance and adaptability in changing worldviews, theological systems and ideologies (James, 1966). Tree metaphors are often also used in Western traditions of knowledge and truth. The Tree of

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Life metaphor seems to be in contrast to the rationalist scientific presentation of structural tree diagrams and representations. The 18th century saw Enlightenment thinking give credence to only two realms of experience, reason and sensory perception, giving no room for the recognition of imagination and non-physical realms (Cook, 1974). The scientific primacy placed on empirical, measurable, cause and effect data marginalises the idea of situated, interpretive, multiple realities as 'soft' research at best (Semali & Kincheloe, 1999). Rather than a structural approach to a tree metaphor, as might be found in the scientific tradition, the Tree of Life recognises more than physical, measurable sensations as sources of information, also acknowledging intuition and inspiration.

Cajete (2000) describes Native American teachings of the Tree of Life as a "metaphor for life, healing, vision and transformation" (p. 285). Central to the teachings of the Tree are four great stages of human development; these bring forth the key meanings and teachings of the Tree:

> Through an understanding of "protection" (the shade of the Tree), we come to see how the Earth provides for human life and well-being. In understanding the nature of "nourishment" (the fruit of the Tree), we come to see what we need to grow, to live a good life. We come to understand how we are nourished through the relationships we have at all levels of our nature and from all other sources that share life with us. We also come to know that as we are nourished, so must we nourish others in return. As a tree grows through different stages – from seed to sapling, to mature tree, and to old tree we see that growth and change are the key dynamics to life. We also learn that growth and change reflect self-determination, movement toward our true potential through the trials and tribulations, the "weather of our lives". "Wholeness" is the finding and reflection of the face, heart, and foundation through which our lives become a conscious part of a greater whole, of part of a life process rooted to a larger past, present and future ecology of the mind and spirit. (p. 286)

In linking the description by Cajete to my work with Aboriginal and Torres Strait Islander knowledges, I spoke with an Indigenous friend about Aboriginal understandings of the Tree of Life. As a Ngarrindjeri man, he told me a story he had recently adapted for a primary school student play:

> There was once an old Goanna Lady who was a healer. She moved from tribe to tribe using her medicine to help people. By making her way between nations she brought the people together and gave them a common connection. When she died a medicine tree grew in the place where she was buried. The Goanna lady's tree continued to bring together the nations and provided a place of healing.
> (D. Nikkelson, personal communication, 30 March, 2011)

Again, the theme of interconnectedness comes to the fore. There are several parallels in this Aboriginal Australian understanding with the Native American representation of the Tree by Cajete (2000). Through her healing knowledge and status as a healer the Goanna Lady connected to Country and to people in a way that promoted peace. The Goanna Lady's tree provided a place of nourishment and protection for future generations. Growth and stages of life are present through the representation of age and death. There is also renewal through the continuation of the Goanna Lady's healing through the tree that grew where she was buried. Interconnectedness is present through all of these metaphors in terms of healing, Country and people.

In recognising the similarities between the narratives of the Tree, while acknowledging the differences and not essentialising Indigenous knowledges, the adoption of a metaphor of life, healing, vision and transformation fitted with my own understandings of PAR methodology, the personal and professional growth of myself and the other project participants, as well as our critical intent in working within the study.

A Tree of Life metaphor

Figure 8: The Tree of Life metaphor for humanising PAR (Desmarchelier, 2012a)

Protection - The shade of the Tree

Freire (2009) described the 'banking model' of education as the act of a teacher making deposits of information which the students receive passively; he articulated this as an exercise of domination, indoctrinating the oppressed into the world of oppression. This project aimed to help teachers' attempts to free themselves of the indoctrinating ways of schooling, whilst still acting within the prescribed system, to provide a liberating experience for their classes and themselves as educators. Figure 8 shows a pictorial representation of the Tree of Life metaphor for humanisation through PAR in this project. In providing a pedagogical space for well-being and growth they were acting in the shade of the Tree and recognising the need for human life and well-being.

Through expressions of alienation and domination, de-humanisation takes place (Freire, 1970). In working to reduce the alienation of the Other, as Indigenous cultures in the colonised world are still seen, the work was very much a humanising and de-colonial project. The process of working towards a pedagogy that was humanising and liberating was hoped to promote *conscientização* in the teachers themselves. In actively opposing oppression in their own praxis, teachers may be able to advance in terms of human becoming as they more clearly begin to see the oppressive ways of the curriculum and their peers around them and become actively engaged in promoting change. As Freire (1970) observed, "liberation can not exist within men's consciousness, isolated from the world; it exists in the praxis of men" (Freire, 1970, p. 3). Figure 8

represents the Tree of Life metaphor applied in this project as linked to concerns about humanisation through the research process.

In challenging the status quo of the marginalisation of Indigenous ways of knowing within the scientific frame, it was hoped that teachers would promote an educative space of protection, where Indigenous knowledges were seen as synergistic with Western scientific ideas. Speaking of the humanist revolutionary educator, Freire (2009) said of the teacher that "from the outset, her efforts must coincide with those of the students to engage in critical thinking and the process of mutual humanization" (p. 75).

Nourishment – The fruit of the Tree

In understanding what is needed for the growth and promotion of a 'good-life' in terms of nourishment of the Tree, the successes of the project were built upon to provide continued motivation and nourishment in terms of understanding our progress. Through the PAR process, participants' experiences were shared, allowing for encouragement and critical reflection to build new ways of considering praxis in terms of pedagogy and challenging the status quo.

Growth and change

The idea of the growth of the Tree through the cycles of life reflects well the progress of a PAR project. The cyclical nature of PAR fosters action and critical reflection at each stage of the research process. Participants are challenged to reflect on their actions to inform their future praxis. Through this constant reflection and the trials and tribulation of the process, critical consciousness emerges.

Wholeness

The project aimed to be an on-going exercise in decolonisation and humanisation for the participants. In order for the teachers to continue to enact their praxis

after the completion of the formal project, considerations of wholeness were needed. The 'big picture' needed to be taken into account in order to contextualise the *Little Stories* of participation and the essentialising *Grand Narrative* of neo-liberalism that influenced the PAR process. It was hoped that through *conscientizção* that teachers would commit to a humanising teaching and continue to challenge institutional barriers presented to them.

The limitations on teachers' practice and agency within the schooling system can impact upon their praxis and their ability to challenge the status quo. While individual teachers may promote humanising curriculums, the de-humanising influences of the system are not easy to overcome. Perceptions of these institutional limitations and conforming pressures were important points of consciousness for the sustained motivation of participants. As Freire (1970) observed,

> the educator who chooses a humanist option, that is, a liberating one, will not be capable of carrying out the obligation bound up in the theme of his option, unless he has been able through his own praxis accurately to perceive the dialectical relationships between consciousness and the world or between man and the world. (p. 3)

Along with this negative representation of wholeness in terms of understanding the constraining contextual aspects of the school system was necessary, a positive wholeness was also inherent in the project. Linking to the idea of nourishment through the successes of the teachers, the collective knowledge generation of the PAR process provides an interconnectedness of the participants and me as a researcher-participant. Through this critical analysis of the systemic influences, historic and social forces, it was hoped that *conscientização* would be achieved and that it would ensure that there was a "reflection of the face, heart, and foundation through which our lives become a conscious part of a greater whole" (Cajete, 2000, p. 286). Through planning activities to carry out the work of the project, participants reminded themselves *"of part of a life process rooted to a larger past, present and future ecology of the mind and spirit"* (Cajete, 2000, p. 286)

This metaphorical, Indigenously inspired, framing of the project ran in parallel with the academically based critical qualitative method built from McIntyre's (2008) model. Both perspectives were necessary in order to understand how methodology and method were applied in the project.

PAR group participant profiles

The core group of participants in the project were five secondary school science teachers who volunteered to participate. Their teaching experiences ranged from being in their first 12 months of teaching to more than 20 years of experience. There were also participants (critical friends) who acted in assisting and advising roles to the core group. Generally, these participants were in direct contact with me as the researcher-participant and I related their feedback and queries to the group.

Sue and Isabelle (all participants names are pseudonyms) taught at the same secondary school. This school was a private Catholic co-educational school that had a social justice orientated motto derived from the Catholic faith the school operated under. Sue was an experienced teacher who also acted as the Head of Department (HoD) for science. She came from a research science (biology) background, having worked in government agricultural research prior to teaching. Isabelle was an early career teacher and had been teaching for approximately four years at the commencement of the project. Isabelle had completed a teaching degree specialising in science and chemistry. Both teachers had previously attempted to include Indigenous perspectives in their teaching but did not feel comfortable with the process. Both teachers identified themselves as non-Indigenous Australians.

Cristy taught junior science and physical education at a private Catholic boys school. She was a beginning teacher, having taught for six months prior to joining the project. Cristy had completed a degree in teaching specialising in physical education with a minor in science. In her first teaching appointment,

Cristy had been part of the staff planning process for the implementation of the (then called) Indigenous Perspective as part of the new Australian Curriculum. This had involved her actively investigating ways to include Indigenous content in her lessons and she had some experience with the implementation of this in the classroom. Cristy identified as non-Indigenous.

Allen had a long teaching career in public schools. He had previously attempted to include Indigenous content in his teaching with little success. Allen taught at a public co-educational secondary school with one of the higher rates of Indigenous students in the region. Prior to becoming a teacher, Allen had trained and worked in geology and had a keen interest in the earth sciences. Allen identified as non-Indigenous.

Karl was the final member of the group. While having taught in the UK for several years, Karl's teaching appointment was his first in Australia. Karl taught at a public co-educational school with a large Indigenous population. As well as teaching science and physical education, Karl was involved in teaching the Indigenous students a subject called *Indigenous Studies*. Prior to this teaching appointment Karl had no experience teaching in Indigenous areas. Karl identified as non-Indigenous.

Critical friends

At the beginning of the project I sought out 'critical friends' who could offer advice around educational and Indigenous aspects of the project. Three individuals acted in this role for the project and provided professional (and sometimes personal) advice surrounding their experiences as teachers and/or Aboriginal people. Individual discussions with critical friends were used as points of data collection. Sometimes these discussions were audio recorded; however, at times, critical friends offered advice or direction that was not recorded due to their unease about direct records being available about their

advice. I reflected on these discussions in my research journal, which acts as data in these cases.

Critical friend John was an Embedding Aboriginal and Torres Strait Islander Perspectives in Schools (EATSIPS) Principal Project Officer. From this position, and as an Aboriginal person, he assisted schools within his education district to meet their obligations surrounding the EATSIPS program. Within John's position he worked with many teachers and school leadership teams across the curriculum.

The second critical friend, Daniel, was an Aboriginal educator who worked for the state education department. His role encompassed an on-line program with remote Indigenous students as well as teaching at a local environmental education centre. Daniel had a keen interest in using Indigenous knowledges within his own science education and offered both this experience and his understanding about Aboriginal culture stemming from his family and local community connections.

In a University based position, Dianne worked for the Indigenous centre as a Student Relations Officer. Dianne, a Kamilaroi woman, offered cultural advice on working with Aboriginal people and their knowledge. This advice informed both the work that the teacher participants were doing in their classrooms as well as my methodological understandings. It was essential for me as a White female researcher to have a female Aboriginal contact to assist with cultural sensitivity and competency within the project.

Position of the researcher

As the researcher in the project I aimed to enable a participant-driven research agenda. This did not exclude me from participating in the decision making processes of the group but it gave weight to the decisions made at a group level. There is a continuum of positions that researchers can take in the action

research process, and clarity about the position occupied by the researcher is necessary to establish the rigour and ethics of the research (Herr & Anderson, 2005). An adequate title for the role of a university researcher in a PAR project has been recognised as problematic (McIntyre, 2008). The term 'facilitator' often carries "connotations of neutrality" (Kemmis & McTaggart, 2005, p. 569). In this project, I named myself *researcher-participant* with an understanding of the responsibility of this position in making or assisting social change, rather than attempting to act in a neutral, objective way (Kemmis & McTaggart, 2005). In order for the research to genuinely be 'with' and not 'about' or 'on' people, a degree of inter-dependant collaborative reflection is necessary (Heron & Reason, 2001). In order for this reciprocity to be achieved, the issue of what each participant wished to achieve through the research was negotiated carefully (Herr & Anderson, 2005).

My role as researcher-participant was sometimes constituted as that of an insider and, sometimes as an outsider to the processes taking place. To name oneself solely as either insider or outsider is a dichotomising perspective that overlooks the complex nature of the relationships within a PAR project and the possibility that a researcher occupies multiple positions (Brydon-Miller et al., 2011). I was positioned as an outsider because I was not part of the schools that the participants worked in, nor was I working as a teacher myself. In other instances I was an insider, working with the group to understand the dynamics of the inclusion of Indigenous knowledges in science education. Drawing on McIntyre (2008), Table 2 describes the multiple positions I occupied as a researcher-participant in this project along with some indicative activities I performed in these roles.

Table 2: The multiple roles of the researcher in this PAR project (identified and adapted from McIntyre, 2008).

Role	Description	Example
Researcher	Provided the theoretical and methodological basis for the project. Analysed project data and generating academic interpretations.	This thesis.
Participant	Actively engaged with the teachers in the research process.	Assumed an equal role in group meetings when discussing plans and critically reflecting.
Facilitator	Organised and chaired meetings.	Kept meeting discussions on track and ensured coverage of important issues.
Resource provider	Located relevant resources.	Provided participants with web site links and academic papers in the area.
Provocateur	Challenged participants to justify their stance and look at issues in different ways.	In meetings and individual discussions ensured critical and thoughtful discussion of issues that may be unrecognised or acknowledged by other participants.
Project reporter	Disseminated project findings.	Wrote academic articles for publication
Friend	Supported participants in their personal lives related to the project. Built relationships with participants.	Allowed time for discussion, especially one-on-one about family issues that impact on working lives.
Comrade	Provided support for like-minded participants in striving to achieve the social justice aims of the project.	Discussion and support, especially with Indigenous participants, about the importance of Aboriginal and Torres Strait Islander ways on knowing in schooling.

Project design

While the PAR process in this project drew from McIntyre's (2008) model of PAR, it was evolving and iterative. The commitment to a participant led process, where participants were located in different schools, meant constant reflection in my role as researcher-participant on how the group was progressing in order to keep the process on track. This brought 'messiness' to the project that Kemmis and McTaggart (2005) recognise as often being associated with PAR.

There were three levels of data collection in the discussions with critical friends; discussions between the researcher-participant and individual teachers and PAR group meetings. Each participant underwent their own cycles of critical reflection, planning, implementing and refining for their own particular contexts. The participants' own cycles fed into the group cycles; however, not all participants completed all cycles. Some participants progressed further along the cycles than others and took more action. Personal actions and reflections were discussed in the group meetings leading to group analysis and reflection.

Knowledge exchange
between participant
levels

PAR Group

Discussions with
individual teachers

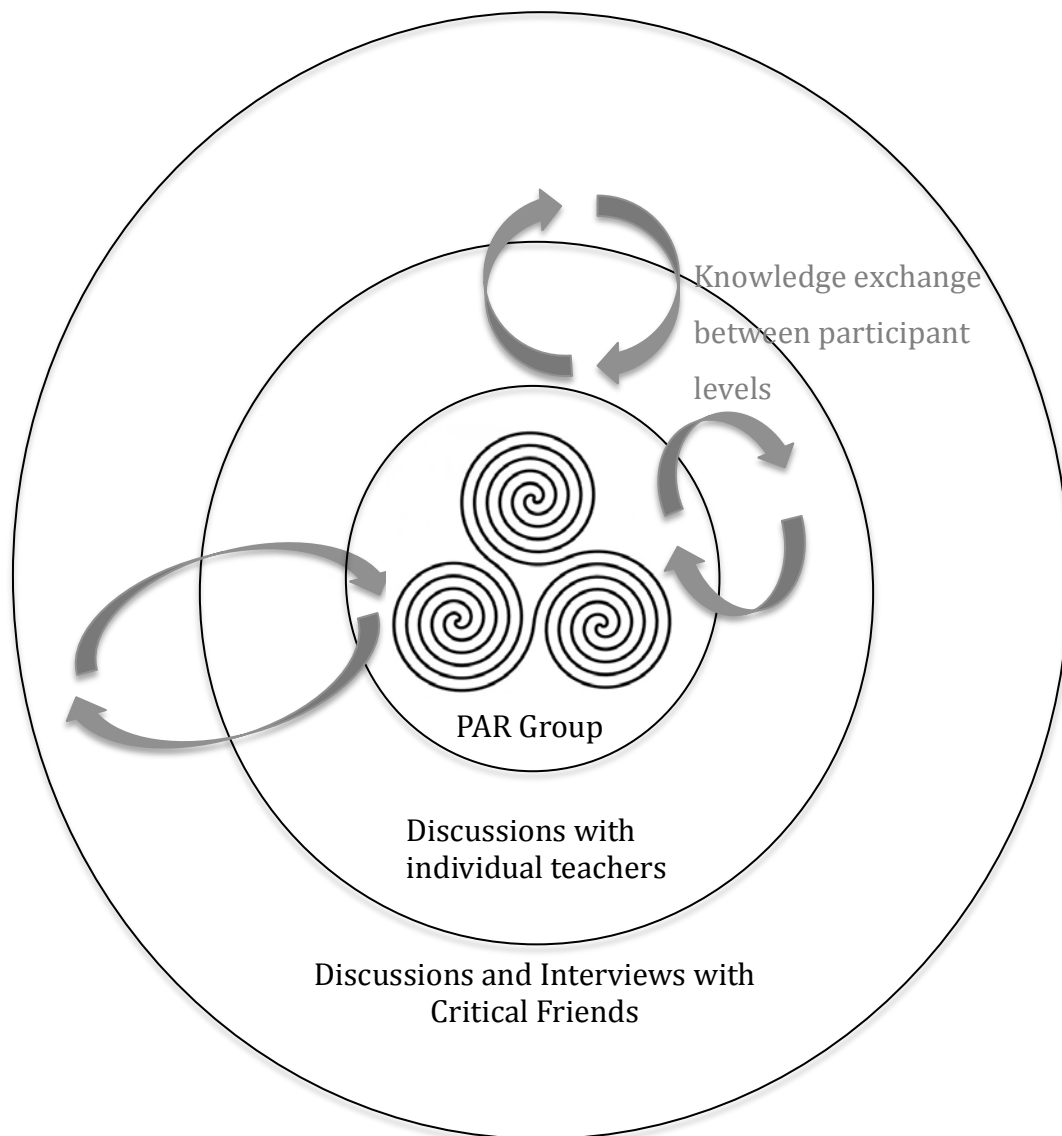Discussions and Interviews with
Critical Friends

Figure 9: The PAR model used in this project

The process and multiple layers of data collection are represented in Figure 9. At the centre of the diagram, representing the core of the project, are the individual cycles of the participants (including myself) informing the group meetings. The middle circle contains the discussions between the individual teacher participants and the researcher-participant. The outer circle of the diagram shows the discussions between the researcher-participant and the project's critical friends. As represented, there is a connection between each of these layers and each layer feeds into the others informing my analysis as the researcher-participant and the other participants' thoughts and actions.

The model of PAR as presented in Figure 9 and used in this project highlights the interconnectedness of method, participants and ideas that PAR generates. The central core of the interconnected spirals shows how the teachers' stories intertwined and influenced and developed from each other. Each participant went through spiralling reflections of their own as they adapted their increasing understandings about the issue being investigated to their own particular contexts. These contexts differed in terms of the type of school (public or private), the level of support for implementing different ways of knowing in the classroom and the socioeconomic backgrounds of the students, among other factors. The teachers' previous personal and teaching experiences also influenced their personal actions, analysis and reflection, making what each participant brought to the group meetings situated and contextual. The interconnectedness of the levels of data collection was an important aspect of the method in this case, because it informed the group's ideas and understandings as well as my analysis of data and facilitation of the group.

Data collection methods

Various data collection techniques were used through the research process. The project evolved organically through the bricolage approach and PAR method and a combination of documentary analysis, interview, observation and field notes were used to capture the richness of data the project supplied. This combination of core collection techniques was sufficient to allow the trustworthiness of the data and analysis to be established. A description of each method of data collection follows:

Documents: Written texts were collected in the form of the curriculum documents and reports that preceded the development of the Australian Curriculum, as well as media stories and other information supplied by professional bodies such as Australian Curriculum, Assessment and Reporting Authority, Queensland Studies Authority or teaching associations. In addition,

school based documents such as unit plans, science department communiqués and teaching resources were collected.

Observation and interview: The gathering of open-ended, first-hand information through observing people in both the group meetings and in the schools they were apart of. Data were collected in terms of field notes. These were descriptive, sensory, reflective, affective and interpretive in nature (Jones, Torres, & Armino, 2006). Observation entailed informal participant questioning (interviewing) in order to understand the field (Fontana & Frey, 2005). For individual interviews, a conversational, semi-structured style of interview was engaged to elicit free-flowing conversation. Foley and Valenzuela (2005) found that an informal and free-flowing approach led to more personal narratives and candid opinions through humanising the interviewer and diminishing the interviewer's power and control of the interview process. This style of interview fits well with the PAR method through showing collaborative intent on the part of the researcher and allows for the prompting of deep critical reflection during the interviews. Interviews were audio recorded and transcribed.

Group meetings: Available participants met to discuss the groups and their individual progress in understanding, planning or implementing ideas. Group meetings were chaired by myself, as the researcher-participant, and all participants were able to critically reflect on their own and others' thoughts and actions. All group meetings were digitally recorded and transcribed. Reflective field notes were recorded in written format (Kemmis & McTaggart, 1985).

Researcher-participant diary: I kept a research diary recording events and my reflections on the group's work. This diary was both reflective and interpretive.

Initial and concluding interviews

In the initial meetings with participants and critical friends, I outlined the intent of the project and what their commitment would be. The initial interviews took place either at the university or in a coffee shop of the participant's choice. They were purposefully kept informal to set the participants at ease and to allow me as the researcher-participant to start building rapport. Using the semi-structured interview style previously mentioned, I started conversations by inviting participants to tell me of their previous experiences with using Indigenous knowledges in their science teaching. An open-ended conversation followed where I responded to the experiences, thoughts and ideas that the participant was conveying by asking for clarification of particular points and asking for more detail when a point of interest was raised. Often these conversations, due to the nature of the project, included discussion of how the participant saw science as a discipline and what they saw the hopes and problems around incorporating Indigenous knowledges in science being.

Concluding interviews were conducted at the end of the data collection period. Participants were asked to reflect on their experiences within the project and if/how the PAR had impacted upon their thinking about their own practice and praxis. Again, these interviews were semi-structured and my questioning responded to the data provided by each participant.

Group meetings and discussions with individuals

Group meetings were initially held in one of the teaching rooms at the university where I studied and worked. Teachers from different schools came together to share ideas, successes and frustrations and to work out plans of action to be implemented in their own schools. After the first three meetings, it was suggested by the group that these be moved to a more informal location. As a result, later meetings were held at either a licensed premises or a coffee shop. Meetings started with me recapping what had been discussed in the previous

meeting and informing them of any conversations I had with critical friends of the project. We then reviewed our individual progress and thinking around the current cycle of the project. This discussion involved each participant telling the group what activities and thinking they had been doing around the project since the last meeting and the group as a whole discussing that participant's actions and ideas. Discussion contained analysis of actions and critical reflection on how the actions and ideas impacted their own approach to the cycle. Towards the end of each meeting, it was decided if the group felt that the current cycle had come to an end and if we were moving to a new cycle and plan of action or if more action and reflection were needed in the current cycle. The meetings ended with me summarising what we aimed to do before the next meeting.

It was extremely difficult (probably impossible) to find a meeting time that was suitable for all participants. With teachers in different schools, all with commitments to planning, marking, moderation and extra-curricular activities as well as personal commitments such as family, finding a firm meeting time that fitted with the needs of all participants was not possible. This resulted in meetings being scheduled and re-scheduled until at least two participants and I could attend.

All meetings were audio recorded for later transcription. The audio files were made available to the PAR group members through a project Internet site. This site was constructed using Apple iWeb® software and hosted through MobileMe®. The site was password protected so that only participants of the project could gain access and contained links to a blog and podcast page. The blog page was initially used by me to keep participants up to date with happenings in the project and to provide a space for the participants to communicate with each other through replying to my blogs. As the project progressed, I ceased writing blogs as I found upon enquiring that the teachers were too busy to read them or reply. I continued adding the audio of the group meetings to the podcast page to allow participants who could not attend to listen to what was discussed. Some participants used this facility but some said they did not have time to listen to the recordings.

When a participant was not able to attend a meeting, I endeavoured to hold an individual discussion with the teacher to let them know the outcomes of the meeting and what the group had decided to do prior to the next meeting. Informal locations such as coffee shops were also chosen for the individual discussions. These discussions tended to be in more depth around the participants' personal actions and reflections rather than the group's progress. The one-on-one nature of these meetings allowed me to build strong relationships with the participants and have them be more comfortable with my asking increasingly probing questions about their motivations, praxis and personal relationships to the issues arising. Sometimes, as relationships built, sections of these conversations would stray off into personal discussions about family or recent activities. For this reason, individual discussions were not transcribed in full. Sections of these discussions that were considered important and relevant were transcribed. Recordings were listened to after the meetings as well as through the data analysis process to ensure that all relevant data were extracted.

Complications and frustrations

The professional lives of teachers are very busy. The participants in this study articulated their concerns both individually and as a group about the high workloads placed upon them. Very quickly, the pressure felt by participants in their professional lives became a defining feature of the project. Organising initial discussions required negotiations around appropriate meeting times with some participants needing to reschedule times on more than one occasion. When group meetings were being arranged, the compounding effect of different teachers in different schools with different commitments made establishing meeting dates that suited everyone essentially impossible.

This led to a renegotiation of my expectations as the researcher-participant in terms of how the PAR methodology was deployed and what expectations I would have of the research process. Initially, I had envisioned fortnightly meetings

attended by all participants where issues would be discussed in depth and formal plans of action would be agreed upon for the teachers to carry out prior to the next meeting. No such formal structure was possible given the teachers' professional and personal commitments. Quickly, my role as a facilitator and intermediary in the project became essential for not only the success but the continuation of the project.

My second important facilitating role was to meet with the project's critical friends who offered advice and Aboriginal perspectives on the group's work. In meetings with these participants I would discuss what the group was considering in meetings and on an individual basis and seek advice and guidance on the progress of the project. This allowed me to then feedback to the group important points from these discussions to guide our progress.

Transcription

After the interviews, audio-recorded data were transcribed using a minimalist approach (Fairclough, 1992) recording what was spoken with no concern for pauses and nonwords. Transcription was performed either by myself or by the professional transcription company Pacific Solutions. All transcripts were checked for accuracy and clarity. Transcripts were then presented to the participants for checking. At this point, participants were able to add or remove comments. However, only one participant chose to slightly modify his transcript. This change did not impact upon data used in reporting on the project.

Data analysis

In the research process, data analysis took place on two levels. Firstly, data were analysed by the participants as part of the ongoing processes of the project. Participants reviewed transcripts of their own interviews as well as transcripts or recordings of group meetings. At times, I summarised interviews and

discussions to produce a document to prompt discussion at meetings. Where data such as initial interviews were being summarised, participants were asked to check the documents for accuracy. The understandings gained through this reflective process then acted as points of departure for either individual or group discussion of emergent themes.

Secondly, data were analysed by me as the researcher-participant (McIntyre, 2008). The transcribed data from interviews, group meetings and individual discussions as well as the research journal and documentary data were examined for themes. Themes were analysed according to a critical theoretical framework using Seidel's (1998) cyclical data analysis process of noticing, collecting and thinking and connected to my knowledge of relevant academic literature.

In this study, the term 'trustworthiness' was used in preference to validity in relation to data analysis, in line with Lincoln and Guba's (1986) suggestion that trustworthiness is more appropriate to qualitative inquiry than validity. Here, trustworthiness indicates that the researcher-participant's interpretations of the data 'ring true' to the participants of the project. An indicator of trustworthiness within a PAR project may be the genuine achievement of a sense of "we" or "us" so that any writing-up of the project contains no surprises to the participants but is embraced by them as expressing theory and practice already trialled (Wadsworth, 2001). This was achieved through the use of collaboration and member checking (Creswell & Miller, 2000) that involved taking transcripts and interpretations back to participants to allow them to "see how their own speech objectified and represented them" (D. Foley & Valenzuela, 2005, p. 223) and allowing for critical reflection and comment on my analysis as the researcher-participant. In addition, the project's critical friends were asked to assist in examining subjectivities and pointing out problematic taken for granted assumptions (Herr & Anderson, 2005).

Critical moments

In order to negotiate the large amount of data that the project produced, and present this information in the form of a coherent thesis, it was necessary to present only the most critical and pivotal moments of the research process. Critical moments are used in Chapter 6 to describe the overall process and progress of the project. This is where my roles as the researcher and project reporter (see Table 2) came to the fore and with guidance from my methodological and theoretical frameworks I have selected data that portray the *Little Stories* of the work.

Sometimes, these moments were obvious as they were occurring and project participants were aware of their importance; at other times, the moments only became critical upon reflection. Examples of critical moments included teachers' descriptions of new practices and pedagogy in their classrooms, self and group reflections, participants' agreements and disagreements and participants feeling they had not achieved what they set out to do. All of these points offered the opportunity for more in-depth analysis.

Reflexive analysis

Douglas E. Foley (2002), in a paper about 'the reflexive turn' in critical ethnography, acknowledges that "developing my own narrative style and voice was what finally made me feel more at home in the academic knowledge production factory" (p. 469). The ability of a researcher to consciously experience the self as respondent, teacher and learner through reflexivity assists with coming to know one's self through the research process (Lincoln, Lynham, & Guba, 2011). In a PAR project, with the complexities around participatory processes and outcomes, it was important for me to make my own research voice distinct from the voices of the other participants. Working from a critical perspective necessitates the acknowledgement of the historically and socially constructed self of the researcher, as well as an interrogation of the epistemological and ontological assumptions operating behind data analysis.

Using a PAR method whilst being mindful of Indigenous methodologies, requires a reflexive notion that borders on the autoethnographic, thereby acknowledging my own positioning, introspection and intuition (Denis Foley, 2002).

Reflexive analysis has been used in this thesis to explore my responses, both theoretical and critically personal, to the data presented. My analysis involved my emotional and intuitive response as the researcher-participant to the critical moments and data being presented. Connections are made to the theoretical framework of the thesis to explore what deeper meanings and knowledges can be identified. In order to clearly identify reflexive analysis as my theoretical and personal voice in the research I have used text boxes and purple font.

The research process

Timeline

The research process was complex with multiple and varied data collection events occurring between May 2011 and December 2012. Participants were approached from April, 2011 with initial discussions held on an individual basis between May and June of the same year. Three group meetings were held between June and August, 2011. Individual discussions with participants were held regularly through the data collection period. A one-day workshop was conducted in December, 2011. Concluding interviews were conducted after participants had finished with their involvement in the project.

The participants did not all contribute in the same ways to the project's data collection. More individual discussions were conducted with some participants than with others. Also, some participants progressed to implementing their strategies in the classroom while others were too tentative about putting their ideas into practice. Table 3 shows the activities where each participant contributed to data collected.

Table 3: Participants' contributions to the project's data collection

Data collection event	Teacher participants					Critical friends		
	Allen	Cristy	Sue	Isabelle	Karl	John	Daniel	Dianna
Initial interview	√	√	√	√	√	√	√	√
Meeting one	√	√						
Meeting two			√	√	√			
Meeting three	√	√		√	√			
Workshop day	√	√			√			√
Individual discussions	√√	√√√	√	√√			√	√√√
Classroom implementation	√√√	√						
In-school observations	√√							
De-brief discussion	√	√	√	√				

Each tick represents a single data collection event. Where more than one tick is shown, this type of data was collected multiple times.

PAR cycles

Given the complex and evolving structure of PAR in this project, the characteristics of the cycles of questioning, reflecting, investigating, planning, implementing and refining (McIntyre, 2008) were very much overlapping processes. The fluidity within the PAR cycles allowed the success of the project in that it did not restrain some participants from pushing ahead with their planning, implementing and refining when other participants were not ready or able to move ahead. Not all participants were active in all cycles. These cycles are fully described in Chapter 6.

Conclusion

Chapters 1-4 of this thesis have explained the contextual, conceptual, theoretical and methodological basis for this work. As the researcher-participant I have explained who I am, the critical theoretical underpinnings of my framing of the project and the ways in which I worked with the participants. Chapters 5-7 engage with the *Little Stories* of the teachers engagement with the PAR process. The starting points of the teachers and their contexts are first considered, followed by a description of the process of the PAR cycles. The final *Little Stories* of participation focus on my analysis of the project's data in terms of epistemology, pedagogy and politics. Chapter 8 describes the influence of *Grand Narrative* on neo-liberalism upon the teachers' contexts and work in their classrooms.

Chapter 5 - The beginning: Participants and their contexts

Introduction

Chapter 4 described both the theoretical connections of the chosen PAR methodology as well as the practical application of the method in this project. The importance of the interconnectedness of socio-political sphere, teacher praxis and practice was described as central to the motivations of the study. The methodology chapter highlighted that the teacher participants worked as a collective within the PAR group but also as individual practitioners in their own schools and classrooms. The collaborative work amongst the group informed each participant's individual thinking and praxis.
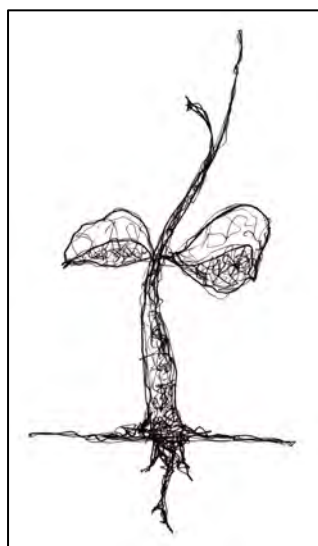

Figure 10: The seedling Tree (Desmarchelier, 2015)

Carrying through the Tree of Life metaphor, this chapter describes the teachers' starting points, which can be seen as the earth and the seedling Tree (the project) grew as represented in Figure 10. Teachers' previous experiences, perceptions and attitudes on entering the project grounded the group's future work and provided a background for the growth of the project. Without the basis of their experiences, or professional curiosity about the topic, the cyclical growth and development of the project would not have been possible. All participants had encounters with the incorporation of Indigenous knowledges to use as a base to grow from.

This chapter presents data from the initial interviews conducted with teachers and the project's critical friends. It is the first of three chapters that draw on the *Little Stories* of teacher participation. From this data, the previous experiences of the teachers are described, their hopes and visions for science education inclusive of Indigenous knowledges are presented and their concerns and trepidations in regard to the topic are explored. Initial interviews were conducted by myself as the participant-researcher of the project and generally were one-on-one conversations with participants (the exception being Sue and Isabelle who were interviewed together). In this chapter, I present my analysis of these interview data.

Previous experiences of teachers

Teachers started from different backgrounds in terms of their amount of experience in incorporating Indigenous knowledges into classroom lessons. Some had been attempting to do this work for many years; others had only considered it more recently, but all participants had previously, in some way, considered how Indigenous knowledges and/or perspectives fitted in their teaching.

All of the teachers except Cristy, considered their previous attempts at incorporating Indigenous knowledges to be relatively unsuccessful. The nature of the previous experience and the length or number of times engagement had been attempted, varied considerably. In all cases, a lack of success was attributed to a lack of access to appropriate Indigenous knowledge, people and communities.

The exception to this perceived lack of success was Cristy's previous experiences. Even though she had been a teacher for less time than any of the other participants, in her first teaching job she had been part of a large science department with a Head of Department (HoD) committed to addressing all of the (at that stage, draft) cross-curriculum perspectives. She was part of a small team

of science teachers tasked with considering the Indigenous priority and how it might be implemented. She considered the planning and teaching that resulted from this investigation to be successful in incorporating Indigenous knowledges.

Sue and Isabelle's stories

As the school's science HoD, Sue bore primary responsibility for incorporating Indigenous knowledges into teaching. At the time of the initial interviews, the draft Australian Curriculum documents had been released and teachers were to be considering how they might be implemented. Sue described her reluctance to do much, if any, in-depth planning prior to the release of more detailed information. She was waiting for exemplar planning documents to be available from the Queensland Studies Authority (QSA) and ACARA. She felt that it would be a waste of her time to plan teaching units when "they're going to do it for me" (Sue, Initial Interview, Sue and Isabelle).

While Sue expressed her reluctance to put too much time into planning at that stage, she also talked in detail about the curriculum documents and expressed numerous ideas about how and where in the curriculum Indigenous knowledges could be incorporated. Sue's previous attempts to implement these ideas had been few and she did not describe any classroom experiences.

Isabelle described her previous attempts at including Indigenous knowledges and perspectives as limited. While she had attempted inclusion in assessment and classroom teaching, she reported feeling a lack of confidence in her presentation to the class, leading to doubts about how respectfully she was treating the content. These doubts lead to reluctance to attempt any further expansion of the Indigenous content of her teaching.

Isabelle	*Are you wanting to know what we are doing currently under this current syllabus?*
Renee	*Yeah, yep.*
Sue	*Yeah, very little.*

Isabelle   *Not a lot at all. We, I know personally I've tried to put some questions in exams looking at Indigenous knowledge and its explanation of things like constellations. But it's sort of so far from what we've actually done in class, and when I do try and do anything in class it sort of doesn't really come across very well because I am obviously not confident teaching it and teaching it respectively. And I think that it comes off a little bit tokenistic. And because of those experiences I sort of just shy away from it completely. And now I'm not even putting it in exam questions because I don't think I'm doing it any justice.*

Initial Interview, Sue and Isabelle

Allen's story

In the initial interview, Allen described how the incorporation of Australian Indigenous knowledges in teaching practice had been of interest to him. Allen had worked previously in a number of schools with what he considered to be high Indigenous populations. His previous attempts to source Indigenous knowledges suitable for inclusion in teaching had been unsuccessful due to a lack of availability of information. When I asked him how far he had proceeded with incorporation of Indigenous knowledges in his teaching, he replied:

Allen   *Probably not far along at all, though - but when I see the Indigenous students in classes, in the classroom I've tried to source information and I haven't been very successful in getting information about Indigenous perspectives. Numeracy and in science - although for as long as I can remember it's been something that we're told to include - it's been very hard to source information that can be included and it's usually quite sketchy if you can include anything at all.*

Even when I've inquired through the Aboriginal community it's

> *really gone nowhere. Either it's been - I remember one response was*
> *simply that the information has been lost. I had someone ask do you*
> *[unclear] now, and they did inquire with their families and they*
> *would say, I'm sorry - got nowhere with the inquiry. There's been*
> *barriers to that information coming through, especially - usually*
> *I've tried to aim at just local Indigenous people - but my work as a*
> *teacher has been no further west than the Great Dividing Range,*
> *and so those communities are disrupted.*
> Initial Interview, Allen

Cristy's story

Although Cristy had been teaching for the shortest time of all the members of the group, she had the most direct experience with incorporating Indigenous knowledges in science teaching. In the initial interview, Cristy told me about the project she had been involved in at the regional state secondary school she had taught in for the previous semester, her first teaching appointment. The science HoD at the school had started curriculum implementation preparation upon the release of the draft Australian Curriculum. Through the planning process, Cristy had been part of the team of teachers responsible for planning the Indigenous content of the Year 9 science program. She had gained experience in the areas of astronomy and chemistry in particular.

In order to develop the teaching program, Cristy had engaged with the other teachers in her team, in a large amount of research to uncover useful information. Cristy found the experience of being involved in a well-organised department where teachers worked together to implement change very rewarding. She described the approach to designing teaching:

Cristy   *Instead of going "we will rewrite the whole curriculum around this",*
            we need to find things that are already going to fit into the units
            that we already have planned. And this is where all of these things
            come about. We looked into; the 9s were doing diet and nutrition so

we looked at food, and those sorts of things. And when we looked at food, the whole sociological aspect came into it as well, because we found that, depending on different tribes depended on different food, depending on your status within the tribe you were allowed to have different foods and all these different things.

Initial Interview, Cristy

Karl's story

Karl worked at the school with the highest Indigenous student population of any of the participants. At the commencement of the project he was in his first semester at the school, having previously taught in the United Kingdom. Karl described his school environment as engaging with and being supportive of students' Indigenous heritage. In order to cater for Indigenous students and engage the wider Indigenous community surrounding the school, an Indigenous Studies course was offered as part of the curriculum. Karl was involved in teaching this course at year 9 level. Although Karl was involved in teaching this course, he described the Indigenous content in his science teaching as minimal. However, he was making attempts to engage with Indigenous knowledges. Karl outlined that while it may have not formed a formal part of curriculum and planning for teaching, he still encouraged in class:

Karl   *In science, basically we still follow the school curriculum but we are incorporating Indigenous stuff when we can so a lot of it is discussion questions and things like that so that when we looked at for example the food and diet for the unit we talk about healthy lifestyles and we also referred back to the Aboriginal people and what sort of food they would eat and why they were healthy, healthy diets and things like that.*

Initial Interview, Karl

Themes in the Initial interviews

Data from the initial interviews formed the starting point for the project and provided discussion starters for Cycle 1. I analysed each interview for broad themes and then re-presented these to individual participants for feedback to ensure I was capturing their ideas and concerns accurately. From these summaries of the interviews, I extracted common themes from across all of the participants' interviews. In their interviews, the participants had spoken about what they wanted to achieve through their participation in the project, as well as about their initial impressions of impediments to the inclusion of Indigenous knowledges in their classroom practice. The emergent themes uncovered were: hopes for inclusion, visions of inclusion, and perceived problems in inclusion.

Hopes

All participants expressed a sense of hope about the group's ability to effect change through working in the project. Teachers articulated clearly their ideas of what the project and the inclusion might be able to achieve if we were successful. The themes of hope emergent from the initial interviews were:

1. Promoting intercultural understanding between Indigenous and non-Indigenous Australians;
2. Providing engaging teaching experiences for Indigenous and non-Indigenous students;
3. Improving outcomes for Indigenous students in education and society more broadly.

The first 'hope' was that science education might promote intercultural understanding between Indigenous and non-Indigenous Australians. All participants shared this hope and expressed a sense of there being a wider social justice concern within the intent of the Cross-Curriculum Priority (CCP). In Sue and Isabelle's initial interview, Sue expressed this concern:

Sue	*I think it could do a lot to* bring the Aboriginal culture into our culture *and allow Caucasian people to understand a lot more within the community where Aboriginal people are coming from. I would hope that down the track not only will we get a lot more knowledge with them because they see us teaching their culture, given that we do it properly,* then that might help link some of that good White traditions into the Aboriginal culture too.
Renee	*So working from each other?*
Isabelle	*Both ways.*
	Initial Interview, Sue and Isabelle

(Purple coloured text in this and other transcripts represents the specific parts I discuss in the following reflexive analysis. As discussed in Chapters 1 and 3, purple text and text box represents my analysis as researcher-participant.)

> **Reflexive analysis:**
>
> Teachers recognised that White Australian society had, in general, little understanding of Indigenous cultures and knowledges (most often including themselves in this). While the social justice intent of teachers' statements was apparent, their expression of this was sometimes problematic in terms of how Indigenous peoples and cultures were framed.
>
> While Sue suggested that both cultures could draw positive influences from each other, hinting at a cultural interface (Nakata, 2002) approach, she expressed this in terms that were operating from what might be described as operating from a deficit paradigm (Vass, 2012). Deficit discourse has been recognised as language and representations that negatively frame narratives around Indigenous students and communities and focus on deficiency and disfunctionality (Fogarty, Lovell & Dodson, 2015). The impact of deficit discourse is the framing of Indigenous education as a 'problem' that needs fixing (Vass, 2012). Sue's framing of the CCP shows that she saw it as contributing to the 'problem' of

Other participants echoed Sue's comments, albeit with less paternalistic overtones. A separation of Indigenous and non-Indigenous cultures was also of concern to Allen.

Renee   *So how do you see the purpose of including that knowledge then? You're talking about the Indigenous kids in your class. Why do you think we've got this push to actually do this, at this time?*

Allen   *Well, it's probably a result of the Indigenous population feeling like they're separate from the wider population and it's trying to bring us to them, in sharing information and saying, 'well it doesn't belong to any one person'. So no one should - especially in science and maths - it's not an ownership thing. It's – everybody owns knowing about the world around you and explaining the world around you, whether it's mathematically or whether it's in a scientific sense. We need to have everybody understand it as a part of their history. It's a commonly shared thing. So by including statements that are specifically aimed at Aboriginal kids it's kind of well, 'hey, you're actually part of this, so you own some of this and you can join in'.*

    Initial Interview, Allen

feeling outside of the wider Australian population, he did not seem to frame this as resulting from a deficit position. Allen's ideas of creating a commonly shared knowledge more genuinely suggest a cultural interface approach where both knowledge systems are valued and draw from each other (Nakata, 2008).

He also seems cognisant of Indigenous students feeling more included in the dominant Western education system. His invitation for Aboriginal students to 'join in' speaks to the necessity of participation in school based education derived from Western models. As Aikenhead (1996) highlights, schooling and particularly science education can necessitate cultural border crossings for students. Allen seems to suggest the inclusion of Indigenous ways of knowing might assist Indigenous students to more easily cross these cultural borders and participate in schooling.

The project's critical friends also spoke of their hopes for promoting intercultural understanding. From an Indigenous person's perspective, project Critical Friend, Daniel, outlined how he used Indigenous perspectives in his own teaching. Through a description of a teaching episode he described how he challenged non-Indigenous students' perceptions of Indigenous stereotypes to promote intercultural understanding. Daniel used his own appearance as a fair-skinned and blue eyed Indigenous person to demonstrate to students that not all Indigenous people have dark skin or other phenotypical traits generally associated with being an Australian Indigenous person.

Daniel   *Okay, just go through the background, "who knows what a Murri is?" No one puts up their hand, or they might. "Who knows what an Indigenous person is?" A couple more, "who knows what an Aborigine is?" Oh right, okay, so you go through that whole thing, alright, well, I'm one and straight away, because I'm fair they say "oh, well" and that sort of thing. So straight away you're challenging those stereotypes*

but you're also embedding perspectives into their whole life,
not just the curriculum.

Initial Interview, Daniel

The second theme of hope emergent from the initial interviews was about providing engaging teaching experiences for both Indigenous and non-Indigenous students. Teachers shared a hope that the use of content that was non-traditional in the area of science might add interest to lessons. Of all participants, Cristy seemed to be the most motivated to change her teaching practice on the basis of increasing student engagement. Cristy had previous positive experiences with student interest and motivation related to incorporating Indigenous content.

Cristy	*The kids absolutely loved it as well because it was something they could relate to and [the school] had a huge, not a huge, but a significant Indigenous population.*
Renee	*Oh, excellent.*
Cristy	*Which was really gratifying as a teacher.*
Renee	*Yes.*
Cristy	*Because you got kids who are usually disengaged, becoming engaged. Funnily enough it wasn't only the Indigenous kids, students, who were becoming engaged. It was some of those low socio-economic status students, the generational poverty kids, that were sitting up and identifying with it as well.*
	Initial Interview, Cristy

The final theme of hope was about improving outcomes for Indigenous students in education and society more broadly. Following on from the earlier comments from Sue (and operating from the same discourse of deficit), she clearly expressed hope that if the inclusion of Indigenous knowledges was done consistently and well, it would lead to improved Indigenous outcomes.

Sue   *But I don't think, if we don't do it well, that won't happen. I don't think it's going to be something that happens overnight. I think we need to look at ten years down the track. Or even twenty years down the track and see if it has impacted on their Aboriginal health and how they live and their integration, you know, are they finding jobs within the population? And it works the other way as well, are we more tolerant? and are, because we've got a better understanding of where they're coming from, we're less likely to be as critical?*

Initial Interview, Sue and Isabelle

There was also acknowledgement from (critical friend) Daniel that the curriculum initiative was, in his view, aimed at improving Indigenous outcomes. As a teacher employed to work on Education Department Indigenous-based initiatives, Daniel felt he had a responsibility to reject the discourse of deficit surrounding Indigenous learners and he said that he felt uncomfortable discussing poor achievement standards. When I asked him why he thought this initiative had been brought in he replied:

Daniel   *Yeah, well this will probably get me in strife but they're doing it because we're so poor. You look at the latest academic record, retention records to attendance, we're atrocious. Murris are atrocious and trying to address that. Because what comes out the other end is a dysfunctional human being in a society now we're in a Western society. That's to my way of thinking, that's the main reason. You know it's not because of some moralistic point of view, it's because it is hammering society so much, rather than a pure moral point of view.*

Initial Interview, Daniel

Vision

The teacher participants also expressed their vision of how science education inclusive of Indigenous knowledges might 'look' if it was successful. They were usually quite clear about what needed to be achieved if the project were to be successful, but less able to articulate how their visions might be achieved. The following four points were the common themes that emerged from teacher participants' interviews:

1. an Australian perspective to the science curriculum – something all students can relate to and find relevance in;
2. Indigenous Knowledge and traditional science drawing value from each other;
3. incorporation of local community connections to assist in embedding;
4. promotion of different ways of thinking about the world – holistic knowledge and critical thinking.

Having an Australian perspective to the science curriculum was a strong emergent theme in the initial interviews with teacher participants and critical

friends. Teachers considered science was generally taught with a Eurocentric (rather than White) focus that limited Australian content in the curriculum. When teaching about the canonical nature of the discipline, most of the historic figures discussed were White European men, something teachers felt students did not relate to. The opportunity arose, through the diversification of perspectives, to show students that scientific thought and innovation were occurring in their 'own backyard' as well.

More broadly, teachers saw science education containing Indigenous Australian knowledges as an opportunity to recognise a more inclusive Australian identity than that which they felt students currently held. Allen and Karl expressed this idea in similar ways:

Allen   *So if we're using Indigenous understanding hopefully it will make them [the students] appreciate their understanding of Australia as a whole.*
Initial Interview, Allen

Karl   *The knowledge that we still have to learn from people that have been living here for thousands of years... I think that's something; and just a part of the whole Australian identity as well, an important part.*
Initial Interview, Karl

The second vision for the curriculum, that Indigenous knowledge and traditional science draw value from each other, came from a desire to teach the knowledge systems as complementary and synergistic. In discussing this vision, Allen expressed his understanding of the way the knowledge systems had historically been presented.

Allen   *Again, it's not just Aboriginal. It's almost like we, historically, have drawn a line between Aboriginal people and, better still, between*

traditional Aboriginal people and everyone else, and said these people know their stuff, well that's their information and this is our information. There is a gulf or a barrier between the two that neither side crosses. So it's a case of saying well, it's all information; it's all a way of understanding our environment, our lives and our existence here on this patch of dirt. It will travel both ways.

Initial Interview, Allen

Reflexive analysis:

Allen displayed a willingness to blend Indigenous and scientific ways of viewing the world. Rather than seeing the two as incommensurable, he was aware of their synergies and again seemed to suggest an approach similar to Nakata's (2008, 2010) views on scientific knowledge in the cultural interface. He also seemed to reject the necessity for science teachers to enculturate all students into only the value system of Western science and he seemed to move beyond the scientism that Aikenhead (2001) suggests is commonly held by science teachers.

The third vision, incorporating local community connections, links not only to the vision of a more Australianised curriculum but also to a recognition of the local, contextual nature of Indigenous knowledges. Sue and Isabelle suggested several local sites of significance to Aboriginal people that they would like to include in their teaching. Some of these sites, such as a local Bora ring[3], are supported and preserved by the local Indigenous community, offering ready access and information. Other sites are known to be historically significant but do not have Indigenous community support readily available.

The contextual nature of Indigenous knowledge was in the forefront of the participants' minds when they considered how science education might 'look'. With this recognition of the specificity of knowledge also came recognition that

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[3] Bora rings are Indigenous scared sites, often used for initiation ceremonies.

as teachers move from locality to locality, new knowledge and connections would need to be sought. As Allen observed:

Allen   *We need to have specific knowledge, it would be lovely to have specific knowledge for the local areas, but it is going to get tricky isn't it? As we move from place to place and we're dealing with different Indigenous groups… it would be nice to get local knowledge so that when we speak to children they can identify features of the landscape or thing that they see and say well, here's the perspective, the Indigenous perspective about these things.*
          Allen, Meeting 1

The final vision, to promote holistic and critical thinking in students, was expressed strongly by several of the participants. In particular, Cristy saw the inclusion as an opportunity to expand the educative value of science lessons beyond just learning about science towards developing critical thinking and questioning abilities that could apply beyond the classroom.

Cristy   *We're not just there for kids to regurgitate information to us. It's about having a holistic knowledge and to be able to be critical thinkers within our world. And to ask questions of our world and question the status quo.*
          Initial Interview, Cristy

Reflexive analysis:

The consideration of the incorporation of Indigenous knowledges and the rejection of the 'banking concept' of education seemed to go together in the minds of the teacher participants. In the consideration of Indigenous ways of knowing that are by nature interconnected and often complex, the compartmentalisation of science is challenged when planning classroom lessons. This led, in the participants' minds, to something more than "teaching out of the text book" as Cristy put it (Initial Interview, Cristy). The hopes and vision

What are the possible/perceived problems of inclusion?

While the hopes and visions for science education containing Indigenous knowledges were in the forefront of teacher participants' minds, these were not held without trepidation surrounding perceived impediments, concerns and fears. From the initial interviews, the following emergent themes were emphasised as points of concern for successful fulfilment of our overall vision and hopes.

1. Teaching must be both respectful and meaningful. Tokenism and 'stepping on cultural toes' needs to be avoided.
2. Different ways of understanding the world and knowledge between Indigenous and scientific understandings are difficult to resolve – the multilayered nature of Indigenous knowledge compared to reductionist nature of science. (Not all participants saw this as a problem, but those who mentioned it saw it as quite significant.)
3. Ability to commit time (inside and outside of the classroom) to develop effective teaching strategies.

(Compiled from individual interviews and endorsed by participants in group meetings 1 and 2.)

Stepping on cultural toes

Teacher participants were fearful of being culturally insensitive. Isabelle in particular expressed her reluctance previously to present Indigenous knowledges in the classroom due to a fear of "stepping on cultural toes":

Isabelle   *I think if it's not done properly... it shouldn't be done at all because I'm worried what I might do to it. I'm worried about myself in front of a classroom... yeah, making a mess of it and appearing disrespectful and, do you know what I mean? Not having, yeah, I don't know. I'm just worried that I'll make a mess of it.*
                Initial Interview, Sue and Isabelle

Cristy also described challenges in terms of cultural appropriateness through her experiences in the planning process in her previous school.

Cristy   *It became quite a challenge, not to then include any, ummm, let's say step on cultural toes, teaching it because if we do wrong, or we haven't researched properly, then it becomes, we're disrespecting culture. It could be a kind of tip toeing thing.*
                Initial Interview, Cristy

Project critical friend, John (Embedding Aboriginal and Torres Strait Islander Perspectives Officer), offered a positive perspective on the issue of teachers being fearful of stepping on cultural toes.

John   *Yeah, as I said, I believe teachers really do a great job but we stay in our comfort zone. Especially with Indigenous education, in places that I've worked and in schools that I've seen, teachers will do their best with what they have, their understanding and their knowledge. When they get to a point where they feel that - the biggest comment I get from teachers is, 'I don't want to say the wrong thing, I don't want to offend anybody'.*

                To me, that's not a weakness, that's a strength because the teachers have realised that they're at a point where they're starting to get out of their comfort zone. I find that they tend to - they'll teach their curriculum, they'll teach their classroom lessons to a point, but when it comes to some very touchy or very difficult content for them

to deliver, based on whether they be Indigenous students or students from any other culture, they tend to hit the ceiling.

They tend to level out there and what they'll do is they'll come back to their comfort zone. As I said, when a teacher says to me, yeah, but I don't know what to say, I think that's a sign of strength because they're realising that they need support.
Initial Interview, John

Reflexive analysis:

There is a high level of consistency between John's comments and the comments of the teacher participants in the project. John, in his role as an EATSIPS project officer, worked with a large number of schools and teachers across the state educational region where the project took place. Given his corroboration of concerns of teachers around fears of stepping on cultural toes, it is likely that teachers see this as an issue more generally. Kanu (2011) highlighted teachers having similar issues of concern in the Canadian context. She found that teachers' lack of knowledge led to them expressing fears around having 'the right' to teach Aboriginal knowledge. In the Australian context, Harrison and Greenfield (2011) identified their concerns around cultural sensitivities in terms of how non-Indigenous teachers positioned Aboriginal people through the use of language and references to Aboriginal people and knowledges in the past tense, perpetuating stereotypes of indigeneity as historically situated. Without having appropriate knowledge and background of Indigenous issues teacher participants seemed to fear perpetuating similar culturally insensitive representations.

Scientific epistemologies

The teacher participants expressed both ideas of incommensurability (on epistemological and ontological grounds) as well as recognition of the synergies of Western science and Indigenous knowledge systems. In order to bring

different ways of knowing in to the classroom, teachers need considered reflection as to how these epistemologies fit into their own teaching praxis. The teachers in this project made links between their epistemologies and pedagogies when considering how they might engage Indigenous knowledges in their lessons. Some participants, such as Cristy, showed a broad understanding of what science is and expressed no personal difficulties with merging the two epistemologies.

Cristy   *I don't think I have a problem putting this into what I've already got. And I think a lot of that comes from thinking outside of the box. And I think, well, I love science, I question everything. And I think you're a scientist if you question how something works, if you question why is that red? You know? I think if you're asking questions you're a scientist.*
                Initial Interview, Cristy

Reflexive analysis:

The scientific epistemology expressed by Cristy is less based on a definition like Cobern and Loving's (2001) Standard Account (see Chapter 3) and reflects a more open consideration of what science 'is'. This led to her having no problems with presenting both ways of knowing in the classroom; there was no epistemological conflict on this basis for her. As Aikenhead and Lima (2009) attest, science is shaped by its Eurocentric origins, but if it is accepted that science is "a rational, empirically based way of describing or explaining nature" (n. p.) it can be recognised that most cultures in the world have a science. Cristy's approach seems to mirror Aikenhead and Lima's position.

However, Cristy recognised that not all teachers in her school may share her position. She linked this to both how her pedagogy and epistemology differed from that of other more 'traditional' teachers of science. Cristy recognised that the inclusion of Indigenous knowledge in science lessons would be difficult

where teachers held different pedagogical approaches to hers. She equated this perspective with most science teachers within her teaching context.

Cristy   *When I said, oh I don't think it's too much of a problem for science, well if I think at my school, I would be the only science teacher that doesn't just straight teach out of the textbook. So, I'll refrain, correct that, I think that it may be an issue in science.*
           Initial Interview, Cristy

Reflexive analysis:

Cristy was recognising pedagogy as a barrier to teachers embracing the inclusion of Indigenous knowledges. When teachers maintained what Freire (2009) described as a 'banking model' of education based on transmission of information to students, "thinking out-side of the box", as Cristy described it, became more challenging. The direct transmission method of teaching from the textbook may also be reflective of a 'one-truth' scientific epistemology (as described by Kincheloe, 2010).

Similarly to Cristy, Allen expressed no difficulties with incorporating Indigenous ways of knowing such as Dreaming stories in his science teaching. Allen described a personal experience of encountering Dreaming stories connected to rock outcrops in Country near Alice Springs in the Northern Territory and how he thought this could relate to his teaching.

Allen   *There were a couple of pictures of the Dreaming story up there so that you can attach geology to it, and it just fits with the geology. Because the Dreaming is related to sites and stuff like that. But I thought you could do a whole term about the geology based on dreaming stories.*
           Initial Interview, Allen

Not all teachers found it easy to reconcile Indigenous and Western scientific ways of knowing in their teaching. Isabelle talked about including "mythology" in her science teaching (Initial Interview, Sue and Isabelle). Isabelle expressed distinct differences between the components of knowledge that could be recognised as scientific and cosmological understandings of Indigenous peoples. This was articulated, however, with a concern for the possible decontexualisation of this knowledge by removing the cosmological understandings.

Isabelle   *I think parts of the Indigenous knowledge, I don't even know if that's the umbrella term of what it is, but I think parts of it are scientific and parts of it are mythology which to me in my definition, in my head, that's not science. So like, I don't see how I'm going to be able to… but then I can't really just cut it, can I? Cut it in bits?*
                Isabelle, Initial Interview, Sue and Isabelle

regard to the differences between Indigenous perspectives and Indigenous knowledges (Harrison & Greenfield, 2011). While she recognised elements of Indigenous knowledge, such as the "mythology" she was unsure how these elements fitted together. There was a realisation expressed that there may be an issue with just taking parts of a knowledge system to use in teaching. This made Isabelle unsure of how to maintain cultural appropriateness in terms of knowledge in her pedagogical approach. She had the desire to ensure that her teaching was culturally appropriate and to treat Indigenous knowledge respectfully, but was unsure how this fitted with her own scientific epistemology that was firmly based in Western understandings.

Aikenhead and Huntly (1999) described barriers to teaching Indigenous knowledges in science education as 'conceptual' if recognition of science as culturally based is lacking. Isabelle's confusion seemed to rise from understanding different cultural bases for science and Indigenous knowledges. However, the impediment was still conceptual in that she did not know how to handle this conflict epistemologically or pedagogically.

Another compounding issue for the teachers from Catholic schools was the marginalisation of Indigenous knowledges through competing spirituality bases. Indigenous knowledges operate from what may be considered a conflicting ontology to that of Christianity. In a school system operated from a specifically Catholic, Christian epistemology teachers felt an additional pressure to be sensitive to particular spiritual (and political) positions. Pressure manifested as anxiety about being challenged on the basis of spiritual grounds by students and their parents (Initial Interview, Sue and Isabelle). Cristy taught within the Catholic system but did not consider herself to be religious. She described her perspective on the merging of epistemologies:

Cristy   *Because as scientists, are we thinking of scientists, we're going to have a different perspective than say our creative arts counterpart. And being in a Catholic education school as well, it's very difficult being a scientist and talking about, some of these Indigenous*

knowledges, because they're not respected. Because of the Catholic faith, you know, this is how we do things. Sometimes I find those tensions very difficult to counterpart so it's productive.
Initial Interview, Cristy

Isabelle and Sue also taught within the Catholic system and both identified themselves as Catholic and taught Religion as a subject within the school. Both considered that it was possible, perhaps even likely, that they would be challenged by parents of students on presenting aspects of Indigenous spirituality in the science classroom, or in fact, within their teaching in general. Isabelle described the difficulties she had experienced with teaching Christian mythology (such as Biblical stories) and how she did not think teaching Indigenous mythology would be palatable to students:

Renee   *So what about that cultural aspect? So last time we were talking Isabelle, you were talking about, you know it's not just the knowledge itself, it's the cosmology, and the, you know, all those connections.*

Isabelle   *Students have a tough, I teach religion as well, and students have a tough enough time getting their heads around arhh, the Christian, umm (pause) arhh, what do you call them?, umm, what's it called, like the stories.*

Sue   *Yeah, parables?*

Isabelle   *No, no, no, like stories that aren't necessarily true. You know like genesis stories. What do you call those again? Umm, the, religious, mythology! The students have enough trouble getting around a traditionally Western mythology of the Christian mythology. Let alone, you know, this one that the majority of people are unfamiliar with. So, and that's in religion class. So I can just see the mythology side of it and the cosmology with the story of, you know, the Rainbow Serpent excreta, being something that's not take seriously.*
Initial Interview, Sue and Isabelle

Despite Cristy and Sue's reservations about merging epistemologies and spiritualties, they described the Catholic ethos of the school as being amenable to the social justice intent of including Indigenous knowledges. They felt the motto of the school "Serve Him in Others" was well upheld and provided a guide to the social justice activities of the school. Indeed, evidence of this was apparent on the wall of one of the science teaching laboratories at the school through the hanging of a student made cross decorated with Australian Indigenous symbols (Figure 11). Despite this representation of the merging of epistemologies that confronted the teachers every day, they remained cautious of students' responses to the presentation in the classroom of different ways of understanding the natural world.

Figure 11: Student made cross hanging on the wall of the science laboratory at Sue and Isabelle's school

Even where some knowledge and/or epistemological conflicts were perceived, teachers were motivated and actively working towards the inclusion of Indigenous knowledges and perspectives in their teaching. While both positions of incommensurability and synergy of the knowledge systems were apparent in teachers' positions, all teachers were keen to move forward in the project. Volunteering participation in the project was reflective of this desire although actually participating proved more difficult for some teachers. Even in the initial interview, teachers identified that competing demands on their time may limit their ability to attend meetings and implement agreed actions.

Time

A very strong theme emergent from the project was teacher participants' concern with the amount of time available to them to implement initiatives such as the inclusion of Indigenous knowledges and perspectives. Indeed, the participants in this study were committing out of school hours time to attend PAR group meetings and perform tasks associated with the project in order to extend their professional learning. All participants spoke of the many out of school hours they devoted to administrative tasks, such as marking and preparing for moderation, as well as planning lessons. Isabelle summed up the frustration felt by many of the participants in being time poor.

Isabelle   *It sucks though because I think teachers, generally, teachers are there for the good of the kids and they want to be the best that they can be. But, resources such as time are so limited. You find yourself in a tug-of-war, like, "do I have time? No I don't, I just need to get something planned". And you're teaching these lessons that you know could be so much better if you only had time. But you just don't, and it's bad.*
Isabelle, Initial Interview, Sue and Isabelle

Participants linked the lack of time to the increasing pressures on teachers in terms of assessment and reporting. In particular, secondary school teachers who taught senior subjects as well as junior courses recognised the assessment and reporting associated as time consuming. Another concern was the pressure put on teaching staff to achieve good NAPLAN (National Assessment Program – Literacy and Numeracy) results. The results of NAPLAN test are used to measure if "young Australians have the literacy and numeracy skills and knowledge that provide the critical foundation of other learning and for their productive and rewarding participation in the community" (ACARA, 2011d).   School results from NAPLAN are reported on ACARA's *My School* website which compares results between schools that are considered to be similar in terms of the socio-economic status of students. In the following transcript excerpt, Daniel quite intentionally describes NAPLAN as NAPALM.

Daniel   *There is so much stuff going on now that was never around five years ago, let alone 10, 20 years ago. Everyone's their [teachers] boss, so they can come and have a whinge, there's so many people they have to answer to, NAPALM is a huge waste of time and all the emphasis upon that. The stress for almost six months of the year, almost all you're focused on, it's so unfair and so detrimental to an active teaching, learning, even happy school room. It is so, so hard and I've met some wonderful teachers in my time and even some of the best ones are now seriously considering their careers because of the ridiculous pressures placed upon them by this NAPALM*

Initial Interview, Daniel

Reflexive Analysis:

Other participants echoed Daniel's recognition of the stress and pressure put on teachers due to NAPLAN and associated accountability measures which result in the intensification of their workload. The frustrations expressed by Isabelle in the previous transcript section are of a similar nature in that they speak to the stress these teachers felt to uphold their teaching performance while struggling with an ever-increasing workload. For Daniel, NAPLAN in particular formed a major part of the stress associated with government based education initiatives.

Lingard, Martino and Rezai-Rashti (2013) suggest that curriculum and evaluation are neo-liberal policy messages that are conveyed through teachers' classroom pedagogies. These authors frame standardisation in curriculum and testing as "test-based, top-down accountability in schooling systems" (p. 539) and recognise the impact on teachers' work. Teachers become the objects rather than the subjects of educational policy (Lingard, 2011) meaning the emphasis is on the teacher to meet the imposed policy resulting in an intensification of externally imposed pressures. Teacher participants in this project seemed to be reacting to these imposed pressures and reporting concerns around a lack of time to engage with the necessary pedagogical changes. The Australian Curriculum was one component of these changes, as Daniel described, associated

Whilst recognising the large number of initiatives that teachers have to negotiate, project critical friend John, described trying to not lose sight of the overarching reasons for embedding Aboriginal and Torres Strait Islander Perspectives and the CCP. Without a focus on outcomes for students in the classroom, teachers focused on the perceived extra work required implementing this and other initiatives.

John   *Whether that area be NAPLAN, whether it be ACARA, whether it be QCATS [Queensland Comparable Assessment Tasks], whether it be Closing the Gap, whatever, if schools are aware and conscious of what we're trying to do, it's only going to make it easier and better for them but a lot of schools see it as another add on - oh, not something else.*

          As I said, we lose focus. We look at all the funding, we look at the NAPLAN results, we look at all the reports we have to fill out, and this and that but, really, are our kids any better off for it?
          Initial Interview, John

Interconnectedness of teacher confidence, epistemology and demands on time

In order to effectively engage in implementing lessons containing Indigenous knowledge, teacher participants identified the need for them to first become familiar with Indigenous knowledges. In addition, teachers desired to make connections with local Aboriginal people and groups to not only enhance their own understandings but to be able to ensure cultural sensitivity in their lessons and involve Aboriginal people directly in teaching. Without sufficient time to engage in these activities, teachers often expressed a lack of confidence in their own knowledge and development of pedagogical strategies and therefore were reluctant to teach lessons with Indigenous content.

When considering the impediments teachers described to incorporating Indigenous knowledges in their teaching, three main areas of concern were apparent:

1. A lack of confidence manifesting as a fear of stepping on cultural toes;
2. The many competing demands of the role of teacher in a neo-liberal education system;
3. Reconciling Indigenous knowledge systems into personal, scientific and institutional epistemologies.

These points were seen as interconnected rather than discrete. For example, in order to make teaching respectful and avoid tokenism, teachers needed access to information, resources and local community contacts. To build these connections and resources takes time. All participants in the project recognised time available to them to engage in the necessary building of knowledge and understanding as a constraint, either for themselves or for those around them.

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This perceived lack of time impacted negatively on teachers' abilities to confidently plan science lessons containing Indigenous content and/or perspectives.

Teachers recognised the connections between their lack of confidence and the busyness of their teaching roles in terms of not having the time to build understanding and resources. All teachers spoke of intense expectations of the education system but did not necessarily link this to the neo-liberal educational policy. Similarly, teachers did not make connections to their personal or scientific epistemologies and lack of confidence or time to plan teaching. I would suggest that all of these factors share strong connections. Figure 12 shows the interconnectedness of teachers' lack of progress relates to issues of confidence in teaching Indigenous knowledges, the competing demands of professional and personal commitments and epistemological roadblocks to implementation.
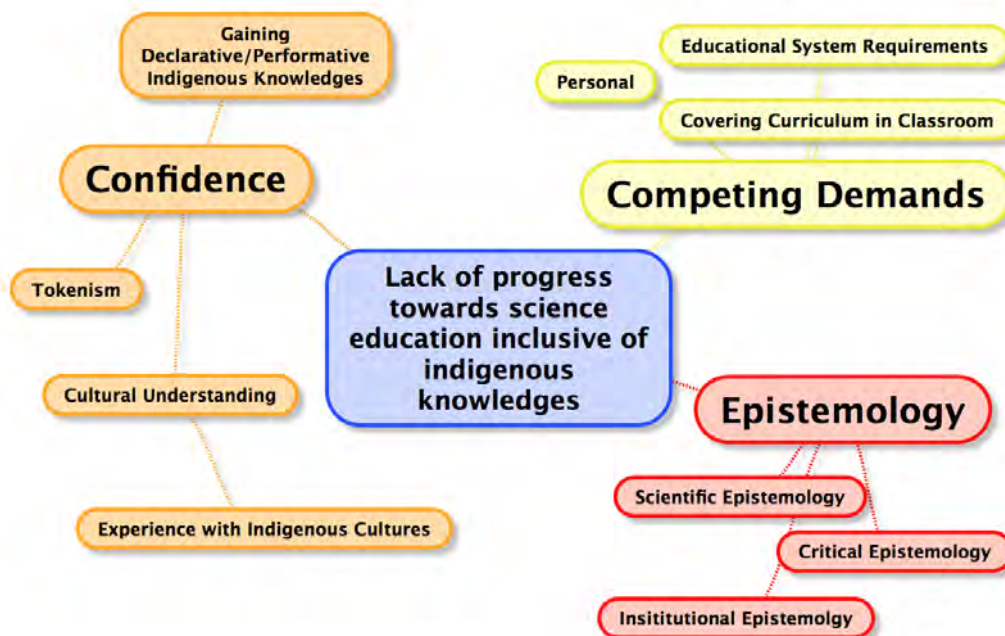

Figure 12: Interconnectedness of factors linked with a lack of progress towards science education inclusive of Indigenous knowledges

The merging of all three of the impediments acknowledged in initial interviews resulted in an atrophy of good intentions and therefore a lack of progress in science education inclusive of Indigenous knowledges. Where teacher participants struggled to reconcile their own scientific epistemologies or institutional epistemologies (such as with the teachers in Catholic schools) with their desired professional practice (and critical epistemology), their confidence in avoiding tokenism and gaining the necessary knowledges, resources and cultural understanding is impacted. In order to gain these skills and understandings, teachers need to spend time in study of materials (curriculum, cultural and pedagogical) as well as in dialogue with Indigenous people. At this point, the competing demands of the educational system become of concern and the teacher participants felt they had no time to engage in the necessary professional learning.

What was apparent from the data was that teacher participants were committed to making the CCP work positively in their classrooms. However, also apparent was that teachers perceived a number of impediments to implementation within the education system that they were not supported to overcome. While teacher participants showed a professional interest and commitment to the project, there were still impediments in the actualisation of this commitment in the project and the classroom.

Conclusion

This chapter described the positioning of the teacher participants at the beginning of the project in terms of including Indigenous knowledges in their science teaching practice. These teachers' hopes for and visions of, science education inclusive of Indigenous knowledges were identified. They saw the social justice intent and concerns inherent in the inclusion of the CCP but expressed their positions from differing perspectives and levels of critical engagement. The overall visions of science teaching praxis involving Indigenous ways of knowing were positive. While these visions in some ways identified

what needed to be done, the path towards implementation was far from clearly held in the teachers' minds. Many questions remained about the 'how to' side of the project.

Also identified were the impediments to implementation. These were linked to personal, school and educational system concerns. Individually, the teacher participants faced different challenges in each of their schools. Overall, challenges were identified that linked to the need to further develop their understanding of Indigenous knowledges and ways of knowing. Identifying this gap in knowledge was integral to the project moving forward. The concerns around finding the time for professional development in the area and the interconnectedness of all of the concerns around implementation were important revelations at this point. Without the interrogation of the interview data and the dialogue between teachers at early meetings, it would not have been possible to keep moving forward.

The following chapter charts the course of the PAR cycles of the project. It builds on the data and analysis presented in this chapter to show the progress of the method, the participation of the teachers and how they each approached implementation in the classroom.

Chapter 6: The PAR cycles

Introduction

The previous chapter described and analysed the initial project data. The interviews with teacher participants and critical friends identified the hopes, visions, fears and concerns of the teachers in regard to the implementation of science education inclusive of the Cross-Curriculum Priority (CCP). The interconnectedness of the lack of teacher confidence, competing time demands and challenges to epistemologies was discussed. Some of these themes are returned to in Chapter 7 considering the overall project data.

This chapter is largely descriptive and outlines the project by describing the PAR cycles. Attention is given to the emergent structure of the PAR process. Description of the cycles is formed through the identification of critical moments that contributed to the plans, actions and outcomes of each cycle. These critical moments are identified from my perspective as the researcher-participant.   In this sense, I am telling my story of the project and its participants.

There is often 'messiness' to PAR work because cycles may not be obviously isolated from each other. Kemmis and McTaggart (2005) described a key feature of PAR to be that the stages may overlap and in light of learning from experience, processes becomes more fluid and open rather than the neat self-contained spirals that are often conceived. Such was the case with this project. Teacher participants worked at different schools, had different teaching and personal commitments as well as differing levels of previous experience of teaching Indigenous knowledges. As a result, individuals moved through the cycles at different times. As outlined in Chapter 4, not all teachers participated in all cycles. In addition, teachers participated in each cycle differently, sometimes having a large input into the group process and sometimes putting more effort into individual processes within their schools.

In this project, the 'messiness' can be defined in terms of asynchronous PAR cycles. As the researcher-participant, I endeavoured to maintain the participatory part of the PAR process and allow the direction of the project to be primarily guided by the teacher participants. At times, this made managing the project difficult. Having teacher participants engaging with different cycles at different times meant that my role as a facilitator, researcher and resource provider (see Table 2, Chapter 4) became pivotal to ensuring the progress of the work. I attempted to keep all participants connected with each others' activities and provided any support needed as appropriate to the particular point each participant was at. Group meetings acted to discuss the progress of the members who attended which acted as inspiration (provided nourishment in terms of the Tree of Life metaphor) for participants not as advanced in the cycles.

My decision as the researcher-participant to take this approach to facilitating the project introduced a complexity to the data that may not have otherwise been present. A large amount of data was produced as multiple data collection opportunities arose in the forms of discussions with individual participants, group meetings and classroom observations. The approach also allowed each participant to engage with the elements they needed in order to make the project more meaningful for them in their contexts. Ultimately, this complexity in the data allowed for in-depth analysis, including considering why some teacher participants progressed further in the cycles than others (see Chapter 7).

In this chapter, through this messiness, I have drawn together an overview of each of the cycles and then highlighted the *Little Stories* of participation through the use of critical moments. At times, attempting to divide the data into cycles felt somewhat artificial due to the constant intersection and interconnectedness of participants' actions and thoughts. However, through analysis clear patterns of progress through the project, common to teacher participants, emerged.

Figure 13: Growth and nourishment (Desmarchelier, 2012b)

In terms of the Tree of Life metaphor this chapter describes the development, maturity and fruitfulness of the work as represented in Figure 13. We worked in the protection of the shade of the Tree through moving towards more humanising pedagogies. Growth and change was the focus of the reflective, cyclical process of PAR in turn allowing all participants to gain nourishment from the successes of the group.

The topics and progress of the cycles within the project and indicative points of data collection are shown in Figure 14. Data collected from other points in the project, such as discussions with an individual participant, may have also contributed to a particular cycle but most of the data contributing to the cycle is from the points identified. Cycle 1 consisted of planning, reflection and re-planning around the production of a Collective Vision Statement for the group to provide a guide to the work. Cycle 2 worked from the Collective Vision Statement to identify what areas of the curriculum might be appropriate to target for the CCP. Cycle 3 saw the implementation of the CCP in the classroom and reflection on the process. Cycle 4 focused on the sustainability of the work after the completion of the project.

Cycle 1 – what do we want to achieve
- Meeting 1
- Collective vision statement
- Meeting 2 confirmation of statement

Cycle 2 – Where will indigenous knowledges fit?
- Meeting 2
- Meeting 3
- Individual discussions

Cycle 3 – Putting plans into action
- Only Cristy and Allen
- Allen – Classification unit
- Cristy –Forces unit
- Workshop

Cycle 4 – Moving forward
- Planned whole school professional development
- Cross-curricular project

Figure 14: PAR cycles within the project

Added to the description of each cycle in this chapter is my reflexive analysis on critical moments, method and methodology. These reflections are designed to place myself as the researcher-participant in the project and describe my thoughts and actions. Theoretical analysis of the themes emergent from all of the project data is presented in the next chapters (Chapters 7 and 8) where the positionality of the teachers individually and within the education system is examined.

Cycle 1

Cycle 1 considered where the starting point of the project was for the teachers as a group and resulted in the production of a Collective Vision Statement. The summary of the emergent themes from the initial interviews was used as a discussion starter at the first group meeting. At the second group meeting, there was consensus that a statement of the project's intent was needed. This resulted in the production of the Collective Vision Statement that acted as a guide during

the process of the project and an aid for reflection after the implementation of plans in the classroom (Cycle 3). Figure 15 outlines the progress of Cycle 1. In all cycle diagrams in this chapter, blue boxes represent the question being investigated and/or the starting point of the cycle, pink boxes represent the action/s taken and orange boxes represent the reflection on this action leading to future work.
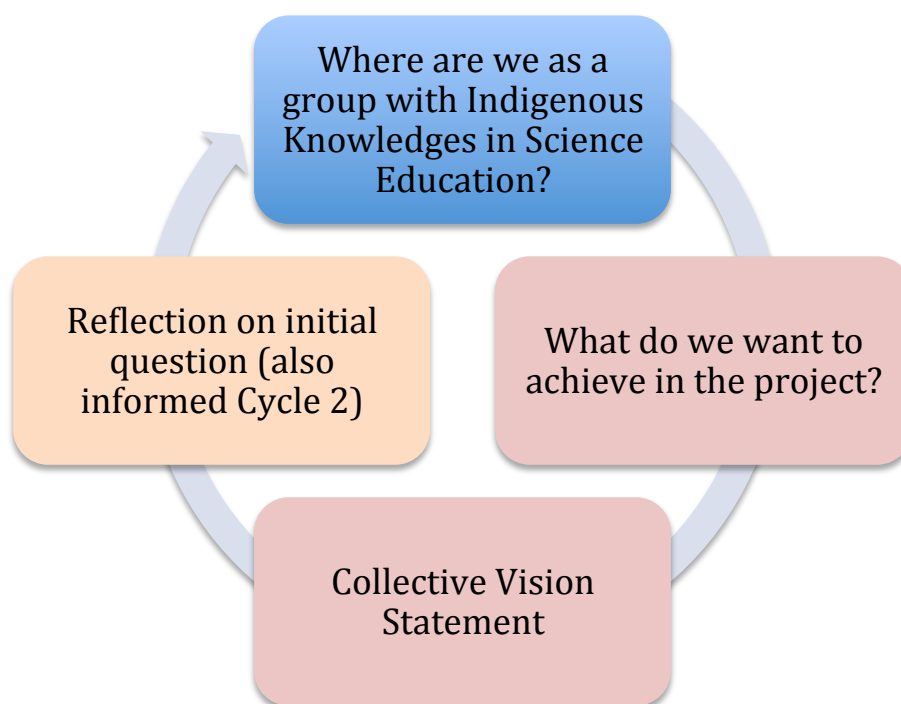

Figure 15: Cycle 1 – Production of a Collective Vision Statement

Teacher participation rates in Cycle 1 were higher than in later cycles. All teacher participants took part in the initial interviews discussed and analysed in the previous chapter. The information these provided on individuals' consideration of where they were starting from in terms of knowledge, experience and confidence was an important part of preparing to enter the first cycle and commencing working together as a group. Meeting 1, attended by Cristy, Allen and myself, considered these issues. Meeting 2, attended by Sue, Isabelle, Karl and myself, was where the decision was made that a statement of our intent in the project was necessary. All teacher group participants worked on, and provided feedback for, the resultant Collective Vision Statement, even if they had not attended the meeting. This statement allowed for individual reflection on the initial cycle topic and movement forward to the next cycle

where participants considered what spaces in the curriculum existed for the consideration of Indigenous knowledges.

Cycle 1 meetings

Getting the group meetings to happen was challenging. Teachers participated in group meetings when they could, but with conflicting timetables and commitments not all teachers were able to attend all meetings. The nature of the profession meant that teachers faced pressures at certain times of semester, such as assessment marking and moderation, as well as pressures specific to particular teachers and/or schools, such as parent meetings and extra-curricular activities. Arranging a meeting time where all participants were available proved to be extremely difficult. What follows is an extract from my research diary where I wrote about the first meeting.

> Excerpt from research diary, 16/06/2011
>
> I have my first group meeting this afternoon. This is the third time slot that has been scheduled. The first one last week was postponed because I had only one participant that had confirmed they were coming. Yesterday was postponed until today because Allen was confused about the days and thought it was today. I only had Allen and Cristy coming anyway. Karl had said he would come but had a parent meeting come up. Isabelle and Sue are too weighed down by marking.

The first meeting offered an opportunity for Cristy and Allen to get to know each other and discuss the themes emergent from the initial interviews. The meeting lasted approximately an hour. As with all meetings, I took a dialogic approach as the researcher-participant to stimulate conversation but to allow teachers to explore issues of their choosing while keeping the meeting on task. The dialogue moved from the participants' hopes expressed in initial interviews to trying to gain an understanding of what the intent of the including the CCP in the Australian curriculum is.

Critical moment 1 – Who is this priority for?

In trying to understand why they were being required to implement this new CCP, Cristy and Allen focused on understanding what education is and what it is perceived to be for. The meeting participants reflected on if there are differences between what Indigenous parents (or parents from other ethnic groups) and non-Indigenous parents want from their children's education. The question of who the CCP was aimed at came to the fore. Cristy was concerned with the 'political correctness' of the intent of the CCP as well as of the emergent theme of promoting intercultural understanding. She challenged the meeting participants over her understanding of what it means to be Indigenous to a country.

Cristy: *I think you're exactly right. And especially just even reading that, promoting intercultural understanding between Indigenous and non-Indigenous groups. I consider myself to be an Indigenous Australian, I am not an Aboriginal or Torres Strait Islander. So looking at, what the political correctness of that statement is. And saying what does that mean for us as educators as well. Because there's so many other cultures and the intercultural connection between different groups of people within schools. What is the objective of having Aboriginal and Torres Strait Islander perspectives or… Simply Indigenous?*

Allen: *Are we aiming at, we are aiming at a particular cultural group. So we're actually aiming at Aboriginal Australians. And when trying to link it to an outcome of an improved outcome in their education. Is that what were trying to do?*

Renee: *Well, that's the question. Yeah.*

Cristy: *Is that what we're trying to do? Is that what the new policy that is embedded in ACARA and of all that sort of thing, is that what it's trying to do? I don't know whether the people writing these documents really have a full understanding of what they want out of it. Or is it just ticking the box?*

Meeting 1, Cycle 1

Critical moment 2 – Valuable, worthwhile and useful

The discussion of what Indigenous people want from education provoked a critical moment in the development of the project. Not only did Allen and Cristy come to the conclusion that the CCP was going to be important for all students

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regardless of Indigeneity or ethnicity, they recognised that, to be successful, any implementation needed to be valuable, worthwhile and useful.

Cristy: *Most definitely and I think that the comment you* [Allen] *made about, what do the Aboriginal and Torres Strait people see education, what is their perspective of what education is supposed to fulfil for them. Indicating that what we talking about ages ago, I think they all have different perspectives.*

Renee: *yeah, as do lots of White parents too I guess*

Cristy: *Sudanese parents, Muslim parents, like…*

Allen: *I think there's some issues that are common in our community, it's not a, the issues about education are not Aboriginal issues they are issues for all of us. And the issues for a lot of people, it does feel from where I'm standing, I feel more like a garage attendant, to a person who has just backed up their car and said fill it up. That's where the ownership of education ends. And they don't understand really what's going on. But anyway, if we're promoting the understanding thing, it's also about, I wouldn't mind trying to get, having things that are valuable and worthwhile and useful. Because as soon as they are three things everybody appreciates them.*

Renee: *Yes.*
            Meeting 1, Cycle 1

Reflexive analysis

Allen highlighted the need for teaching that is "valuable, worthwhile and useful", which became a guiding principle through the project. Related to increasing student engagement, Allen centred his idea on both teachers and students gaining nourishment (to return to a Tree of Life metaphor), from the teaching and learning experience. In this sense, Allen was rejecting the banking concept of education, using a dialogic and problem posing pedagogy, which was an expression of a humanist and liberating praxis which engaged learners as taking an active role in their own education (Freire, 2009).

Adding to the idea of what was valuable, worthwhile and useful, Cristy argued that the objective of the curriculum inclusion was broader than just improving Indigenous students' and people's outcomes. In a dialogue about the hope of improving Indigenous outcomes she reminded me that:

Cristy: *That wasn't a huge concern of mine with the whole perspectives coming in. I didn't, and you know that's not, improved outcomes for Indigenous students. I think it's about improved outcomes for all students.*

Renee: *Yes*

Cristy: *Using these methods and knowledges to improve outcomes for all students, to have a wider perspective.*

Meeting 1, Cycle 1.

The recording of the first meeting was made available through the project website for all participants to listen to prior to the second group meeting. Sue, Isabelle, Karl and myself attended the second group meeting. In this meeting, the participants recognised the need to have a set of aspirations to work towards and decided that a Collective Vision Statement was needed.

Critical moment 3 – The Collective Vision Statement

The meeting 2 participants initially struggled to find a starting point for our work. We discussed the possibility of starting with 'big picture' ideas of what the CCP might look like if it was implemented well or if a starting point should be looking at individual teaching units. How the group was to work together to achieve its goals, whether they were big picture or unit based was also discussed. Here Allen's idea of providing work that was valuable, worthwhile and useful served as a guide to how the group could progress. There was much dialogue surrounding how we as a group would know if we were being successful in our efforts. Isabelle was the most insistent of the meeting attendees that a statement of what we were working towards was important to the planning of the future activities for individuals and the group. It was through her persistence that the Collective Vision Statement emerged.

Through the dialogue in meeting 2, participants agreed that the themes found in the initial interviews that formed hopes and visions were actually an expression the group could use to guide its work. Much of what the meeting participants

discussed as being valuable, worthwhile and useful was already contained in the interview themes. In discussing what needed to be in a Collective Vision Statement, we found we were repeating what had already been brought to light in the identified themes. Therefore, it was decided that I would compile these into a statement for circulation and approval by the group.

The teaching members of the PAR group approved the Collective Vision Statement shown in Figure 16. It differed minimally from the themes that I had presented as emergent from the initial interviews. All group members agreed that it represented what the group was aiming to achieve and could serve as a guide for future work.

Collective Vision for the inclusion of Indigenous Knowledges (including Priorities and Perspectives) in Science Education

By the PAR group participating in the "Whose Knowledge?: Science Education, Indigenous Knowledge and Teacher Praxis" project.

Overall Vision

An education in science that:
1. Has an Australian perspective and offers something all students can relate to and find relevance in;
2. Shows Indigenous Knowledge and traditional science drawing value from each other.
3. Incorporates the local Indigenous community to assist in the use of knowledge and the understanding of teachers and students;
4. Promotes different ways of thinking about the world – holistic knowledge and critical thinking.

Hopes

Within this it is our hope that:
1. We are promoting intercultural understanding between Indigenous and non-Indigenous people;
2. We are providing engaging teaching experiences for both Indigenous and non-Indigenous students;
3. We are working towards improved outcomes for Indigenous Peoples in education and society.

Figure 16: The PAR group's collective vision statement

Reflexive analysis

The production of the Collective Vision Statement was a crucial moment in the project. By committing to paper some aspirations for our work and ourselves, we made clear our political intentions. The statement articulates a position that was not, and did not claim to be, politically neutral. The social justice and humanising intent of a praxis emerging from the group's work was clearly articulated.

L. T. Smith (1999) described 25 projects that Indigenous peoples have embarked upon as acts of "reclaiming, reformulating and reconstituting indigenous cultures and languages" (p. 142). One of these projects "Envisioning" works from a Freireian sense of hope and is similar in its process and intent to the production of a Collective Vision Statement. Envisioning is "a strategy which asks that people imagine a future, that they rise above present day situations which are generally depressing, dream a new dream and set a new vision" (p. 142). L. T. Smith describes the importance of a politics of resistance for Indigenous people to change their own lives and set new directions despite their impoverished and oppressed conditions. The production of the Collective Vision Statement also represented a politics of resistance where the group were addressing their perceived deficiencies in traditional science education and ensuring the project addressed power differentials between Indigenous and Western knowledges as well as reclaiming science education as "education for all" (Roth, 2009a, p. 1).

To return to the metaphor of the Tree of Life, the Collective Vision Statement can be seen as a sapling tree, emergent from the earth of the teachers' experiences. It was the first step in moving forward to the implementation of science teaching praxis inclusive of Indigenous knowledges. The statement connects with the idea of protection and nourishment of the Tree. Through providing a pedagogical space for well-being and growth in terms of intercultural understanding the participants were acting in the shade of the Tree. The statement itself was designed to be nourishing to the project. It provided a

Reflection

In reflecting on Cycle 1, and the Collective Vision Statement, participants identified a clarification of their understanding of the valuable, worthwhile and useful aspects of the CCP. Teacher participants were then situated in a position where they were ready to start considering the practical implementation of the CCP in their classrooms. This meant that they needed to identify where they might fit Indigenous knowledges into their current teaching practices and the curriculum.

Cycle 2: Where will Indigenous Knowledges fit in the curriculum?

Once the Collective Vision Statement was established, Cycle 2 considered where Indigenous Knowledges could fit in the science curriculum. The progress of this cycle is represented in Figure 17. Participants aimed to identify the areas of the curriculum, in terms of teaching units, where they wanted to direct their efforts. Through these initial stages of the project, teachers brainstormed ideas for areas that could be appropriate for further work in general. Ideas generated in initial interviews as well as individual and group discussions contributed to Cycle 2. At this point, participants worked individually, considering what they thought would work at their particular schools, and contributed to group discussions. Although Isabelle, Sue, Cristy and Allen all participated in the brainstorming phase of this cycle, only Cristy and Allen planned in detail future teaching units and lessons.
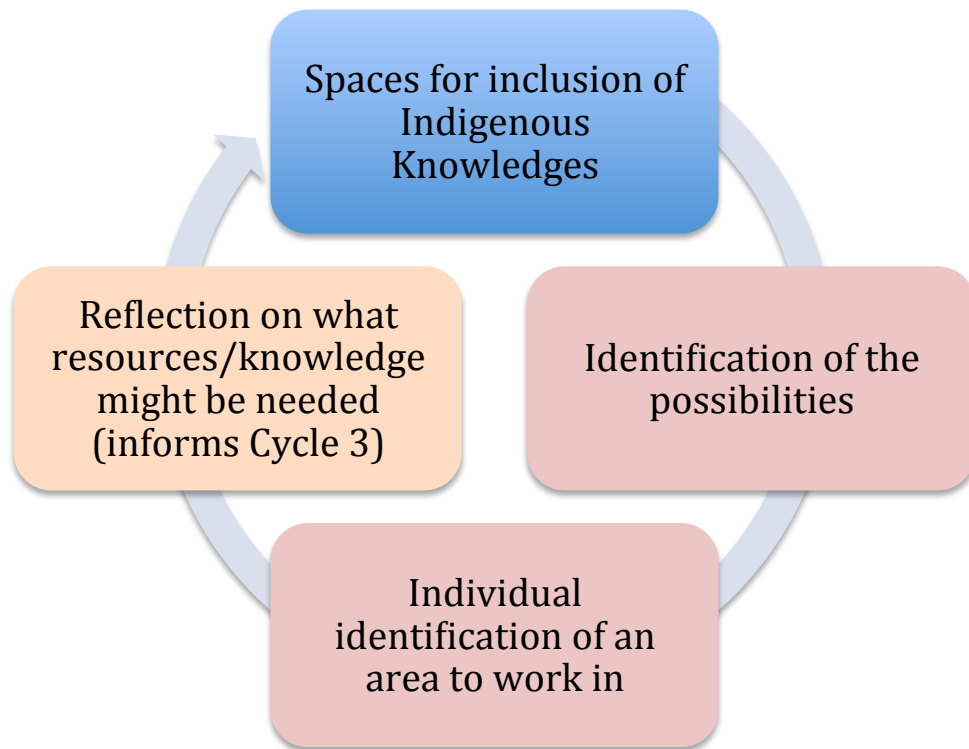
Figure 17: Cycle 2 - Where will Indigenous knowledges fit?

Spaces found in the curriculum

Teachers found many spaces for inclusion of Indigenous knowledges in the science curriculum. Possibilities arose from across the scientific disciplines including ecology, biology, chemistry, physics, geology, and astronomy (from initial interviews, individual discussion and meetings). In particular, Sue provided many examples of ways in which she thought Indigenous knowledges could be considered. She showed an interest in linking her ideas for spaces in the curriculum to local Indigenous sites of significance.   For example, she was interested in exploring the possibilities of addressing Indigenous ecological understanding through a visit to a near-by national park (Initial Interview, Sue and Isabelle). A feature of the park is many grassed areas on the sides of the mountain, known as balds, which resulted from Indigenous use of fire to manage vegetation.   Other points of interest for Sue were x-ray rock art paintings (relevant for biology) and traditional fire making (relevant for physics) (Isabelle reporting for Sue, Isabelle Individual discussion 1). Cristy outlined how she had previously included Indigenous knowledges in her teaching through astronomy

and a consideration of the chemistry of ochre and body paints (Initial Interview, Cristy). While Allen took a more critical view and as a former geologist, was interested in how the manipulation of the landscape through activities such as mining might impact upon the connection to Country that Indigenous people have (Individual Discussion 2, Allen).

Allen showed a different approach from the rest of the group and was implementing lessons in the classroom (the activity for Cycle 3) while other participants were still considering what area they wished to work in (for Cycle 2). He considered his already set teaching program and how Indigenous knowledges could fit into those topics rather than waiting until a particular topic came up in the curriculum schedule. Allen conceptualised and implemented a unit on classification for Year 8 where he included information and a guest speaker talking about Indigenous classification systems and how these compared and contrasted Western scientific classification. This unit included an assessment item that required the students to present their understanding about the Indigenous classification of specific animals. (More detail of this unit is available in the following section on Cycle 3.)

Both Isabelle and Cristy chose a Year 8 physics unit on forces as their target area. They planned to consider Indigenous simple machines such as digging sticks, boomerangs and woomera and describe the forces and physics at work from a Western perspective. I found it interesting that both teachers had chosen the same unit to work on. Physics had not been a discipline that had featured in previous dialogue as an area of interest for the project. Meeting 3 gave the group the opportunity to explore why Isabelle and Cristy considered the area appropriate and wished to explore it further.

Critical moment 4 – Physics unit

Allen, Cristy and Isabelle attended meeting 3, with myself facilitating the meeting. Allen shared some of his experiences with incorporating Indigenous knowledges into the unit he had been teaching on classification (see Cycle 3).

This interested the group and led to further discussion of the areas in which other members would like to attempt inclusion. Through this discussion Isabelle and Cristy discovered that they were both considering working in a physics unit for Year 8 students.

Renee: *I find it fascinating that you've both found the same topic that it fits with. There's heaps of places where you can fit it. I know it's just a matter of what you're doing at the time and what you're looking at the time but I think that's really interesting.*

Isabelle: *What I like about this unit is that it - Western sites and Aboriginal sites really work together - they go in the same direction - rather than with the astronomy and the traditional stories of how the stars were placed and all the rest. It's very contradictory. I find that that's dangerous ground for me teaching because I don't feel confident - because I don't share the beliefs - do you know what I mean? Whereas here, I feel a lot more confident because they're working together and they're empowering each other, both the traditional and the Western. So I will feel more confident teaching this than trying to explain how the emu exploded in the sky and it's little eggs popped up - do you know what I mean?*

Allen: *No, I didn't know that story.*

Isabelle: *It's in one of the textbooks that we have.*

Allen: *I didn't know that story, I like that story. I'd happily talk about that.*
[Over speaking]

Isabelle: *It's chauvinistic if I tell them - that's what I'm worried about - whereas this has a lot of value.*

Cristy: *It's got a lot of substance because we still use it today.*

Isabelle: *Exactly.*

Cristy: *So there's making [unclear] connections with the class connections now and in the future with*

Isabelle: *The future one is really good because something - I read here something about the boomerangs. The actual development of the helicopter was based on boomerang models. Like how much value does that put on a traditional science and understanding when a technology that we use quite frequently here was based on that? So it's really - you feel good about teaching it rather than nervous about teaching it.*

Renee: *Yes, that's important - it is.*

Isabelle: *For me it is.*
Meeting 3, Cycle 2.

Reflexive analysis

The above conversation was, to me, one of the most significant conversations of the project as a whole and was reflective of the epistemological concerns some teachers had. Isabelle expressed feeling comfortable with teaching a physics unit using Indigenous 'simple machines', such as spears, woomera, digging sticks and boomerangs. She also expressed discomfort with using traditional Indigenous stories in her teaching.

It may be that Isabelle had not been able to reconcile her differing ontological and epistemological positionings, both in relation to being a Christian and a scientist, to be able to feel comfortable and confident incorporating Dreaming stories into her teaching. The idea of the knowledge systems (Western and Indigenous) working together, through showing how Indigenous people used the basic laws of physics, seemed to appeal to Isabelle. She also expressed that she felt she would feel "chauvinistic" using Dreaming stories. I understood she meant it might seem paternalistic coming from someone with a non-Indigenous background. These concerns may come from not wanting to teach Indigenous people about their own culture and they seemed to speak to the concern of 'stepping on cultural toes' that she expressed in her Initial Interview. Again, this data align with other authors' findings around teachers' perceptions of including Indigenous knowledges and perspectives in their classroom practice (see Harrison & Greenfield, 2011; Kanu, 2011).

It seemed that the idea of this inclusion into the physics unit would allow Isabelle to find a starting point in working with Indigenous knowledges in her classroom, in a way that she was comfortable and confident with. As such, areas like this might be able to act as a launching point more broadly for teachers who are interested in the inclusion but lack the confidence and strong knowledge base to engage with more culturally sensitive areas. There is a dearth of literature about why teachers choose specific units of work for including Indigenous content and perspectives. However, Quince's (2012) research suggests that, as teachers engage in professional development programs aimed

at increasing their understanding of Indigenous knowledges/peoples/cultures, their reluctance to engage with such curriculum initiatives decreases.

While I was pleased at Isabelle's progress in finding an area she felt comfortable with, I was also concerned that she did not feel comfortable using Dreaming stories or engaging with the cultural side of the knowledge she was considering. While she considered the use of artefacts as examples to be culturally neutral, I considered that these things might be more than just implements used to hunt and gather food. Considering the holistic nature of Indigenous knowledge, it seemed likely to me that seemingly simple artefacts, such as spears, might hold more meaning. Without exploring the deeper cultural meanings of the objects, were the teachers lapsing into tokenism? Nakata (2011) contends that the Australian Curriculum asks teachers to normalise the presence of Indigenous content, not to present it as a novelty, token or add on. However, Harrison and Greenfield (2011) suggest that if 'add on' activities are supported by Indigenous people (Elders, parents and community) they may be an effective way of presenting Indigenous knowledge in schools.

Participants returned to discuss the possible inclusion of Indigenous knowledge into physics lessons later in the meeting. Cristy presented her concerns about lessons potentially conflicting with the beliefs of the students' families.

| Cristy: | *I think you run into a little bit of trouble as well. I know my daughter came home from school the other day and she did the whole "we stole this land", because that's what she'd been told at school. I find words like stole very, very negative. I think this needs to be a positive - it needs to be empowering. It needs to be embraced as a knowledgeable experience for all instead of...* |
| Renee: | *It can be very confronting to people too when - even just talking about invasion as opposed to colonisation, which is the language I tend to use most of the time, it's, some people do find it very confronting. When we start talking about stealing land and stuff, sometimes people put their walls up, which can make it difficult to* |

keep communicating with them after that.

Cristy: *That's exactly right. I think it's, when we start talking about history, it's really something that we need to be careful about because we don't know what the message is being taught at home either. Someone educated like myself, I can handle the whole when my daughter came home and said about stealing. I said "hang on, we didn't steal anything." This is how it happened back then. It wasn't just our country that - the Aboriginals' country that was invaded. There were lots of countries that were invaded and that was what happened in that time. Was it the right thing to do? No. But that's what happened in that time, you know? I can deal with that but a lot of parents aren't educated the way that we're educated on those issues and how to communicate those issues. So I know if - excuse me - I said that to some of the boys at our school and they went home and conveyed that message at home there would be a - it wouldn't be consensual. I'd say it'd be very much conflicting with what the thoughts are at home. So - and talking about - I think that's what you said Isabelle, these forces, it's not confronting. It's not conflicting. It's not - it wouldn't create - it doesn't create tension.*

Isabelle: *No.*

Cristy: *It doesn't at all. Whereas there are some issues that - sorry, not issues. There are some knowledges and information if presented would cause tension and conflict.*

Renee: *Yes.*

Isabelle: *Yes, absolutely. I don't feel equipped to be able to deal with that conflict in the right way. So currently my strategy is to avoid it and to find good topics like this until I've had some professional development and an idea as to how to tackle it.*
Meeting 3, Cycle 2.

Reflexive analysis

This part of the meeting showed how contentious the idea of including Indigenous knowledges and ways of knowing in the classroom were seen to be by some of the group. While all members of the group had expressed (though their willing involvement and previous interviews and meetings) their understanding of the importance of the CCP, it seemed their confidence in the community also seeing this was low. Their own critical understandings of conflict around colonisation/invasion were lacking and as a result they found the idea of teaching that might link to this challenging. The idea that what was taught in the classroom might conflict with family beliefs and values seemed to

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be related to racist perspectives. While Isabelle and Sue had identified potential issues with presenting different spiritual views in their Catholic school previously (Initial Interview, Sue and Isabelle), the concern in this conversation seemed to be more connected to a perception of a lack of respect for Indigenous people and cultures on the part of the broader school community. Neither Isabelle or Cristy identified an evidential basis for this belief, it seemed to be more of an intuitive feeling. I wondered if their reluctance was linked to a lack of experience with critical perspectives on the histories of policies and practices impacting Indigenous Australians in their own education through schooling and university teacher preparation programs. Both in terms of how to model this type of teaching and a lack of full understanding of the issues involved.

With this potential conflict in mind, the physics unit became more attractive as a space for Indigenous knowledges to Cristy and Isabelle. Through showing students that Indigenous people had an understanding of what is constructed in Western science as physics, Cristy and Isabelle seemed to consider that they were showing Indigenous people in a positive light, while simultaneously avoiding any areas that may cause conflict between the teaching and family beliefs (and perhaps their own).

I suspect that this approach to teaching about Indigenous knowledges was also less challenging epistemologically and pedagogically for Isabelle and Cristy. The approach allowed these teachers to use Indigenous knowledges as specific examples in isolation from cultural meanings. In this way, the questions of why or how Indigenous knowledge is scientific did not need to be addressed. This meant less of a challenge to their own epistemological understandings of science as well as less requirement for change of their pedagogies. The likelihood of a less challenging response from students allowed Cristy and Isabelle to focus on teaching the fundamentals of the unit in Western scientific terms.

Reflection

With a clearer idea of where Indigenous knowledges might fit in the curriculum, teachers were able to consider what plans for implementation might be appropriate for their contexts. Considering all the possibilities put forward gave them a broad range of options for future planning. At the end of meeting 3, the teachers agreed to commence work on planning their units of work and considering implementation in the classroom. The exception to this was Allen, who had already started his classroom implementation (Cycle 3) and was continuing to plan what other topic areas he could work in.

Cycle 3 – Putting plans into action

Cycle 3 saw some teacher participants actualise their aspirations to include Indigenous knowledges in their teaching and grapple with epistemological questions in order to develop effective pedagogies. The active participant numbers dropped in this cycle as it came time to apply what we had learnt to classroom practice. Only Cristy and Allen moved from the conceptualisation stage to the actualisation of units and lessons. Other group participants had little to do with the project from this point. Isabelle and Sue became too busy in their school lives to attend meetings and apart from a final interview, did not contribute any more to the project. Karl was transferred away from the area before completing this cycle and I was unable to maintain contact with him.
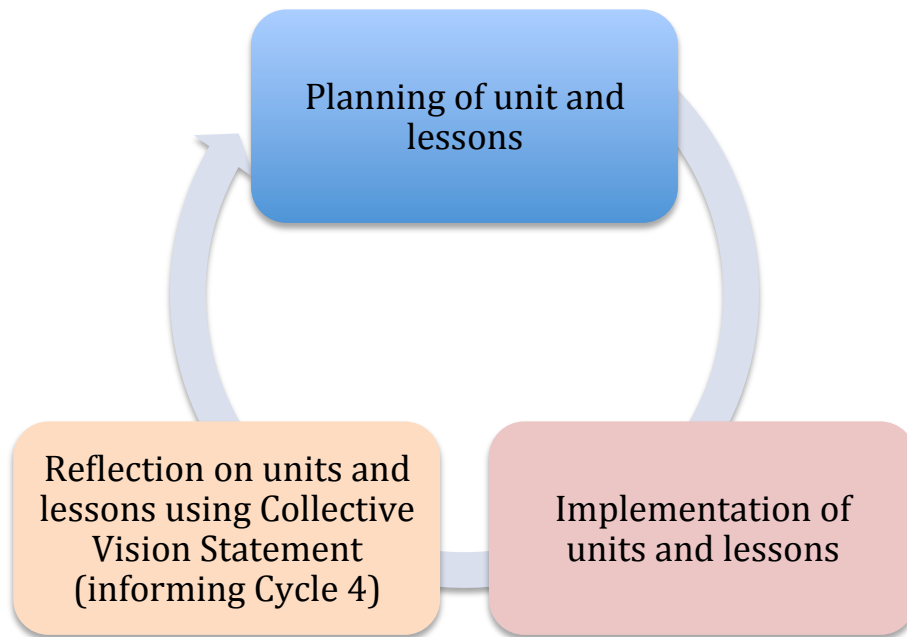
Figure 18: Cycle 3 - Putting plans into action

At the end of Cycle 2, Cristy commenced and Allen continued individual work to plan where Indigenous knowledges would fit in their unit and lesson plans. Allen acted independently in his school and was the only teacher there implementing Indigenous content. Cristy planned a unit that was offered to all teaching staff engaged in teaching Year 8 science. Both Cristy and Allen participated in a full day workshop where they presented the work they had been doing with their classes to each other and to me (and to Karl who attended for part of the day). Following each of their presentations, vigorous discussion took place around their teaching ideas, the students' reactions and their personal reflections. More of this data will be drawn on in Chapter 7.

Critical moment 5 – Allen's implementation

Allen chose to work with a unit on the classification of life for his initial classroom implementation. The students explored scientific (Linnaean) classification systems while also considering how Australian Indigenous peoples classified the world around them. Allen gathered knowledge about Indigenous perspectives on the topic through Internet based research and also engaged an Indigenous guest speaker to speak to the class group. Figure 19 includes two

PowerPoint slides from the accompanying assessment item showing how one student interpreted Indigenous ways of classifying and an Indigenous perspective on two species.

Figure 19: Slides from student assessment in Allen's classification unit

Allen also implemented a geology-based unit titled *Rock Never Dies*. In this teaching he considered an Indigenous perspective of the geological landscape and its cultural and economic significance and ownership. He focused on shared values and differences between Indigenous and non-Indigenous perspectives and looked at a case study of iron-ore mining rights and negotiations with Traditional Owners. The students were presented with a news article about mining taking place on traditional lands in Western Australia. Students were asked to consider what the Traditional Owners of the mining area stood to gain from a mining deal, what they lost and highlight some interesting facts about the article. Allen got the students to record this information on fish shaped charts as pictured in Figure 20. This activity sat alongside more usual classroom activities in relation to geological understandings as seen by the whiteboard shown in Figure 21.

Figure 20: Fish charts from *Rock Never Dies* geology unit
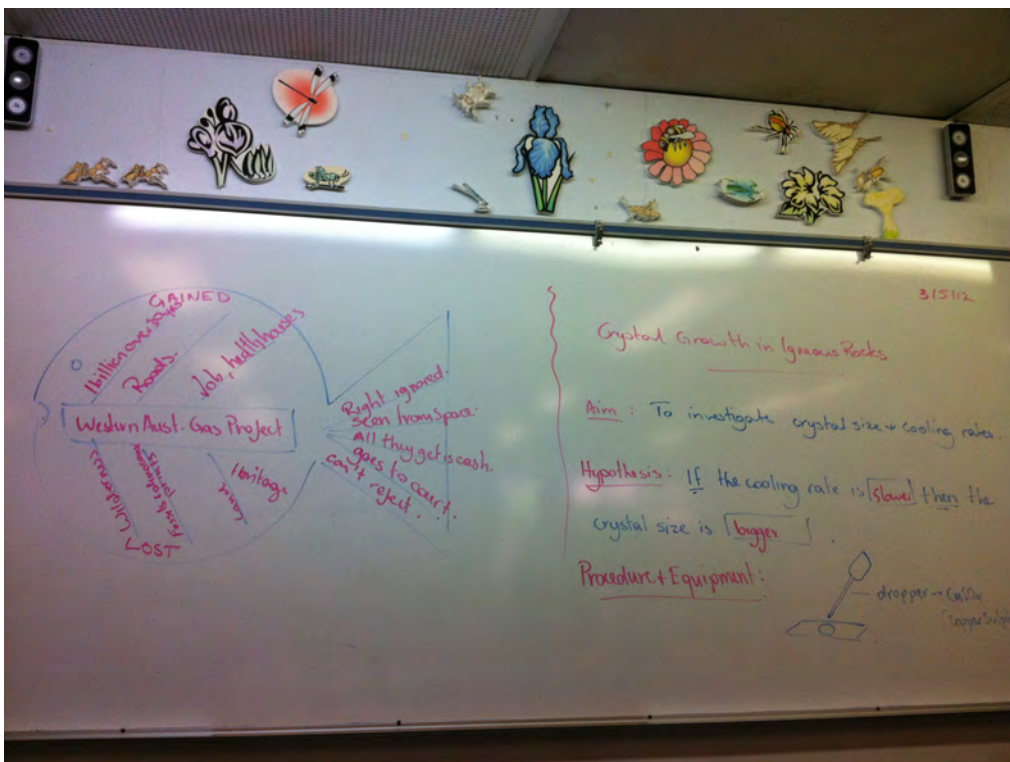
Figure 21: Whiteboard showing Allen's different pedagogical strategies

The use of rocks as Indigenous tools was considered from a practical and cultural perspective and Allen attempted a demonstration of stone knapping to construct tools as shown in Figure 22. The demonstration allowed him to show the students how difficult it was to construct an effective tool while allowing for scientific discussion of the physical characteristics of the rock.
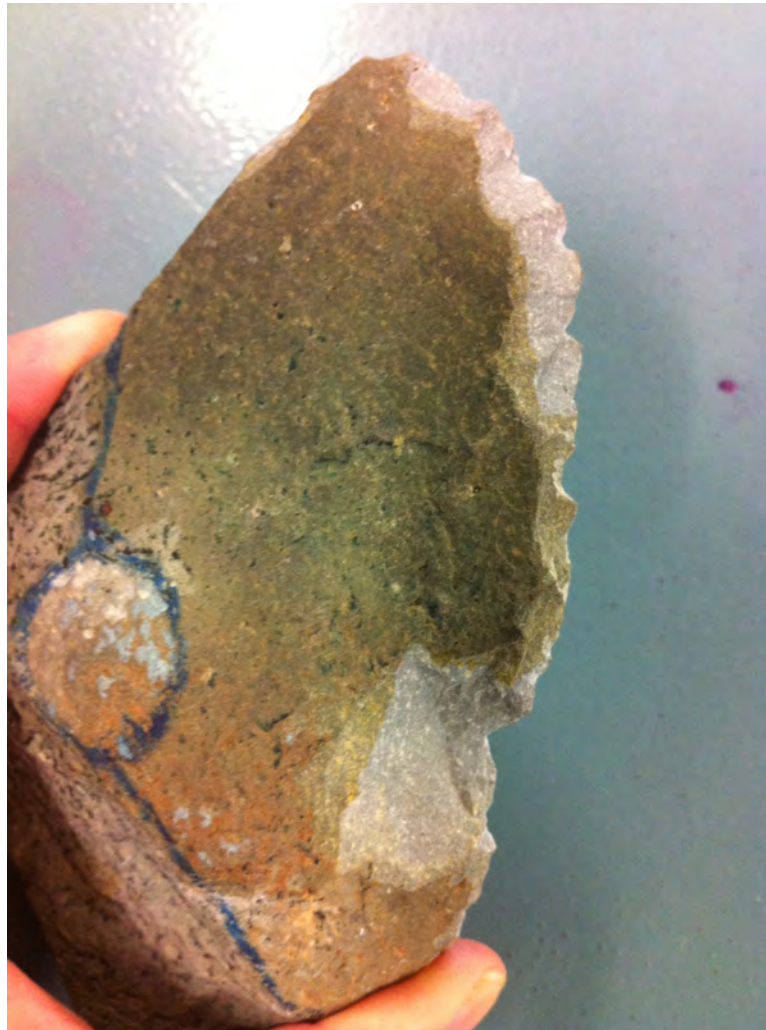
Figure 22: Demonstration of stone tool making for *Rock Never Dies* unit

Reflexive analysis

Through Allen's approach to teaching the above units, he again demonstrated a rejection of the banking model of education and embraced a model of teaching where he became both teacher and student. Freire (2009) suggested that problem-posing education is a humanist and liberating praxis, enabling "people

to overcome their false perceptions of reality" (p. 86). In this case, Allen's approach challenged his students' and his own assumptions about the nature of science through considering a different perspective on classifying the natural world and including cultural and social implications. Indigenous considerations of animals as direct relations to people and differences in classification of living and non-living elements of the environment challenged the students' ontologies giving more than just a Western perspective to science. Science was also socially and culturally contextualised through the consideration of the implications of mining on an Indigenous community. Figure 21 clearly shows how Allen situated teaching with Indigenous content and perspectives alongside other pedagogical strategies such as laboratory based activities. Allen showed no reluctance in presenting these differing pedagogical approaches and seemed to embrace the opportunity as a learning experience not just for the students but also for himself.

Allen's own knowledge increased through the learning process making it a constructivist teaching experience for himself as the teacher as well as the students. Much of the information that students uncovered about the Indigenous perspective on their animals was also new information to Allen. Teaching did not start from a point where the teacher knew what information would be uncovered or even necessarily where information would be accessed. Allen's praxis also demonstrates how the teacher being the producer of knowledge, in conjunction with their students, can resist the deskilling and 'dumbing-down' of curriculum (Kincheloe, 2008).

Critical moment 6 – Cristy's implementation

As was apparent in Cycle 2, Cristy's approach to how Indigenous knowledge could be incorporated into her science teaching differed significantly from Allen's. Cristy took a more structured, less exploratory, more content-based approach to her teaching. She also extended her teaching plan out of her own classroom and made it available to all of her school's staff teaching the same unit. This met with mixed success. One teacher used her plan and collaborated with

her to deliver his teaching program. The only other teacher involved refused to use Cristy's plan and completely omitted any Indigenous content from his teaching, preferring to teach straight from the textbook. This issue will be discussed in more detail in the Chapter 7.

Cristy's unit plan consisted of a four-week block; where one week was devoted to the topic *Forces of the Past* where Aboriginal simple machines were considered, as seen in Figure 23. The summative assessment item for this unit required students to produce a poster on their choice of six topics, one of which was Aboriginal simple machines, as seen Figure 24. Cristy reported that the Indigenous topic interested students with approximately one third of her class choosing it for their assessment.
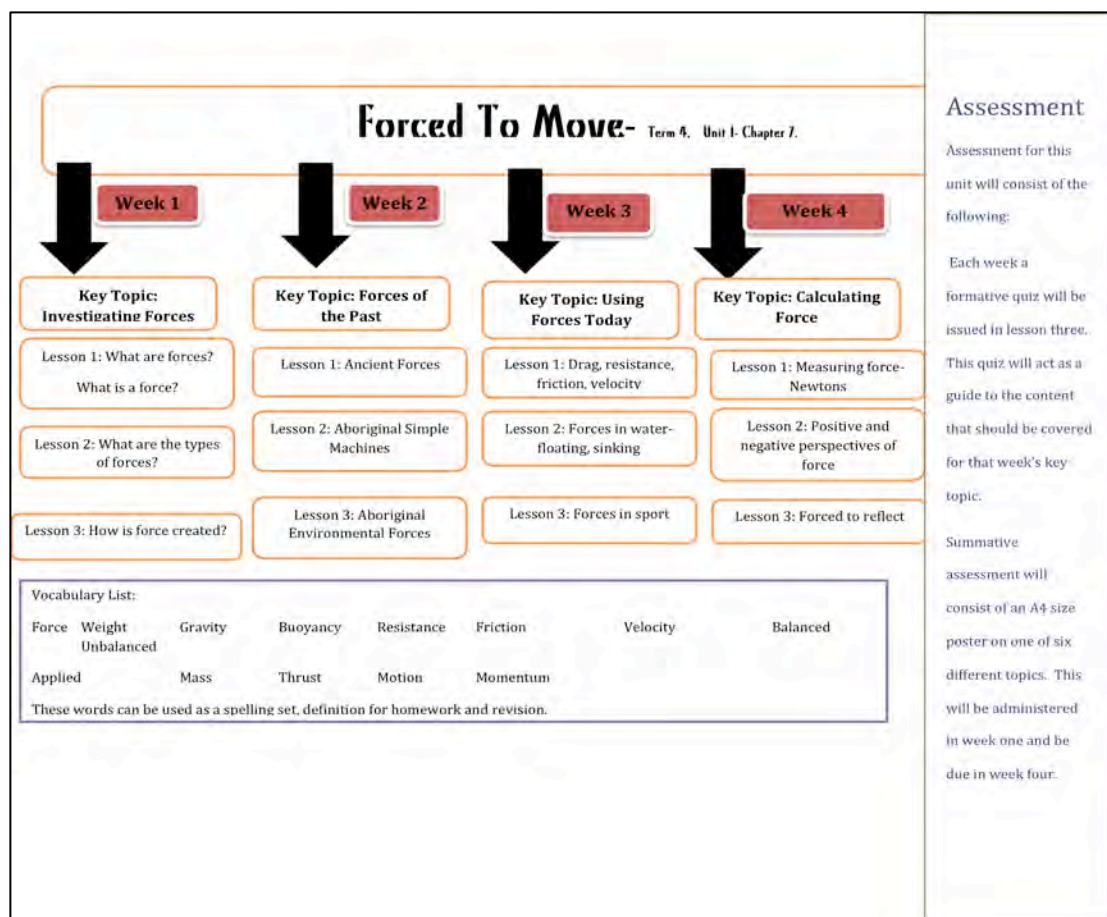
Figure 23: Cristy's *Forces of the Past* unit plan for Year 8

Figure 24: Assessment task for Cristy's *Forces of the Past*

Cristy's structured approach was also apparent at the Workshop Day in the way she chose to reflect on her teaching experience. While Allen's reflection was more of an intuitive response to his teaching, in order to judge her success Cristy considered how she had addressed the points from the Collective Vision Statement produced by the group in Cycle 1. She described how the other teacher (John) who had also taught the unit had found it a positive experience. A powerful part of the teaching experience for Cristy seemed to be in the interactions with an Indigenous student (Tom) who assisted in teaching the class and providing examples of artefacts.

Cristy described how her unit addressed point 1 of the Overall Vision, to bring an Australian perspective and offer something that all students can relate to. Through using examples of spearheads, axes and woomeras as wedges and levers she made connections "between the past and the present, connections between Indigenous Australians and other cultures" offering "an historical feel" (Workshop Day, Cristy).

She also considered her that teaching had addressed point 2 of the Overall Vision, to show Indigenous knowledge and traditional science drawing value from each other. She particularly saw this Vision through the impact of having the student, Tom, be part of the teaching. In the students' enthusiasm for Tom's teaching she recognised them valuing him for his Indigenous scientific knowledge. Tom presented his knowledge through integrating it with the scientific knowledge of the unit. He used Indigenous examples but described the science using Western scientific terms. Both Cristy and John noted the impact this had on Tom's confidence as well as an increase in his grades.

Cristy addressed Overall Vision 3, incorporating the local Indigenous community, through her connections with Tom. The knowledge that Tom presented came from his cultural connections with family such as his grandmother and grandfather. The artefacts he presented to the class, such as woomeras, boomerangs and digging sticks were related to his specific cultural knowledge. The impact on the rest of the class was large, with the students electing to stay in class into their lunchtime because they were so interested in Tom's presentation.

Promoting different ways of thinking about the world (holistic and critical), point 4 of the Overall Vision, was also addressed. Cristy reported that her approach to the unit provided "the perfect way of promoting that this is science and that we can work together, irrespective of where we come from and what we bring to the table, to pass on knowledge and critical thinking" (Workshop Day, Cristy). She commented that during and following the Indigenous content of the unit she did not get asked "how's this science?" by students, as she had previously. After Tom's lesson, students continued to relate further teaching back to the Indigenous perspectives presented.

Reflexive analysis

Cristy's self-reflection using the Collective Vision Statement is a good example of how participant analysis contributed to the understandings generated by the project. Her points led to extended discussion around how her teaching showed

the vision of science education that we had intended. While Cristy's approach was very structured, similar discussion occurred around Allen's contributions.

The approach to inclusion of the CCP differed markedly between Allen and Cristy. Allen concentrated primarily on what might be described as a 'perspectives based' approach. His work centred on understanding how Indigenous perceptions were similar and different to Western scientific understandings. Cristy's approach was more linked to content, but still had a constructivist pedagogical base. She built the Indigenous component into the content of the unit and used examples, artefacts and information from Tom to link to Western scientific understandings.

Cristy valued the "historical feel" that the inclusion of Indigenous knowledges brought to the classroom as well as the increased engagement of all students with the topic. This perhaps novel approach to teaching seemed to be a positive experience for both the teacher and students in this case. However, I was apprehensive about framing Indigenous knowledge as historical knowledge perhaps leading to tokenism. Harrison and Greenfield (2011) expressed similar concerns in their work with teachers and schools. However, Cristy suggested that she had avoided this by having an Indigenous student involved in describing and transmitting the knowledge and sharing his experiences of how to make the tools, giving more of a contemporary context to the lesson. The outcomes for the Indigenous student seemed to be very positive. The confidence, status and understanding the student gained in the classroom was strongly valued by both teacher and student. This translated into much improved grades for the student in this unit. As the researcher-participant I viewed this success as part of a liberatory praxis on Cristy's behalf through giving this student a voice in the classroom to showcase his cultural heritage. There were also liberatory components for the non-Indigenous students through valuing Tom's specific knowledge and critically considering the worth of Indigenous knowledges within the scientific realm.

Reflection

The teaching experiences and reflection time at the workshop gave Cristy and Allen a sense of having successfully implemented most of the goals set out in the Collective Vision Statement. They seemed to enjoy hearing and reflecting on each other's experiences and praised each other's work (again gaining Nourishment from their collective experiences). There was also recognition that this was only the start to their potential work in incorporating Indigenous knowledges. The final cycle of the project, Cycle 4, considered where Allen and Cristy wished to place their efforts towards sustaining the momentum they had gained in their work. For Cristy, part of this consideration was how to overcome some of the resistance she had encountered from staff in her school through Cycle 3.

Cycle 4 – moving forward

Cycle 4 focused on how Cristy and Allen might move forward with their work on including Indigenous knowledges in teaching when the project had finished. After their self-evaluated success in implementing their teaching plans in Cycle 3, it was important to keep the momentum of the work going and to make plans for the future. While the outcomes of these plans did not form data for the project, ending the project with thoughts for its sustainability and advancement was important to me as the researcher-participant. The opportunity for lasting change in teachers' praxis was apparent but it needed to be represented concretely through future planning.
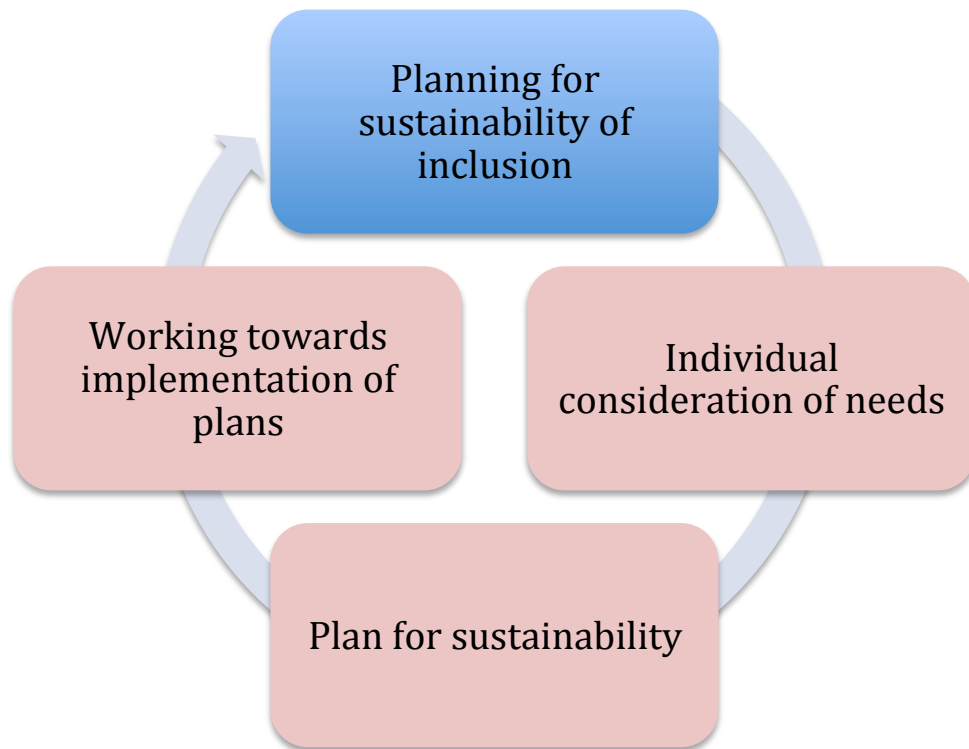
Figure 25: Cycle 4 - Moving forward

Both Cristy and Allen found areas specific to the needs of their schools to plan further work (Figure 25). Cristy planned to start by running a professional development day for all of the teachers in her school that captured her experiences of incorporating the CCP and offered some suggestions on how this might be done in other classrooms. Allen was part of a teaching team that was to work on a cross-curricular project with Year 8 students. This offered the opportunity to focus on an Indigenous topic and continue the connection between him and myself as a university representative.

Cristy had entered the project initially with the full support of the principal of her school. The principal had been the only school principal willing to meet with me to discuss the project in the participant recruitment stage and asked his staff if they were interested in taking part. Cristy responded to this request. When she approached the principal about running a professional development session for all school staff, he was supportive and said he was willing to allow Cristy to

conduct the session on a pupil free day. Cristy asked me to assist her with preparation and during the session.

Critical moment 7 – Cristy encounters resistance

Unfortunately, Cristy was unable to secure a date for the professional development session. Although supportive of the idea, when it came to setting a date and time for the session, the principal was less willing to commit. Other issues of the implementation of the new curriculum were given a higher priority. With an already crowded agenda for pupil free staff development days, Cristy was unable to get a commitment from the principal to actually run the session.

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Reflexive analysis

It was disheartening to see Cristy fail in her efforts to implement the planned professional development session. The idea had the potential to explain to the broader school audience what Cristy had achieved and the benefits she perceived had flowed to students in her class.

The initial commitment in principle and then the lack of actual implementation reflected the experience of some of the project's participants (discussed in more detail and with analysis in Chapters 6 and 7). Sue and Isabelle for example, were able to conceptualise teaching inclusive of Indigenous knowledges but did not end up implementing any teaching programs.

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Critical moment 8 – Allen's success

Through Allen's involvement in a cross-curricular teaching project, he was in a position that allowed him to take direct responsibility for the implementation of his future plans. The project, known as Year 8 Knowledge Production Skills (KPS), was a collaboration between teaching staff in the areas of Science, Mathematics, English and Studies of Society and Environment. The aim was to have the students produce a tangible outcome that reflected skills gained across

the subject areas. Students also had to collaborate with someone from an organisation outside of the school. In this case, that person was me, as a representative of the university.

Allen chose the students' project of producing a tourist style brochure of important sites of the local area from an Indigenous perspective. He worked through the semester with the students to choose appropriate locations to discuss, research background information and write and design the brochure (see Appendix 1). I provided support to the teachers and students through in-class sessions looking at Indigenous history and culture and monetary support for the printing of the brochure. With university colleagues I was able to secure a small grant for a research project that supported the students' work. Once the brochure was printed, the students held a presentation night. Each student took an active part in the presentation of their work to teachers, parents and friends.

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Reflexive analysis

Allen had a high level of motivation to complete the KPS project and really drove the initiative forward within the team of teachers. Allen's many years of teaching experience, reflected in not only a high level of pedagogical skill but also a confidence in his own abilities, probably made it possible for him to be successful in such a project. Allen needed little input from the other teachers or from me to make the project work. Again, his willingness to take pedagogical risks and work from a problem posing perspective resulted in a successful teaching experience.

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Conclusion

Teacher participants who were successful in implementing lessons with Indigenous knowledge in their classrooms took different approaches to the inclusion. While they completed the same cycles as part of the group, their experiences were shaped by their school contexts and scientific and pedagogical understandings. Cristy and Allen took different approaches to teaching but both

teachers designed lessons with constructivist-based pedagogies that involved active student engagement.

The reflective process of PAR allowed considered discussion about the impediments and benefits of the CCP in science education. The asynchronous nature of PAR in this project allowed teachers time to engage with developing an understanding of the positioning of the knowledge systems at their own pace. For Cristy and Allen, this was not a time consuming task and they were able to move on to classroom implementation. For Isabelle, Sue and Karl, this was more challenging and required longer consideration. This was a factor in no classroom lessons being implemented for these teachers. Chapter 7 details analysis of some of the factors that influenced how and if teacher participants implemented lessons inclusive of Indigenous content and ways of knowing.

Chapter 7: Epistemologies, Pedagogies and Politics

Social transformation necessarily involves negotiating new identities for both the collective and for individuals in society (Carson, 2005, p. 7)

Introduction
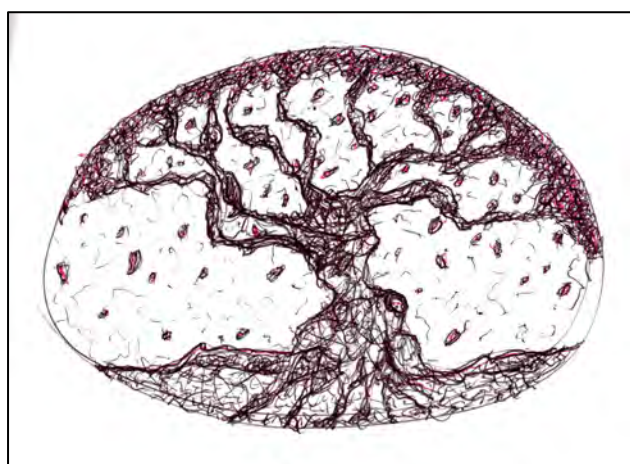
Figure 26: The Tree of Life (Desmarchelier, 2012c)

Chapter 6 reported on the process of the PAR and the outcomes of each cycle describing how each participant engaged in the project and the outcomes for the teachers who implemented their planned teaching activities. Chapter 7 contains an analysis of all of the project's data, still with a focus on the *Little Stories* of teachers' participation. This chapter completes the cyclical metaphor of the Tree of Life (represented in Figure 26) by considering the analytical side of the teachers' actions in the classroom and how this may be important for understanding how teachers engage with epistemologies they are unfamiliar with. The wholeness of the project is described in the recognition of the multiple factors implicated in teachers' progress through the cycles of growth and change. Teachers' were operating in the protection of the shade of the Tree to enact socially just pedagogies and open their praxis to the challenges that faced them.

Analysis of the project's data showed three general positions held by the teachers. These positions related to if and how the CCP was implemented and

the ways in which Indigenous knowledges were presented in teaching. The positions were:

1. Teachers were interested, but did not follow this interest through to classroom implementation. These teachers were engaged enough with the idea to join the project but for various reasons did not manage to plan or implement teaching containing Indigenous knowledges or ways of knowing in the classroom. Sue, Isabelle and Karl took this position.
2. Indigenous knowledges formed part of teaching in terms of content, primarily as examples used to support Western science. Cristy took this position.
3. Indigenous knowledges and ways of knowing were presented as different and valid ways of knowing in the science classroom. Allen took this position.

These positions can be linked to three emergent analytical themes of epistemologies, pedagogies and politics. This chapter proposes that there is an interconnectedness of these three themes as represented in Figure 27. In order for the CCP to be implemented in what could be considered a successful way, all three areas need to be addressed and reconciled.
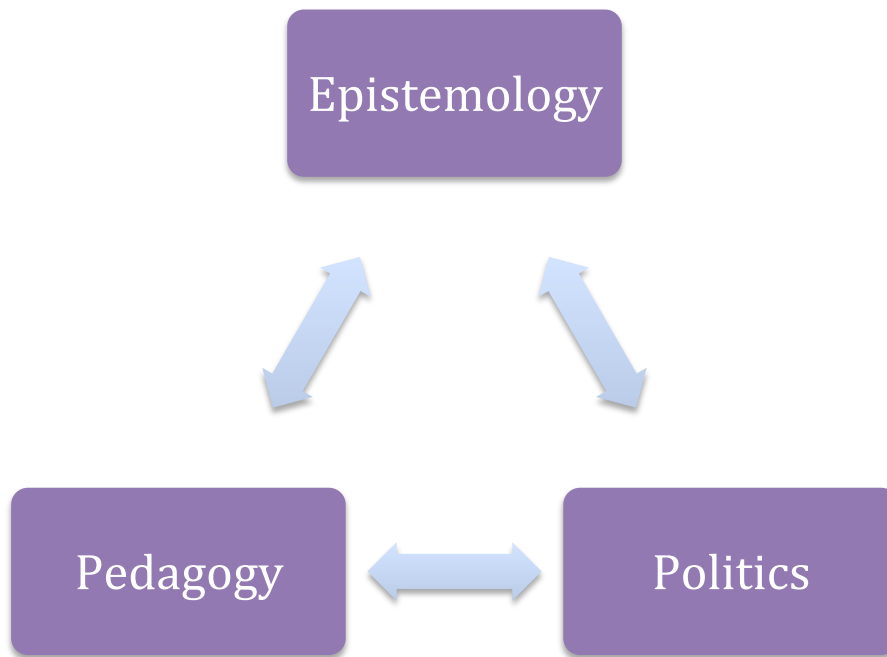
Figure 27: Epistemology, pedagogy and politics in the positions of the teachers

Defining positions

The three positions of teachers were well supported by data throughout the length of the project. Data were collected over approximately 12 months of project work. During this time, the group started from a united position (as seen from the Collective Vision Statement, Cycle 1), with a commitment to implement the CCP in their own schools but by project completion only two teachers had done so. These teachers, Cristy and Allen, did so in different ways reflecting their differing perspectives related to the emergent themes of epistemology, pedagogy and politics.

The teachers taking Position 1 did not seem to be able to overcome the perceived problems of incorporating the CCP as outlined in Chapter 5. At the end of the project, Sue and Isabelle were still cautious about "stepping on cultural toes" and did not find time to commit to developing effective teaching strategies. Although Sue, Isabelle and Karl did not implement any classroom work, progress was still made towards understanding how this might be done. The following transcript from Individual Discussion 1 with Isabelle, reflected her position at the end of

the project as she did not make any more progress towards implementation from this point.

Isabelle: *We are kind of being forced* [through involvement in the project] *to actually think about it. Because if I didn't have this meeting I wouldn't have looked this up and I wouldn't have realised what a great opportunity this would have been* [referring to a forces unit] *to put my Indigenous perspectives into my science classroom in a really interesting way, in an empowering way for Aboriginal and non-Aboriginal people. So, I think it's great. There's a lot that we can gain from it. I think getting to the meetings and the troubles that you're having and I'm pretty sure you are going to continue to have, I think they're a good kind of metaphor for what's going on with this as well. Because we all have great ideas and we all want to do it but it's just, is it realistic at the moment? Who knows?*
              Individual Discussion 1, Isabelle

As discussed in Chapter 5, the emergent theme of time was a concern for some of the project participants. While Isabelle made progress in understanding how Indigenous knowledges might be incorporated into her teaching, she did not overcome her perceived problems around finding the time to commit to planning units and lesson with Indigenous content. While teachers occupying Position 1 still understood the importance of the work in the ways described in the Collective Vision Statement, the convergence of epistemologies, pedagogies and politics did not result in a change in their classroom praxis.

Cristy displayed Position 2 of using Indigenous examples to support teaching about Western Science. As per the data presented in Chapter 6, from Cycle 3, Cristy implemented a unit on forces including a focus on *Forces of the Past* with Indigenous content. The use of the examples of Aboriginal simple machines showed how Western scientific concepts were demonstrated by the use of Aboriginal artefacts such as digging sticks and woomera. Cristy reported on involving an Indigenous student in the presentation of the artefacts and

information and identified the student's use of scientific words and concepts to describe these. While the teaching had Indigenous content, this was used primarily to support a Western scientific perspective.

Allen took Position 3, presenting Indigenous knowledges as alternative but equally valid ways of knowing in the science classroom. This was best exemplified (as reported in Cycle 3, Chapter 6) through comparing and contrasting Indigenous and Western ways of classifying the natural world. In this unit, Allen was comfortable with discussions around fundamental differences between ways of knowing, such as what could be considered animate.

All three positions can be analysed through the emergent themes of epistemology, pedagogy and politics involved in teachers' progress through the project and chosen methods of implementation of their teaching praxis. Through examination of the differing positions and the interconnectedness of the themes, suggestions can be made about how to encourage and support teachers to implement the CCP.

Epistemology – Using a post-formal lens

The post-formal approach to understanding epistemology proposed in Chapter 3 can be used to analyse the project's data. This approach combines perspectives from personal, scientific and critical epistemological approaches. At the commencement of the project, impediments related to scientific epistemologies were identified in terms of understanding how to 'fit' Indigenous and Western ways of knowing into a teaching program. Similarly, the critical intent of work was identified in the Collective Vision Statement in terms of the overall vision and hopes expressed which could be related to the teachers' critical epistemologies. Teachers' pedagogical approaches may link to their personal epistemologies.

Isabelle presented as an example of how a teacher's scientific epistemology could make it difficult for her to formulate a plan as to how to implement the CCP. From the beginning of the project she expressed concern around Indigenous mythology connected to Indigenous knowledge not being scientific and cutting Indigenous ways of knowing "into bits" to present in the classroom (see Chapter 5). Isabelle did make some progress toward seeing how she could reconcile her epistemological conflicts around Indigenous knowledges becoming part of science. Through the less (politicly) confrontational suggestion of a unit on forces (see Chapter 6), Isabelle found a way to start conceptualising a pedagogical approach she felt comfortable with epistemologically. Isabelle's conceptualisation of a forces unit approached Position 2 of using Indigenous examples to support Western science, shown by Cristy, but she did not move to the implementation stage.

Isabelle described the pressure she felt to just get something planned to teach in the classroom (Chapter 5). This resulted in her adopting more teacher-centred pedagogies in order to feel that she was covering all of the necessary curriculum content. As such, she showed more reliance on the 'banking model' and less on constructivist based instruction. As such, Isabelle's personal epistemology seemed to approach a realist position described by Schraw and Olafson (2003) as deploying a pedagogy of direct instruction. However, her intent in conceptualising a unit on forces was to take a contextualist approach, which Schraw and Olafson described as more concerned with the co-construction of knowledge between teacher and student. Cristy displayed that type of contextualist approach in her *Forces of the Past* unit.

Both Isabelle and Cristy found an epistemologically (scientifically and critically) safe space through the use of Indigenous examples in teaching about forces. Work on this unit allowed a celebratory approach to Indigenous knowledge. Through using examples that sought to explain the everyday use of artefacts by Indigenous peoples through a Western scientific lens, Cristy broke down the dichotomy between Indigenous knowledge and science. Western science was still privileged through this approach but students explored how, even in the

absence of something called science, Indigenous peoples were able to understand and put to use scientific principles. Cristy rated the success of her forces unit through students being able to describe the actions of Indigenous artefacts through Western scientific terminology, rather than through cultural significance. Cristy and Isabelle found that resources on this topic were easy to find and had some previous experience through their own educative experiences of these objects.

Isabelle: *The other thing with Indigenous tools, like there are certain parts of Aboriginal life that are more well known and therefore you feel more confident with. Like, I don't know anything about ochres, I really don't, and when Sue suggested that, she's like "oh, we could do that!" I'm like, that sounds like so much work. Because I know zero about that. So, chances are it's not going to be taught properly in my class. Whereas, spears and boomerangs, we all know about spears and boomerangs and we know how they work. So I'm more excited about a unit like that because I've already got some grounding knowledge. I don't have to teach myself from scratch.*
Individual 1, Discussion Isabelle

For Isabelle, her approach to a physics unit meant that it was not necessary to spend as much time on preparation and developing her own understanding as she was drawing on pre-existing knowledge. This went some way to negate her concerns around the time available to prepare teaching but did not result in her actually getting to the stage of implementing new lessons in the classroom. The challenge of finding the time for personal epistemological and pedagogical change remained unresolved.

In Isabelle and Cristy's approach to a forces unit, there was no perceived necessity to engage with the different ontological and epistemological roots of the knowledge being presented which meant there was less challenge to the authority of both Western science and the teacher themselves. Once the teacher had gained the content knowledge necessary, lessons could be planned and

taught. Epistemologically, this approach required less work in terms of negotiating Western and Indigenous ways of knowing for both teacher and students and therefore consumes less time in lesson preparation.

In contrast, Allen confidently presented Indigenous knowledge as an alternative epistemic position. Through the implementation of his unit on classification (see Chapter 6), Allen clearly engaged with and promoted a way of knowing that is different from Western scientific knowledge. In this unit, students were shown that there are other ways of naming the natural world that did not equate to Western science. This was achieved without placing a value judgement on knowledge from non-Western backgrounds. Therefore it challenged students to consider their own epistemic stance. Pedagogically, this approach suggests Allen worked from what Schraw and Olafson's (2003) described as a relativist personal epistemology where the primacy of teacher's knowledge is not emphasised and students are encouraged to think and learn independently.

Allen's approach aligned with a cultural interface positioning of knowledges (Nakata, 2002, 2010). Presenting differing ways of knowing and naming the world recognises the discontinuities and convergences of the cultural interface while showing an appreciation and acknowledgement of the presence of Indigenous and non-Indigenous standpoints (Nakata, 2011). Allowing the two knowledge systems to sit side by side without competition also connects with the multilogical epistemic stance described by Kincheloe and Steinberg (2008) as being necessary to non-Indigenous peoples' understanding of Indigenous knowledges. This way of framing the CCP shows direct contributions to the *Intercultural Understanding General Capability* through allowing students to engage in a range of ways of understanding and languaging the world (Nakata, 2011).

The opportunity to 'name the world' (Freire, 2009) from other than Western knowledge systems also contributes to L. T. Smith's (2012) Indigenous project of 'naming'. L. T. Smith connects to Freire's work and suggests that in an Indigenous context using Indigenous names for places and contexts allows

people to "name for their realities" (p. 157) and "retain(ing) as much meaning as possible" (p. 157). In this case, considering Indigenous ways of knowing and naming (even if the Indigenous language has been lost) allows for a consideration of ontological realities and challenges epistemologies in the classroom for both students and the teacher. Allen extended this approach in the final cycle of forward planning (see Chapter 6). Through considering the local landscape through an Indigenous perspective, teacher and students were engaging in a project that epistemically challenged the Western way of understanding their community and again engaged in a multilogical approach, which placed value on both ways of knowing.

Allen and Cristy displayed differences in their scientific epistemologies and understandings of the nature of science that may explain their different approaches. Fundamentally, they had conflicting understandings of what science is. This led to a difference of opinion between them as to whether Indigenous knowledge could be classified as science, or not. Cristy's stance that Indigenous knowledge is science justified her use of Western scientific terms in relation to Indigenous knowledge presented. Allen's perspective that Indigenous knowledge is a different way of classifying the natural world was manifest in the multilogical epistemological presentation of classification in his class.

Data from three points in the project shows Cristy's epistemological position on what constitutes science. Firstly, in the initial interview Cristy identified her approach to science:

Cristy: *And I think, well I love science, I question everything. And I think you're scientist if you question how something works, if you question why is that red. You know. I think if you're asking questions you're scientist. It is depends on what sort of level.*
            Initial Interview, Cristy

The identification of science as being about asking questions (about the world) shows a broad understanding of the nature of science and links to a scientific

epistemology that is not narrowly defined. The position shows an acceptance of science being present in everyday life not just in the realm of the professional scientist. It is possible that Cristy's stance reflects a critical realist scientific epistemology which Cobern and Loving (2008) described as understanding that some elements of knowledge are socially constructed but not seeing science as locally based.

The second point is the project displaying Cristy's epistemological understanding of science was the actualisation of her *Forces of the Past* teaching unit. Positioning science as part of everyday life allowed Cristy to easily make connections between the scientific concepts related to forces and the experiences of Indigenous peoples using specific artefacts. Her broad conception of the nature of science allowed assimilation of scientific aspects of Indigenous knowledge into a science educational context. However, the cultural aspects of the knowledge were not included, meaning that the Indigenous examples included were seen from a scientific epistemic basis rather than from an Indigenous or multilogical one.

The third point in the project was evident in a discussion between Allen and Cristy about the success of their endeavours:

Allen: *I said, oh anybody else looked at this thing that we got on the internet about Aboriginal perspective in science and someone said, Aboriginals don't do science. I actually was in agreement at the time, but I was looking for something and I thought - and the more I thought about it, the less I'd say, well it's not classic science, but...*

Cristy: *But what is classic science?*

Allen: *But, at the end of the day, this is working, this is going to work on a much broader - it's going to be more successful than I ever thought. I think it's going to give you your cultural understanding and appreciation of Aboriginal knowledge, but I also think it's going to give us engagement on a level that - I think really to sell it as this is going to work for our Indigenous students. It's going to give us a feeling of*

belonging to a knowledge that people have got things to share. They might have come at it from a different way, they might not have come at it from a scientific method, they might have figured out fish, through generations, figured that this type of spear works, that this type of fisherman, because of course we've got this problem…

Cristy: *Can I just object to that, because science is about observations, it's about making a prediction and then observing - making observations on that actual - on that prediction. That's what we do, that's what science is. Even looking at - with all the food and everything, these people, not just Indigenous Australians but tribes and different groups of people all over the world, that's what they do, is about trial and error. It's about making a prediction. What's going to happen if I do this? Okay, that's not going to work. What's going to happen if I do this? It's just not documented in a Westernised or a European way that we call science. If we're asking the question why and they would have been doing it in their own language and saying, well this happened because of this, didn't happen because of this, it's still science, because it's inquisitive and it's explaining the world around them. That's what science is, in my opinion.*

Allen: *Yeah, I know what you're coming from, but I think as far as wanting to define science*

Cristy   *Well obviously we define science differently.*
          Workshop Day

The idea of what science education should be often comes from a belief that if professional scientists do X and Y then science learners should learn to do the same (Russ, 2014). Russ contends that this sets up an *a priori* definition of what science is that defines the contexts and problems of what science can be. Allen's conception of 'classical science' could be seen as coming from this base, perhaps influenced by his former scientific career as a geologist. The result of this scientific epistemology for Allen was that he was unsure as to if Indigenous knowledge could be classified as science. Cristy however, was able to fit Indigenous knowledge *a priori* into her scientific epistemology as her definition

of scientific contexts and problems was very broad and included everyday life situations that she did not see as confined or defined by culture. In some ways, Allen used Indigenous knowledge to challenge the normativity of a "classical science" based epistemology. Indigenous knowledge was used for other epistemic purposes related to critical epistemology and promoting the value of Australian Indigenous histories, cultures and peoples. In this way, Allen took an approach similar to that suggested by Ostman and Wickman (2014) that learning scientific epistemology is part of a Western based practice but does not necessarily have only scientific purposes.

It is difficult to define Allen's scientific epistemology from the project's data, in some ways he presented an epistemology of philosophical multiculturalism, as described by Corbern and Loving (2008), where he saw all knowledge as local and culturally situated. However, he also seemed to suggest there is only one way of 'doing' science related to scientific method as seen in the description of the Cobern and Loving's (2001) Standard Account of Science but does not deny the validity of other ways of knowing. Given the sophistication of his relativist pedagogical approach, it may be that he displayed a philosophical multicultural epistemological stance – meaning epistemological beliefs are taken as generalisable across domains as Schraw and Olafson (2003) suggest, not disrupted due to other factors as Kang and Wallace (2005) posit. To say with more certainty where Allen was positioned in this regard would have required data collection and analysis that was well beyond the scope (and intent) of this project. What is apparent is that Allen saw scientific and Indigenous explanations of the world as epistemologically different but equally valid and he did not have any trouble fitting this into his critical pedagogical approach.

Russ (2014) proposes a scientific epistemology for science education where science "is equivalent to constructing knowledge of and making sense of the world around us". This approach suggests decentralising the role of the professional scientist as the "arbiter of 'correct' epistemologies for learning science" (Russ, 2014, p. 392) and engaging in science education where the "motivation for and value of particular learner epistemologies is the productivity

of those epistemologies for constructing knowledge about the natural world"
(Russ, 2014, p. 391). Cristy's epistemic position approached that suggested by
Russ allowing her to classify Indigenous knowledge as science and show her
students the value of Indigenous knowledge in understanding the world.
Combining Allen's approach to using science for other epistemic purposes and
shifting an educative scientific epistemology away from a professional science
base may allow a version of science education that looks at other domains to see
how people engage in the task of making meaning about the world (Russ, 2014).
The possibility of a genuinely multilogical science education emerges, one that
has a critical epistemic base.

Through the process of examining their scientific epistemologies, both Cristy and
Allen also encountered challenges to their critical epistemologies. The process of
examining what science is and how it operates led to conversation considering
how they had been trained as scientists. There was recognition that the nature
of science is not discussed in the process of becoming a scientist (in Allen's case)
or a science teacher (in Cristy's case):

Cristy: *This is the thing though, Allen, is that even talking to Isabelle that day,*
           I just don't see how it would fit in and I think that would be - when
           we're talking about praxis - that is one of the biggest barriers because
           people don't go - like we come to our Westernised institution like this
           and we're almost...
Allen: *Well we're trained to think that...*
Renee: *They put your blinkers on for you.*
Cristy   *They do, like we're prepared that - they groom us to think and act a*
           certain way.
           Workshop Day

Recognising how knowledge is constructed is an important step in developing
critical epistemologies. Critical epistemology requires an understanding of
criticality beyond the neutralised understanding of the word as nothing more
than 'thinking skills' (McLaren, 2007). Critical epistemology involves the

interrogation of the production of knowledge taking into account political, cultural and historical dimensions.

Knowledge is never neutral or objective but ordered and structured in particular ways. As Mclaren (2007) acknowledges, "knowledge is a social construction deeply rooted in a nexus of power relations" (pp. 196-197). Critical epistemologies consider how and why knowledge gets constructed the way it does and why some knowledge constructions are considered legitimate and others are not. This then leads to questions like whose interests are served?, who gets excluded? and who is marginalised? (McLaren, 2007). These core epistemic questions began to become embedded in Cristy and Allen's thinking and manifested in conversations like the following:

Allen   *Yeah, but you know what I mean, I think when people say science, I think it's a way of investigation and you follow the scientific method. It's not to say there isn't any other knowledge, it's not to say that other knowledge is invaluable, it isn't us saying other knowledge isn't right, it doesn't say any of those things. I don't think science makes value judgments. In actual fact, when you think of science, it's a value free way of looking at the world.*

Cristy   *It proposes to be a value free way of looking at the world, which is a big difference.*

Allen   *Yeah, I know and of course we've got - yeah, I can understand arguments there, but I still think that I don't think - I don't know if Aboriginal people describe what they know as science, I don't…*

Cristy   *No and that's a good point.*

Allen   *They would say - they would describe it in other ways and they wouldn't - I don't know if you - if I was a Buddhist and I was looking at the world, I would say I'm looking at it in terms of Buddhism, it's not science but. Or if I was - you know what I mean? There is a different way. It's like this is the way we'll get - this is the way, we'll do this way. But still say, but just not share - I think the reality, for us here, is that we've got a way of actually showing value in knowledge and like I said*

earlier on, I don't think - knowledge is something that no-one really owns it. We can share it and I think it will give our students an appreciation of culture and of other people.
Workshop Day

The necessity for epistemological curiosity (Freire, 2005) in the process of developing units and lessons was apparent for both Cristy and Allen. The necessary negotiations between the knowledge systems resulted in them needing to give considered thought to how their own beliefs had been constructed. As Kincheloe and Steinberg (2008) put it:

> via a study of indigenous knowledge, Western scientists come to understand their work in unprecedented clarity. As they gain a critical distance from their scholarship, they also gain new insights into the culturally inscribed Eurocentrism of the academy and the politics of knowledge in general" (p. 153).

For Cristy in particular, there was more critical awareness in conversations such as the transcript above than there was early in the project. For example, Critical Moment 1 (Chapter 6) describes Cristy's concerns around "political correctness" and how she considered herself to be an "Indigenous Australian". This type of language and understanding seemed to be altered by the end of the project as evidenced through the above transcript where she recognised the social constructedness of knowledge. In addition, in discussion with Critical Friend Dianne at the Workshop Day, she recognised the need for non-Indigenous teachers to engage with Indigenous knowledges in order to improve outcomes for Indigenous students. Previously Cristy had specifically stated that she was not concerned about the importance of the CCP specifically for Indigenous students, instead focusing on its good for all students. This progression apparent in the data, may show Cristy's conscientization, related to developing a critical epistemology, through the project.

Kincheloe (2010) argues that developing a critical epistemology is grounded upon an appreciation and respect for subjugated knowledges. Both teachers

displayed these qualities that manifested in classroom teaching challenging students to think differently about their world. As reported in Chapter 6, both teachers reported positive student responses from the teaching that they assert helped to develop respect for Indigenous peoples and cultures. Critical epistemologies led to critical teaching practice that evidently impacted on students who engaged and valued the different knowledges being presented. In this way teaching practice led to teaching praxis, with the teachers describing the following impacts for students:

Renee   *How do you think that sat with the students in terms of understanding cultural differences and race?*

Cristy   *I think once again it got - the Sudanese boy talking about well in Sudan, to keep cool we - everyone was willing to listen...*

Allen   *It opens up and it makes people think, oh there's value in that and there's value in you and value in - I think it does, it opens that, it's like my Congolese boy and my Indigenous boy, they - it was like a recognition that, oh I've got something to say about this from my standpoint.*
            Workshop Day

Although Cristy and Allen approached science and working with Indigenous knowledges from different perspectives and pedagogies, both teachers engaged in a conceptualisation of education that promoted dignity, self-determination and survival of Indigenous people (Kincheloe & Steinberg, 2008). As Nakata (2011) attests, from his standpoint as a Torres Strait Islander man, "our presence cannot be denied and nor can our contribution to the fabric of Australian history, culture and environment. We cannot simply be relegated to the history and social studies curricula as remanets of the past" (p.6).

Pedagogy

Cristy and Allen's differing scientific epistemologies resulted in different pedagogical approaches to unit and lesson construction. Cristy included Indigenous knowledge as content in her lessons; whereas Allen presented differing worldviews related to knowledges and content in more of an Indigenous perspectives approach. While Cristy embraced the opportunity to engage in a critical way with students around Indigenous knowledges, the content approach to pedagogy could lead to Indigenous knowledges being presented as token or an add on to the curriculum. Nakata (2011) suggests that both content and perspectives have important places in the curriculum. A perspectives approach that acknowledges different histories, knowledges and experiences needs to be present in the delivery of content. This helps normalise the presence of Indigenous content but is much more difficult for teachers as it "presupposes that teachers know and can transmit these perspectives" (p.7). Nakata also recognises that difficulties exist at a schooling system level as the approach involves "an appreciation of the partial nature of knowledge and the different investments in various positions that come out of our different histories, knowledge and experience" (p. 7). These may not always be present within a particular school.

Teacher participants' understandings of how to approach the CCP were not always supported within their schools. Cristy encountered resistance to her pedagogical (and perhaps epistemological and political) approach from another teacher involved in teaching the same cohort of students. As shown in the Chapter 6, Cristy had prepared a unit of work on physics complete with assessment and lesson plans. This unit was taught only by one of the other two teachers involved in science teaching at that year level. The teacher who chose not to teach the unit, as Cristy had designed it, cited concerns framed pedagogical about the topic not being taught as text books prescribed:

Cristy   *This is where I got really, really angry, was when I went and approached the teacher that didn't engage in what - because like I did the whole unit up for the other teachers and I put it on their desk before the start of the term and let's just say, okay this is what we're doing this term, can you - this was before this term, so last term I put it all together, a whole thing, lesson by lesson. I think there was 18 lessons so that I did up PowerPoints, I did up - I did all the research and he just point blank said to me, I'm not doing it because it's not in the textbook.*
Workshop Day

Cristy described the teacher as someone who had taught at the school for a very long time and who did not engage with technology (or even a white board) in his classroom and relied upon teaching direct from the textbook for all lessons. To this teacher, the approach may have presented pedagogical risks that he considered to be unacceptable. Combined with the need to take the time to develop understanding of the content of the lessons, the teacher did not wish to engage in the unit. Cristy related that the teacher removed all mention of Indigenous content from the assessment for the unit and proceeded to teach the content as he had been teaching it for many years.

As this example demonstrated, pedagogical change inspired by curriculum change contains inherent risks for teachers. Risk is a socially constructed phenomenon that different teachers will consider differently in terms of what is seen as a risk and to what degree (Le Fevre, 2014). In the case of pedagogical change that is linked to a specific political and epistemological context, and designed to have socially just outcomes, the perceived risks may be high. In the case of this project, the epistemological challenge to ideas of 'what science is' may act to make teachers feel vulnerable "as they must question the effectiveness of both their previous and current beliefs" (Le Fevre, 2014, p. 57). Added to this is risk around taking a critical pedagogical stance and encouraging students to consider their personal beliefs about knowledge and the value and importance of Indigenous knowledges.

For example, while Isabelle confronted her epistemological stance on how Indigenous knowledges could be part of science education, she was unwilling to take the pedagogical risk of classroom implementation. Throughout the project Isabelle had express concerns around "stepping on cultural toes" (Initial Interview) and "it not being done well in my classroom" (Individual Discussion 2) as well as concerns around how parents of students and her school may consider the inclusion of (Cycle 2, Meeting 3, see Chapter 6). The risks of a pedagogical approach that valued and promoted Indigenous knowledges were perceived to be high and acted as a barrier to classroom implementation.

Cristy and Allen took the pedagogical risk and produced lessons that, at a classroom practice level, were both challenging and enjoyable for students:

Allen   *I think it is, I really think it's going to be is something that will work lovely I think the Indigenous approach. I just like the fact that you can put your hand on this stuff and they can model it very quickly too. Like pretty much when you think, okay, we've got stone tools, alright, there are the stone tools, but we can go into all the wooden tools and the wooden tools are easily modelled, even if you don't get the model perfectly right, it's going to proximate it pretty closely. Let's face it, all boys like stone and fire, so normally they're pretty keen…*

Cristy   *The friction one.*

Allen   *They'd love to…*

Cristy   *There were boys with blisters on their hands.*

Allen   *Well that's right, I don't think it matters. I think at the end of the day there's some vehicles there that make what we teach very accessible and I'm starting to think, well maybe - it also brings in this idea that we have a deeper history here and so we've got a lot of human experience in this country. I don't think we've really allowed - it's a huge depth.*
           Workshop Day

The reference to "the friction one" and "boys with blisters on their hands" refers to a practical exercise trying to make fire through traditional techniques with two appropriate pieces of wood. (In this case, the woods were not actually appropriate to the task for occupational health and safety reasons and the blisters were ironically a side effect of this concern.) Allen particularly found that these types of hands on activities engaged students in the topics and made a critical pedagogy easier to enact.

Where desired outcomes are connected to the exploring issues such as the depth of human experience in this country, as Allen suggested, the role of learning in social change broadens the notion of the political and makes it more pedagogical. Giroux (1997) reminds us of the importance of recognising pedagogy in this context as cultural practice. Just as curriculum construction is political (Apple, 2004), so too pedagogy does not act from a neutral position (Freire, 2009). While the introduction of the CCP may be seen as prompting a necessary change in pedagogy for teachers, the approach they take to this pedagogical change could vary. Both Cristy and Allen recognised richness in the teaching experiences possible from a critical pedagogical approach. Their willingness to take this approach seemed linked to their political positions, which differed, to that of other participants who did not proceed to implementation.

Politics

A critical perspective holds that all choices about what knowledge is taught and how such knowledge is taught represents political choices (McLaren, 2007). Being political in this context, does not mean engaging in party politics or participating in the electoral process, but instead relates to recognising the power in our actions, thinking and social conventions (P. Carr, 2008). As Freire (1985) reminded us "washing one's hands of the conflict between the powerless and the powerful means to side with the powerful, not to be neutral" (p. 122).

For the teachers in this project, they needed to engage with politics on three levels. Firstly on a personal level, which could be related to developing personal critical epistemologies and the understandings of how what they were selecting to teach could engage in promoting social justice in their classrooms. Secondly on an institutional level, the reactions and responses of their peers and school leadership needed to be negotiated. Thirdly, the politics of curriculum change and the impetus behind the inclusion of the CCP in the first place had to be considered.

One consideration for teachers occupying the first position of being interested but not proceeding to classroom implementation was that of being seen to be political. Isabelle and Sue were aware that the students they taught held diverse views about Indigenous Australians. On occasion, both prior to and during the project, students had voiced opinions that could be considered racist. These opinions are not cited here as they fall outside both the scope and ethics approval of the project. Although these student opinions did not represent the attitudes of the teachers, they represented one aspect of teaching Indigenous content that presented pedagogical and moral issues for Sue and Isabelle. Isabelle saw the potential to change some of the students' attitudes through her pedagogy but the topic still challenged her sense of comfort in the classroom:

Isabelle   *But, it's really good and it hopefully will help with students' perspectives of Indigenous Knowledge because at the moment… The more I teach and the more every now and then I'll bring up something about Indigenous Knowledge or Indigenous ways of living and things like that. You can really see clearly that the kids have a whole spectrum of values and ideas about what Indigenous knowledge is and there is a lot of negative connotations in the classroom, coming from the students.*
            Individual discussion 1, Isabelle

Isabelle seemed to be expressing a concern around appearing to be political and taking a stance that might conflict with student and parent beliefs around

Indigeneity. Engaging with Indigenous knowledges may lead to discussions of Indigeneity and racism, and acknowledging the existence of racism in the classroom may disrupt a teacher's sense of self (Carson, 2005). Isabelle's reluctance to engage in political issues in the classroom was also apparent through her pedagogical approach to the selection of the physics unit as a potential (if not actualised) space for Indigenous content. Combined with allowing for her scientific and critical epistemological standpoint, working pedagogically in a safe space where she expressed comfort in confronting potential challenges from students also suited her political stance. Here we start to see the convergence of epistemology, pedagogy and politics.

Cristy made it clear from the commencement of the project that her primary concern was to provide good teaching and learning for all students. Cristy's position was shown in Chapter 6: "I didn't, and you know that's not, improved outcomes for Indigenous students. I think it's about improved outcomes for all students" (Cristy, Meeting 1). As such, her political concerns were about equity and reaching all students through her pedagogy to produce useful, critically engaged learning. This position acted as a motivation for her participation in the project and successful classroom implementation of teaching.

Allen was motivated politically through the consideration of the purpose of education. Previous to joining this project he had worked with students to produce a video presentation about what they saw as the purpose of education (Workshop Day, Allen). After the project, I assisted him with his student project on an Indigenous perspective of the local landscape. This demonstrated his previous and on-going commitment to education as an agent of social change. His consideration of his purpose as a teacher extended beyond teaching the content of his subjects to assisting the many low socio-economic status students he taught to engage effectively in education and consider their places in society. As such, Allen acted politically, taking it upon himself to enact pedagogies and teach content with a social justice motivation.

From my perspective as the researcher-participant, school level politics seemed to have little influence on Allen's pedagogy. As a very experienced teacher, he seemed to have a large degree of autonomy in the classroom. While his principal and HoD were aware of his participation in the project, they did little to either support or interfere with his work. The school principal did offer support to the project on Indigenous perspectives of the landscape and attended a presentation night where students spoke to an audience of family and friends about the brochure they had produced. This suggests that the principal supported the pedagogies Allen was using even if she had no direct involvement with his classroom practice.

There seemed to be little discussion or emphasis placed on the CCP in Sue and Isabelle's school. As HoD of science, Sue could have pursued the priority in the subject had she desired. Overall, the school had no position on the CCP and the school principal showed little interest in the project or Indigenous issues in general. In my initial conversation with him, he questioned if the school was an appropriate site for the project given that it had fewer than 10 Indigenous students enrolled. Due to the small number of Indigenous students there seemed to be no emphasis placed on Indigenous initiatives. This represents a particular political position that sees Indigenous issues in teaching as only important for Indigenous students. This position allows the political marginalisation of the CCP as unimportant and therefore not something teachers need to spend their time on. The Australian Curriculum documents clearly state the intent of the CCP is "Students will develop an understanding that Aboriginal and Torres Strait Islander Peoples have particular ways of knowing the world" (ACARA, n. d.-c, para. 6). Perhaps, for clarity, 'All' needs to be inserted at the beginning of this statement so it is clear that the curriculum initiative is not only for Indigenous students. This project worked from the position that Indigenous issues and therefore the CCP were important for all students, as outlined in the Collective Vision Statement (Chapter 6).

For Cristy, school level politics became the most challenging political issue. She encountered resistance to teaching Indigenous content from other teachers and

from management, despite initially having the principal's support. As cited in the pedagogies section, one particular teacher refused to teach lessons with Indigenous content. While he gave the reason of the content not being in the textbook and Cristy considered him to be an old teacher with out-dated attitudes to teaching, his refusal can also be understood in terms of politics. Not engaging with lessons designed with social justice intent is also taking a political position, as is not engaging with the requirements of a new curriculum. From Cristy's position, the school's and science department's politics became clearer when the HoD refused to intervene and direct the teacher to teach the content. Subsequently, when planning for the next school year, the decision was made by the HoD and supported by the principal, that there were too many other considerations in implementing the new curriculum to be concerned with continuing to pursue Indigenous knowledges and perspectives. While Cristy insisted "that this is part of the curriculum and you can't just ignore it" (Individual Discussion 2, Cristy), she was not successful in getting the CCP considered for the next teaching year leading to her conclusion that "the only person that values it [Indigenous Knowledges] there is me" (Individual Discussion 2, Cristy).

In the face of roadblocks at the level of the school, it was difficult for Cristy to make the changes to pedagogy that she desired. While she could still be responsible for some change in her own classrooms, as a beginning teacher she did not have much power to influence the institution's politics. If, at an institution level, the school held a political position that implementing the CCP was important from a social justice perspective, she would likely have been more successful in her efforts. While educational policies frame the possibilities for teachers and their pedagogies (Lingard & Mills, 2007), how these policies are implemented at a school level depends on the school and its management and the political position that is valued.

At the end of the 2011 school year, looking forward to the full implementation of the curriculum in 2012, policy level politics became Allen's most challenging political issue. He was uncertain whether the state education department would

allow him to design and teach his own units. In Queensland state schools are required to periodically undergo teaching and learning audits designed to place "a strong focus on key curriculum, teaching, learning and assessment practices at schools to improve education outcomes of students" (Queensland Government, 2015, n. p.). Allen's school had not achieved a good rating in their audit and was originally directed to follow mandated unit and lesson plans.

Allen   *There is a bit of uncertainty. Schools are rated. We have people come out and rate schools. The state schools, if you were given a certain rating, you basically have been told to follow the prescribed unit plans and work programs put out by the department. So I don't think that we'll be doing anything different in the near future. You can talk to some people, because I think it might be a bit - I don't know about the other people in the state schools, what they've heard and been told, but if you are not rated at the very highest level, the message has been - at least the message we've been told has been that you shall follow the prescribed unit plans that have been written for you.*

In some ways, it's a bit of a slap in your face, but in other ways, you think, well, it takes the guesswork out of it. It's not unfamiliar. In about 1980, they released programs called P-10 which is pre to 10 years. They did have all that stuff written in there in the documents they got before they cancelled it and started the next one. There were lesson plans. In numeracy and science, you went down to lesson plans if you wanted. They were given to you to use if you chose to. The school wrote their own programs, so the idea of schools writing their own programs to suit their clientele was the old idea. The research has basically flipped back and said, look, your clientele is not that different.

So the thing that we've been pushing for the last 20 years about your clientele being so different you all need different work programs is not really the case, that there is some local adjustment to be made but it's not significant. You could argue it's more so if you're in some remote

Indigenous community where they don't speak English so therefore English is their second language, therefore there is an extremely - and they'd probably say fine. I don't know the full politics of that, but really at the end of the day, we're being told this is how we're going to go ahead. We're using something called C2C.

Individual Discussion 2, Allen

Allen's understanding at this time was that the Curriculum into the Classroom (C2C) planning resources would be mandated for his school. These resources were aligned with the Australian Curriculum and provided by the Queensland Department of Education and Training. However, the mandating of C2C did not eventuate in Allen's school in 2012. While initially school leadership endorsed the use of the resources, they were found to be underdeveloped for the needs of the school and classroom and Allen was allowed to return to planning his own lessons.

These moves to impose pedagogy on teachers and schools can be read as part of a neo-liberal schooling agenda. Mclaren (2007) recognises the adoption of management-type pedagogies and accountabilities, linked to neo-liberal educational policies as actively promoting the deskilling of teachers. Further, Lingard (2010) sees the education policy in which a national curriculum was suggested as an "authoritative allocation of values, which means that ideology (values) is an important component part" (p.132). While Allen described potential benefits for teachers in reducing their lesson preparation time, the provision and imposition of pedagogies strongly suggests a lack of trust in teachers, thereby effectively de-skilling them by taking away the opportunity for them to express their own personal epistemology, pedagogy and politics in their teaching. The broader politics and policies surrounding the curriculum are discussed in further detail in the next chapter which considers the *Grand Narrative* of neo-liberalism.

Interconnectedness of epistemology, pedagogy and politics

I argue that in order for teachers to be successful in implementing classroom praxis inclusive of Indigenous knowledges in science education, all three areas of epistemology, pedagogy and politics need to be engaged appropriately. While I have considered each element of this interaction individually, there are clear connections between them. Critical epistemologies, influenced by scientific epistemologies that are commensurate, need to be enacted in order for critical pedagogies to occur in the classroom. Critical pedagogies rely on a personal political stance that motivates teachers to work in a critical way, a school political environment that allows teachers to enact critical pedagogies and, the national level political environment to produce policies that assist teachers to have legitimacy for their desired praxis. I now discuss each of the three positions teachers took in the project.
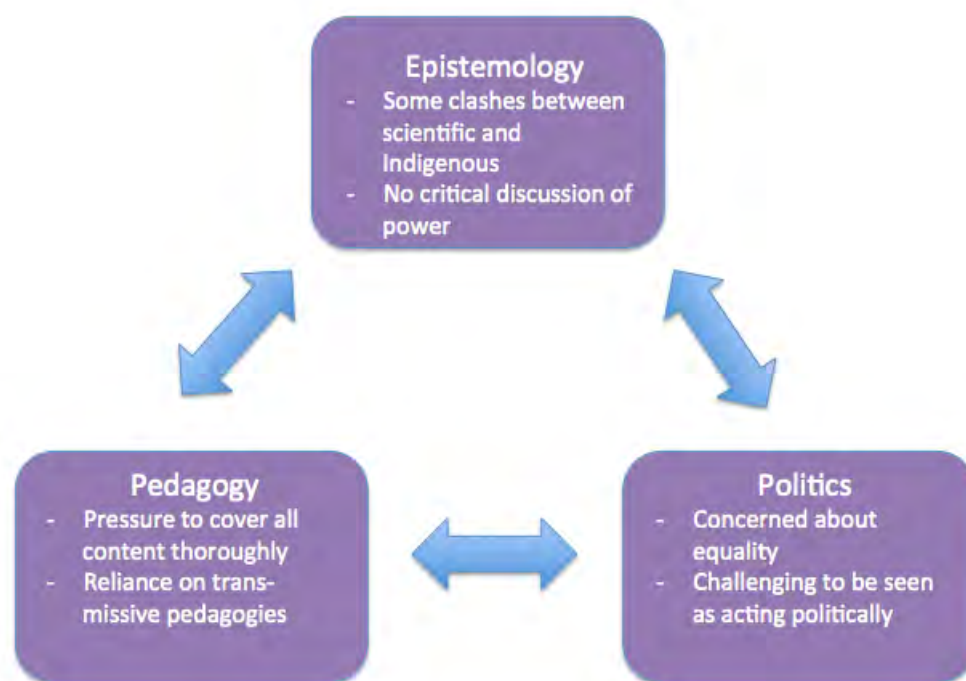
Figure 28: Epistemology, pedagogy and politics for teacher Position 1

Position 1, being interested in the project but not achieving classroom implementation, taken by Isabelle, Sue and Karl can be represented as in Figure 28. Initially, the teachers occupying this position had some difficulties reconciling their scientific epistemologies with Indigenous knowledges. There was also little discussion about the power differentials of working with different ways of knowing with these participants through the length of the project. While there was a concern for equity, to be seen as acting politically was challenging particularly in terms of what students and students' parents might think or say. Pedagogically, Isabelle in particular felt pressure to thoroughly cover all of the content required by the classical science side of the curriculum. This led to anxiety about the time available to prepare lessons with Indigenous content and the provision of lessons with largely transmissive elements.

In position 1 the epistemological position influenced the transmissive pedagogical approach, and the pedagogical approach reinforced the epistemological position. The lack of interrogation of power differentials influenced the political stance through not providing political motivation to enact a critical pedagogy. The result of the interaction of epistemology, pedagogy and politics led to an atrophy of good intentions in regard to the CCP and no classroom implementation.
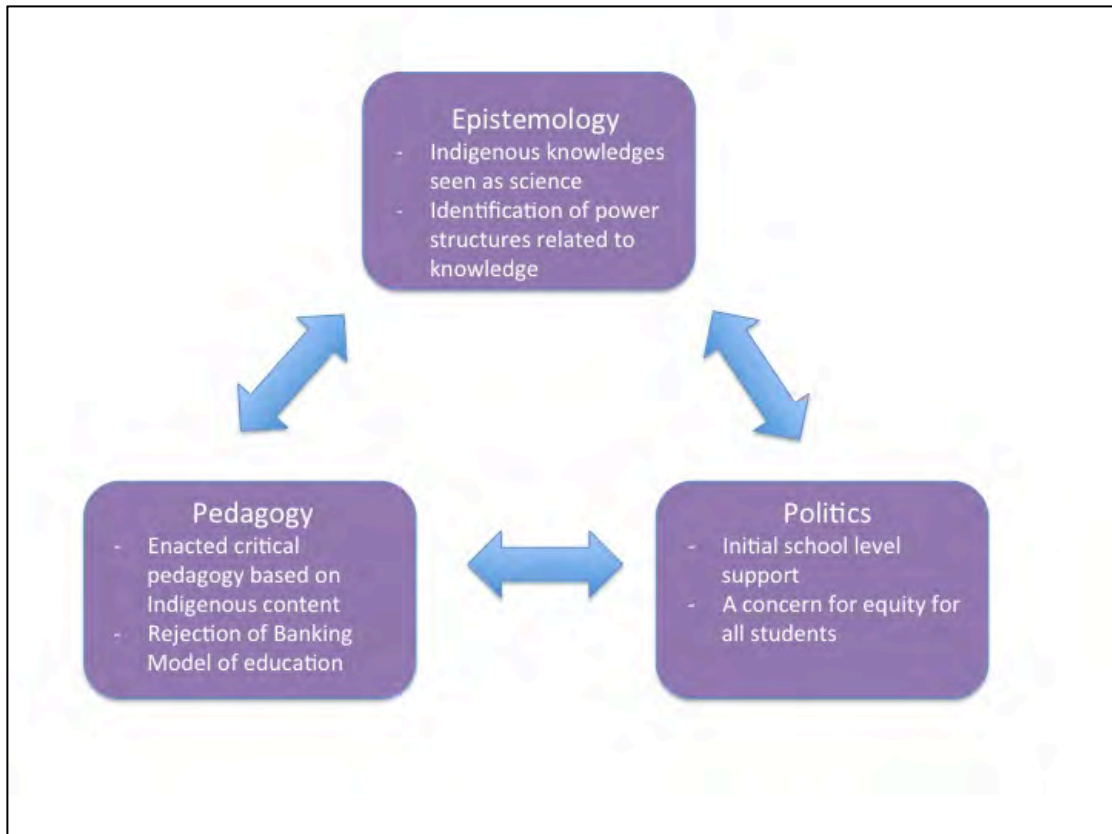
Figure 29: Epistemology, pedagogy and politics for teacher Position 2

The Position 2, taken by Cristy, was a content-based approach with Indigenous examples supporting Western science. The interaction of pedagogy, epistemology and politics in this position can be seen in Figure 29. A scientific epistemology that allowed Cristy to see Indigenous knowledges as scientific knowledge and a critical understanding of power structures of knowledge were congruent with a political position that had concern for the equity for all students. Politically, at the beginning of the project Cristy was supported by her school to enact her critical pedagogy in the classroom and offer to other teachers the opportunity to do so as well. There was enough motivation in her political position to challenge pedagogical practices within her school setting.
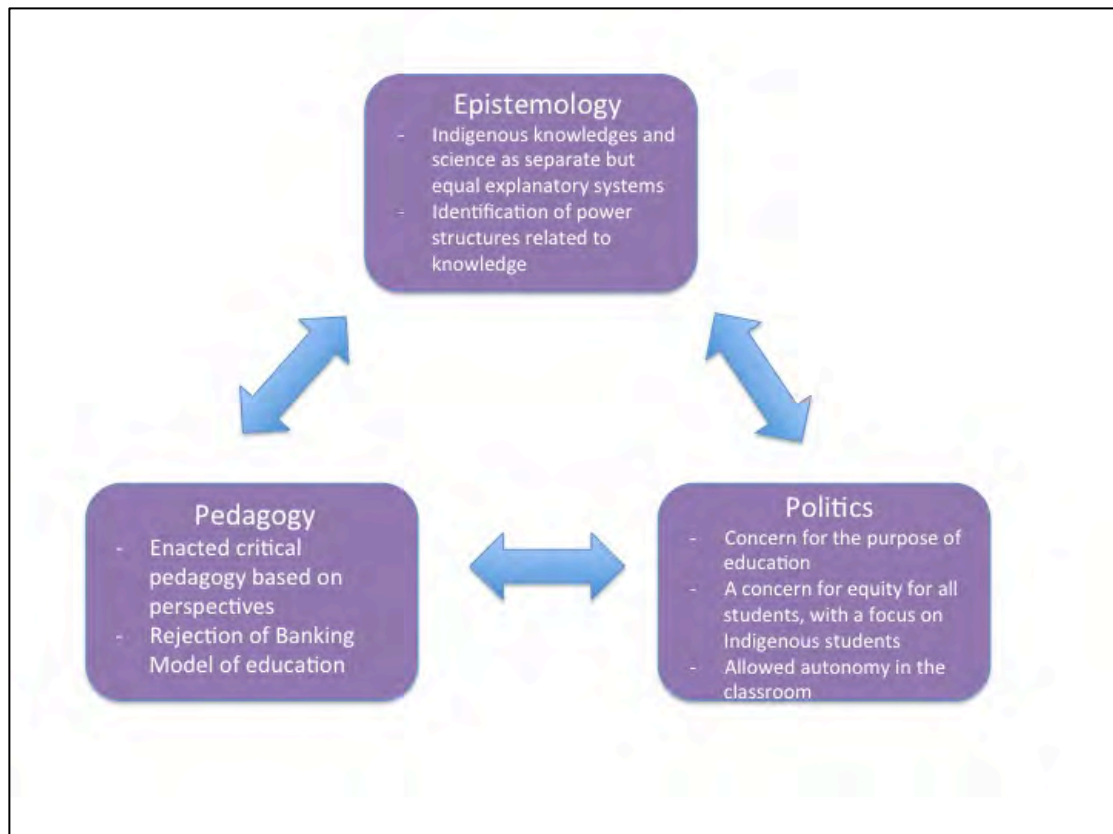
Figure 30: Epistemology, pedagogy and politics for teacher Position 3

Allen took the third position of presenting Indigenous knowledges as an equal and valid but different way of knowing the natural world. Epistemologically, Allen was aware of the power structures related to knowledge and while he did not view Indigenous knowledges as science, he did value them as important explanatory systems about the world. This led to a different critical pedagogical approach where instead of focusing on knowledge, he focused on the different perspectives of the knowledge systems. Politically, he was motivated to enact his critical pedagogy through a concern for the purpose of education and the valuing of Indigenous peoples. At a school level, his autonomy in the classroom allowed him to enact his praxis.

The imbrication of epistemology, pedagogy and politics needs to be considered if teachers in general are to be successful with the engagement of the CCP in the science classroom. Without a critical understanding of the power structures related to knowledge systems, the political motivation to act pedagogically in a

critical way may be lacking. However, epistemology does not necessarily need to be the starting point of the cycle. Having a political persuasion with a concern for social justice and equity in teaching may in turn influence epistemological curiosity and lead to critical pedagogies.

This project ran over a twelve-month period. This meant that the teachers involved had time to develop and consider their epistemological, pedagogical and political positions. As seen in Isabelle's concern with time available to make pedagogical changes, significant amounts of work may be necessary for some teachers in order to engage these elements and be in a position to successfully implement the CCP. Teacher identities, pedagogies and professional knowledge are dependant upon each other (Lingard, 2007). Kanu (2011a) contends that in socially transformative curriculum reform, such as introducing Indigenous knowledges, the identity of the teacher is being re-negotiated. Kanu suggests that curriculum change can threaten existing identities that have been constructed through particular histories and social norms.

Challenging teacher identities for productive professional development

The data collected in this project and analysed in this thesis suggest that, in order for professional development activities around implementing the CCP to be successful, they need to engage with teacher epistemology, pedagogy and politics and allow for the necessary re-negotiation of teacher identity that this may entail. While it may be possible for single session professional development programs to assist teachers with particular strategies to include Indigenous knowledges, this approach does not engage teachers in critical reflection of their teaching praxis over the long term. In the past one-off or short term projects have raised hopes of change but failed to deliver classroom practice that deeply embedded Indigenous knowledges (Whalan & Wood, 2012).

The project's PAR method may have assisted some teachers to have the prolonged engagement necessary to engage with epistemological, pedagogical and political concerns. Burridge and Chodkiewicz (2012) report on success achieved by teachers in several primary schools in embedding Aboriginal cultural knowledges into the curriculum. They also found that through an extended professional development program involving an action research method, teachers were able to "develop a stronger empathy towards Aboriginal people… and begin to draw on that knowledge to make some positive differences in their teaching" (p. 148). Through allowing teachers to engage in a professional development process that saw them working in teams, on a specific project, through participant led cycles of inquiry and reflection, the "capacity to be transformative" (p.153) in curriculum was apparent.

Through allowing the teacher participants in this project to drive the topic choice and progress of the PAR cycles, I have been able to identify some of the possible factors involved in their manner of engagement with the CCP. While Burridge and Chodkiewicz's reporting considers the impact of the professional development on the teachers involved, it does not describe in detail how these personal transformations occurred. As Kanu (2011a) points out, the voices of teachers are rarely addressed in literature. It is possible that, given the extended time to reflect and develop professionally, teachers in the projects described by Burridge and Chodkiewicz engaged in similar challenges to the epistemology, pedagogy and politics and also re-negotiated their professional identities.

Teachers' re-interpretation of who they are professionally and the roles they are expected to play, affects their ability to cope with educational changes (Le Roux, 2011). In many curriculum change initiatives, teachers are seen as the subjects in educational reform, this reduces teachers to being only the installers of curriculum, rather than the originators of curriculum (Carson, 2005). Allowing extended professional development, such as was the case with this project, offers the opportunity for teachers to regain some agency in terms of their pedagogies related to mandated curriculum. By attending to the question of identity in this process;

we begin to shift discourse away from "the what" of what is to be implemented, i.e. the change as "some-thing" (in the form of an idea, policy, theory etc.) to be put into practice. Instead, we come to a notion that change involves a conversation between the self (identity) and new sets of circumstances that are external to the self. For educators, these new circumstances come into play from a variety of directions, only one of which is the official curriculum (Carson, 2005, p. 3).

Applying Carson's point to the idea of engaging with teacher's epistemology, pedagogy and politics, it can be seen how PAR (or action research as described by Burridge and Chodkiewicz, 2012) can engage with identity. The extended nature of this type of professional development activity gives teachers the opportunity to interrogate their positions and consider what it is they want to achieve in the classroom for their students. Teachers' subjectivities are formed through their own personal and national histories and these factors impact on how a teacher will engage with the curriculum to effect the desired change (Carson, 2005). Teachers' identity positions are constructed within social norms and school structures, this often results in maintaining and giving authority to Western cultural values and ways of knowing (Kanu, 2011a). Unease with epistemological issues has the potential to challenge teachers in terms of understanding their own identity and their identity locations within the education system. This challenge may be what is necessary to engage positively within the Cultural Interface in order to be able to plan lessons with Indigenous content without lapsing into tokenism.

Conclusion

This chapter was the final data chapter addressing the *Little Stories* of teacher participation. Drawing data from across the project, it was identified that teachers aligned with one of three positions. Position 1 was described as where teachers showed interest in the CCP but did not proceed to implementation. Position 2 was where a content based approach was taken to including

Indigenous knowledges in classroom lessons. Position 3 was Indigenous knowledge and ways of knowing presented as different ways of understanding the natural world but with equal validity to scientific knowledge.

The importance of recognising teachers' negotiations around epistemology, pedagogy and politics in terms of the identified positions was highlighted. Each of the factors interacted in different ways to produce the three positions teachers took in the study. Where no scientific epistemological conflicts existed and teachers were committed to the political project, implementation took place. Conversely, where scientific and/or critical epistemological conflict existed and there was a reluctance to be seen to be acting politically, implementation did not happen. Either content or perspectives based pedagogical approaches were apparent depending on teachers' scientific epistemologies. However, approaches deployed critical, constructivist pedagogies.

It was argued that the extended nature of the PAR process allowed some participants the agency to negotiate new professional identities that allowed them to implement teaching the CCP in their science classroom. The asynchronous nature of the PAR process allowed teachers to develop knowledge and understanding at their own pace. The next chapter shifts from the *Little Stories* of the project to the influence of the *Grand Narrative* of neo-liberalism.

Chapter 8: The *Grand Narrative* of neo-liberalism

A necessary step in refusing these new conditions of our existence is to be aware of the discourse through which we are spoken and speak ourselves into existence.

(Davies, 2005, p. 1)

Introduction

In the previous three data analysis chapters, the understandings generated by teachers' engagement with the Cross-Curriculum Priority (CCP) have been explored.   How the teachers were positioned at the commencement of the project was considered initially (Chapter 5).   Then, the practical processes around the project and teachers' progress through the PAR cycles were presented (Chapter 6).   Finally, teachers' engagement with the CCP was theorised through the interconnectedness of epistemology, pedagogy and politics. Exploration in these chapters was presented through the *Little Stories* associated with teacher participation.

The process of schooling involves more than just the interactions between teachers and students in classrooms. In order to gain a more comprehensive understanding of the ways in which teachers engaged with the CCP, the *Grand Narrative* of neo-liberalism that framed their participation and frames the schooling context in Australia, is examined in this chapter. This was necessary analysis when taking a critical methodological stance, in order to interrogate the context of study and the positionings of the knowledge systems. Other *Grand Narratives,* such as those around defining Indigeneity, teachers and knowledge also acted in defining ways in the project. The narrative that seemed to have the largest impact on the policy environment related to the project was identified as neo-liberalism, hence the focus on it in this chapter.

Revisiting the literature

Down (2009) identified neo-liberalism as the *Grand Narrative* which acts as the organising principle for all political, social and economic decisions in Australia. Giroux (2004) describes neo-liberalism as "one of the most pervasive and dangerous ideologies of the twenty-first century" (p. 495). At its core, neo-liberalism holds the market as the central organising principle, and that individuals within a society should be able to manage their own lives in a way that can lead to personal profits based on fair and equal competition (Kanu, 2011b). This leads to the role of schooling being narrowly defined as to 'get a job' (Down, 2009).

Neo-liberalism is considered to be the main *Grand Narrative*, a term Lyotard used interchangeably with 'metanarrative', (Roberts, 1998) that framed how the curriculum initiative was situated in the schooling system and what impacted on the implementation of the project. Lyotard recognised *Grand Narratives* as theories that offer universal explanations and trade off the authority this gives them (Sim, 1998) (also see Chapter 4). Lyotard characterised the postmodern era as "incredulity toward metanarratives" (p. xxiv). In the Foreword to the 1984 English edition of *The Postmodern Condition*, Jameson (1984) suggests that it is not the "disappearance of the great master-narratives, but their passage underground as it were, their continuing but now *unconscious* effectivity as a way of 'thinking about' and acting in our current situation" (p. xii) that needs to be considered. This chapter takes Jameson's position and argues that, while the curriculum documents seemingly embraced different ways of knowing, the *Grand Narrative* of neo-liberalism confined both the teachers' and the schooling system's responses to the CCP.

School-based educational policy in Australia has previously been recognised as being part of a neo-liberal regime, particularly through the emergence of national testing and curriculum (see Connell, 2009; Davies & Bansel, 2007; Lingard, 2010). The neo-liberal state holds a particular view of schooling in which market driven values are produced and legitimated (Giroux, 2004).

Through the implementation of accountability measures such as NAPLAN and My School, schooling in Australia has been exposed to market forces in terms of more parental choice and competition between schools as accepted ways of driving up standards (Lingard, 2011). Down (2009) argues that this type of restructure shows instrumentalist values and results in a narrowly conceived version of education. Some authors (Camicia & Franklin, 2015; Lingard & McGregor, 2014) argue that knowledge in the Australian Curriculum has been selected to position students to have desirable skills and dispositions as global citizens and workers in an interconnected global community, placing the curriculum within a neo-liberal frame.

This chapter is an exercise in 'naming' in the Freireian sense (and connects to L. T. Smith's project of 'naming' – see Chapter 4). In order to be able to change lived realities in humanising ways, Freire (2009) outlined the imperative to "name the world" (p. 88). It is through naming the forces of power that reside in a society that it becomes possible to reflect upon them and act otherwise. Naming is a precursor to dialogue. Without naming the world, there is no way to engage in the act of creating a new way of being, that is, enacting praxis. Denouncing reality through naming it also announces the possibility of a better world (Freire, 2004). As such, it is important to recognise and name the overarching *Grand Narrative* of neo-liberalism that influenced teachers' abilities to act in the project. Without addressing and understanding the impact of the *Grand Narratives*, dialogue (or rhetoric) around the inclusion of the CCP will be empty and ineffective.

Naming the *Grand Narrative* of neo-liberalism and drawing on Apple's (2000b) theories surrounding Official Knowledge and schooling (see Theoretical Framework, Chapter 2), I conceptualise the rhetorical inclusion and simultaneous practical marginalisation of Indigenous knowledges in the Australian Curriculum for science. As Apple points out, "the politics of official knowledge are the politics of *accords* or *compromises*" (p. 10), where dominant groups must take the concerns of the less powerful into consideration. The official inclusion of Indigenous ways of knowing in the Australian Curriculum for

science shows recognition of the contribution of Indigenous peoples to the development of science. While the idea of such inclusions is not new, the mandate to include them in such a way is. However, the pressures of a neo-liberal based education system limited the effective implementation of the CCP in the classroom. This will be shown through the experiences of the teachers in this project and publications and commentary about the curriculum in the public sphere.

Figure 31: Speaking back through humanisation (Desmarchelier, 2012d)

In terms of the metaphor of the Tree of Life, this chapter recognises 'wholeness' in terms of "becoming a conscious part of the greater whole" (Cajete, 2000, p. 286). I see this chapter as speaking back to the context of power framing the project. Figure 31 represents resistance through recognising the wholeness and processes of humanisation through the PAR process.

Consideration is given to teachers' responses to the CCP, their agency within the schooling system and their ability and willingness to challenge the status quo. The interconnectedness of the *Grand Narrative* of neo-liberalism, its influence on the development of a standardised curriculum and what this meant in the project for teachers is discussed.

Neo-liberal influences on teacher participation

Chapters 5, 6 and 7 are drawn on in this section to assist in analysing the neo-liberal influences on the project. Teacher participants experienced the project within their own institutional, personal and epistemological contexts. However, many of the overarching influences on their work, individually and with the PAR group, were common experiences for them all.

In order to theoretically frame this analysis, I have drawn upon Davies' (2005) characterisation of the neo-liberal subject. Davies contends that there are several definable elements of individuals "appropriately subjected within neo-liberal discourses" (p. 8). These elements are in *italics* to identify the terms used in the rest of this section. The first is *consumption*, seen as the definition of the self in terms of income and the capacity to purchase goods, which constitutes subjects' identities in term of their jobs. Secondly, the notion of *individual responsibility* leading to the possibility of each person within a society being responsible for their own wealth generation. Coupled with this is a removal of individuals' dependence on, and links with, the social. This results in individuals being *set adrift from values*, and with the focus on individual responsibility, less commitment is generated for outcomes linked to the social good. The development of a humanist self is less important than individual skills for survival linked to generating income. Within this neo-liberal constitution of self, *surveillance* becomes key due to a lack of trust between individuals generated by "the heightened emphasis on the individual's responsibility and the de-emphasizing of inner-values and commitment to the social good" (p. 10). However, an illusion of *autonomy* is created. While the emphasis is on individual responsibility, more surveillance is introduced in forms such as accrediting bodies. Davies summarises her view of neo-liberalism as:

- a move from social conscience and responsibility towards an individualism in which the individual is cut loose from the social;
- from morality to moralistic audit-driven surveillance;
- from critique to mindless criticism in terms of rules and regulations combined with individual vulnerability to those new rules and regulations, which in turn press towards conformity to the group. (p. 12)

Data from this project can be directly related to Davies' characterisation of neo-liberalism to demonstrate the ways in which the overarching *Grand Narrative* confined and constrained participants' practical implementation of the CCP in their classrooms.

Consumption

Some participants identified a link between the inclusion of an Indigenous based CCP and improving economic outcomes for Indigenous students. Chapter 5 showed the positionality of the participants at the beginning of the project and considered the 'why' of including such a CCP. The 'Hopes' expressed included "Improving outcomes for Indigenous students in education and society more broadly" (Cycle 1, Chapter 6). For example, Sue suggested that success of the CCP may be judged well into the future if "it has impacted on their Aboriginal health and how they live and their integration, you know, are they finding jobs within the population?" (Sue, Initial Interview, Sue and Isabelle). While project critical friend (and Indigenous teacher) Daniel considered the implications of poor Indigenous achievement on society, stating that the inclusion was "not because of some moralistic point of view; it's because it is hammering society so much, rather than a pure moral point of view" (Initial Interview, Daniel). Both of these positions framed the inclusion of the CCP as a way of mediating economic impact on society produced by Indigenous underachievement in education thereby, allowing Indigenous people to more fully participate in the consumption of the goods and services provided by society.

Within the neo-liberal context, the function of education is framed as 'to get a job'. By participating in the discourse around schooling being primarily for employment, teachers such as Sue perpetuated a version of success for students as individuals participating in the market through their role as consumers. What is unsaid is the assumption that Indigenous students are seen to be less likely to be this type of neo-liberal subject. Critical friend, Daniel, recognised this discourse of deficit in his statement about the implications of poor Indigenous achievement in formal schooling. The diagnosed deficit in Indigenous students going on to hold 'good jobs' speaks strongly to Davies' (2005) construction of identity through "income and the capacity to purchase goods" (p. 9).

Individual Responsibility

Strongly linked to ideas of consumption, survival in a neo-liberal frame is seen as an individual responsibility. The CCPs in the Australian Curriculum have been framed as a way for students to increase their cultural competence in order to be successful in a globalised economy (Lingard & McGregor, 2014). As Kincheloe and Steinberg (2008) assert, Indigenous knowledge comes to be viewed as either a threat to Western ways or as a commodity to be exploited. In some ways, the teacher participants of this project were attempting to use the CCP to speak back to some of these neo-liberal notions through the development of praxis with socially just motivations.

It is both the voices of the teachers and what remained unsaid in the data that are important in interrogating the sense of individual responsibility and its relationship to neo-liberalism. For example, in Cycle 1 (Chapter 6), the group produced the Collective Vision Statement including the hope that "we provide engaging teaching experiences for both Indigenous and non-Indigenous students". In part, this was recognition that current teaching practices were not necessarily doing so. It is possible, given the focus of some participants on the function of education as getting a job, to view this from competing perspectives. Either, the statement linked to gaining nourishment through a humanising and liberating praxis or the focus was engaging students to enculturate them into being individually responsible for their own welfare (socially and economically). Indeed, the hope of "working towards improved outcomes for Indigenous peoples in education and society" (Collective Vision Statement, Cycle 1, Chapter 6) could be read in a similar way, depending on how the purpose of education is viewed.

Similarly, concerns around "who is this priority for?" (Chapter 6) presented the underlying scepticism of participants Allen and Cristy as to whether the CCP would be enacted in a way that benefited society as a whole. The ensuing discussion around the purpose of education challenged the political motivations of the CCP. The suspicion of the intent of the curriculum manifested in Cristy's

statement: "I don't know whether the people writing these documents really have a full understanding of what they want out of it. Or is it just ticking the box?" (Cristy, Meeting 1). She was questioning if there was a commitment from Government to genuine and broadly conceived educational outcomes for Indigenous and non-Indigenous students or if the construction of the CCP was just 'lip service'. It was from this point that Cristy and Allen agreed that, for them, the CCP was about benefitting all students through providing a perspective broader than just that limited to Western ideas (see Critical Moment 2, Chapter 6). The group's intent was to benefit society through generating an inclusive version of an Australian perspective that all student could find relevance in (Overall Vision 1, Collective Vision Statement, Chapter 6). This speaks to generating a humanising and liberating praxis, rather than enculturation into neo-liberal ideas about individual responsibility.

A recognition of this inclusive Australian perspective may be used to speak back to the pathologisation of Indigeneity. Through inclusive praxis based around the CCP, the positioning of Indigenous peoples and societies as 'in deficit' may be problematised in students' minds. The neo-liberal frame of individual responsibility places Indigenous people facing disadvantage as holding sole responsibility for their situation, rather than recognising the systemic, historical and institutional forces that are at play. While the inclusion of the CCP in the curriculum may be seen as an intent to counteract this, as Darder (2012) points out, "those who practice neo-liberal multiculturalism enact a structure of public recognition based on acknowledgement and acceptance.... while simultaneously (and conveniently) undermining discourses and practices that call for collective social action and fundamental structural change" (p. 417). Darder provides further analysis recognising that where professionals such as educators see the complexities inherent in the politics of difference, they can be deemed disruptive to the prevailing neo-liberal order. It is an individual teacher's approach to how the CCP is implemented and their reading of the intent of the curriculum that frames how or if critical pedagogical practice is enacted in individual classrooms.

Set adrift from values

While the personal factors around epistemology, pedagogy and politics that influence teachers' implementation or otherwise were analysed in Chapter 7, neo-liberal external pressures may have also played a role in participants' willingness to change their pedagogical practice. As Davis (2005) explains, individual survival under the influence of neo-liberalism trumps the need to act for the collective good; in fact, it becomes risky to act in a way that promotes the liberal and humanist self at work. While all participants saw a 'common good' in societal terms in regard to the CCP, only two proceeded to actual implementation. It was challenging for teachers who held Position 1 (where they thought the CCP was a good idea but did not implement - see Chapter 7) to be seen to be acting politically. Combined with the epistemological and pedagogical challenges around implementation and a lack of institutional support, their best intentions did not bear pedagogical fruit.

But why did the teachers see the implementation of a mandated part of the curriculum as a political act? Institutional knowledge as to the benefits the CCP may hold, particularly for Indigenous students, was apparent from past pushes surrounding the embedding of Indigenous perspectives. The rhetoric of why the CCP was a good idea had permeated the teachers' ideas and motivations. However, the reality of implementing pedagogical practice framed around a minority way of knowing presented challenges. As Isabelle highlighted in her initial interview, she feared that students would not be interested in Indigenous knowledges as it would not be relevant to their future careers:

> *There's not many courses at university that have any IK prerequisites. Do you know what I mean? So I think that's a big problem as well. Is that they're going to say well where am I going to use this knowledge?*
> (Isabelle, Initial Interview, Sue and Isabelle)

While this statement also speaks to the construction of the purpose of schooling being to get a job, it also highlights Isabelle's hesitations around being challenged

by her students and their parents (also see Scientific Epistemologies, Chapter 5). She indicated that her responsibility as a teacher was to assist students to enact their individual capabilities in regard to increasing their capacity to get 'a good job' rather than to broader social issues. So while the rhetoric surrounding the common good that was possible through the CCP was recognised and sympathised with, the sense of responsibility lay with individual concerns set adrift from values surrounding the common good.

Sue and Isabelle found it difficult to follow through with their commitment to the social justice concerns of the project in the face of overwhelming pressure to produce the right type of neo-liberal subject. The only teacher who did not was Allen, whose high level of autonomy and experience allowed him to implement the planned future activities as outlined in Cycle 4 (see Chapter 6). Cristy's planned activities did not bear fruit because, while her school principal also supported the rhetoric of the CCP, he did not in the end allow Cristy to carry out her planned professional development activities (Cycle 4, Chapter 6). As with the teachers occupying Position 1 (as described in Chapter 7), concerns around improving social cohesion were pushed aside in favour of moving forward on other areas related to the new curriculum.

Institutional and educational system pressures on teachers to engage with the areas of curriculum implementation that were seen as more important, contributed to teachers' concerns around not having enough time to gain the necessary knowledge and skills to implement the CCP. This was evident where epistemological and political conflict existed for teachers, such as Isabelle's concerns about the inclusion of Indigenous 'mythology' in science teaching (see Chapter 5) or when she questioned how students' parents might see the inclusion (Critical Moment 4, Chapter 6). A lack of time imposed through institutional pressures to emphasise other curriculum elements acted as motivation for the teachers to disengage from the project and from their commitment to implementing the CCP. Where teachers saw it as challenging to 'act politically', especially in the face of little or no institutional support, it was professionally risky to push forward. In this case, committing the time to

develop knowledge and skills became a personal responsibility, not one upheld by the institution. This meant that it was not linked to being a requirement of the teachers' job thus relieving them of both the social and individual responsibility to implement.

Surveillance

Also strongly linked to the concerns that teachers had around not having enough time to appropriately engage with the CCP was the rise of accountability measures in the Australian education system. This frustration was summed up by Isabelle (Chapter 5) when she acknowledge that "you're teaching these lessons that you know could be so much better if you only had time. But you just don't, and it's bad" (Initial Interview, Sue and Isabelle). As Apple (2000b) explains, time becomes a less available resource, "getting done is substituted for work done well" (p. 119). In their exit interview, Sue and Isabelle reiterated their concerns around fitting in this type of project while attending to their accountability responsibilities. This suggests that they did not see the CCP planning as possible from them for some years in the future. Sue saw the focus of their teaching practice as meeting examination and reporting requirements, thus leaving little time for planning other elements. Sue and Isabelle's experiences highlight the pressures of surveillance in the neo-liberal education system.

The intensification of teachers' work due to surveillance measures was also highlighted by project Critical Friend, Daniel. In Chapter 5, Daniel's response was presented:

> *There is so much stuff going on now that was never around five years ago, let alone 10, 20 years ago. Everyone's their [teachers'] boss, so they can come and have a whinge. There's so many people they have to answer to. NAPALM [NAPLAN] is a huge waste of time and all the emphasis upon that.* (Initial Interview, Daniel)

His teaching experience allowed him to recognise the pressures of increasing accountability and surveillance and the effects that these were having on himself and his teaching peers.

High levels of surveillance of teachers' activities do not only act to reduce the amount of time they have available to devote to pedagogical development, but they also act to shift responsibility from the social to the individual good. In order to be 'trusted' as a good teacher by the educational system, emphasis is on individual teacher's responsibility to meet reporting requirements. This self-responsibility can overshadow any commitment to the social good, especially if punitive measures are involved in non-compliance. Therefore, the focus of teachers' work becomes a commitment to reporting, accountability and surveillance.

(The illusion of) Autonomy

While teachers mostly seemed to have autonomy over their teaching practice, in reality their work was framed largely by the neo-liberal discourse around the function of schooling and the need to comply with accountability measures. Pressure within their schools usually resulted in their rhetorical commitment to implementing the CCP being overshadowed by the privileging of other curriculum elements. For all teachers in the project, their autonomy to engage as they wished was undermined to greater or lesser degrees by their individual responsibilities to meet other institutional demands.

The lack of autonomy over curricular and pedagogical choices was sometimes invisible to the participants themselves. Sue for example, as Head of Department for Science in her school, spoke of the choices she was making around session attendance at a curriculum related conference. In her and Isabelle's exit interview, she relayed that she was attending a state education authority conference where there would be sessions discussing the implementation of the CCP. However, she was choosing to attend the concurrent sessions on the student verification processes that were related to assessment. Her sense of

individual responsibility outweighed her sense of teaching for the common good, as did her desire to ensure that she was meeting surveillance and accountability requirements. While she believed she was exercising autonomy in her choice of session, her choices were framed by neo-liberal demands.

A lack of autonomy can also be linked to reductions in teacher agency. In Chapter 7, data were presented about the possibility of Allen's school being required to teach pre-designed lessons in response to not meeting the requirements of accountability measures. As Apple (2000b) describes, through the "degradation of labour" (p. 116), people working outside classrooms and schools now have greater control over what is taught by a teacher in the classroom. He argues that this leads to a pedagogical deskilling of teachers through the loss of the ability to control a large portion of their own work. While the prescription of lessons in Allen's school was not implemented in the end, mainly due to a lack of suitable lesson plans being available, the apparent intent was to exercise control over teachers and schools where standards are not being met. This speaks to a systematic lack of trust in teachers' abilities to exercise autonomy and agency in ways that meet audit requirements.

Through this analysis of *consumption*, *individual responsibility*, being *set adrift from values*, *surveillance* and *autonomy*, it can be seen how the *Grand Narrative* of neo-liberalism impacted upon the teachers' participation in the project and on their positions around implementing the CCP. These interactions have been summarised in Table 4. While each of these elements impacted on each teacher, the *Grand Narrative* also impacted on systematic and pubic responses to the curriculum initiative.

Table 4: Summary of the manifestation of Davies' (2005) categories of neo-liberalism in the project

Davies (2005) categories	Explanation	Manifestation in the project
Consumption	Defining self in terms of capacity to purchase (wealth)	◆ CCP was linked to improving Indigenous economic outcomes ◆ Education framed as 'to get a job'
Individual responsibility	Responsibility primarily for self and own wealth generation	◆ participants' desire to speak back to pathologisation of Indigenous disadvantage as an individual responsibility ◆ suspicion of the intent of the CCP – genuine commitment to making change or a 'box-ticking' exercise?
Set adrift from values	Focus on individual responsibility over collective good	◆ difficult for some participants to be seen as acting politically ◆ some participants focused on their responsibility to educate to 'get a job' rather than for the greater good ◆ Lack of institutional support for implementation of CCP
Surveillance	Lack of trust in individuals, leading to increased accountability measures	◆ lack of time for teachers to work towards implementation ◆ acted to shift teachers' concerns from social good to individual responsibility
Illusion of autonomy	Autonomy in classrooms overshadowed by accountability measures	◆ threat of de-skilling through enforced unit/lesson plans ◆ invisibility of influence of accountability on teachers' professional choices

Rhetoric and practical marginalisation: Preserving the knowledge status quo

Through the analysis of how neo-liberalism framed teachers' responses to the CCP, the simultaneous inclusion and marginalisation of Indigenous knowledges can be seen. The rhetoric around the reasons for the inclusion of the CCP was offered by ACARA and teachers mirrored these concerns through social justice orientated pedagogies. However, the concerns for individual responsibilities,

accountability and reductions in teacher agency, produced by the neo-liberal system acted to confine their implementation.

The conflict between rhetoric and practical implementation and the impact of sustaining the curricula knowledge status quo can be theorised through the work of Apple (2000a, 2000b, 2004), Freire (2009) and Darder (2011). The importance of recognising the context surrounding educational practice and policy and the impact on the knowledges being legitimised is recognised by Apple (2000a, 2000b, 2004). Also important is Freire's (2009) concept of 'false generosity' where those in power profess sympathy for oppressed peoples but fail to address the structural forms of inequality present in the system. Extending on Freire's concept of false generosity, Darder (2011) recognises the political backlash that happens when mainstream ideologies or *Grand Narratives* are threatened. Each of these theoretical frames has relevance when considering the positioning of Indigenous content and perspectives in the Australian Curriculum.

Apple's (2000b) term, the "rightward turn" (p. xxiv), has been used to describe the conservative tendencies in society which influence institutions such as schooling. In addition to neo-liberal influences, Apple also recognises three other elements or groups. The second group is the neo-conservatives as the "economic and cultural conservatives who want a return to 'high standards', discipline, 'real' knowledge, and what is in essence a form of Social Darwinist competition" (p. xxv). The third element Apple termed the 'authoritarian populists'. This group is comprised largely of white working-class and middle class groups who are concerned with traditional and fundamentalist religious values and knowledge. Apple suggests that authoritarian populists exert a powerful influence on education and other areas of politics. The final group Apple identifies are the professional new middle class. This group provides the technical and managerial "solutions" to the neo-liberals and neo-conservatives to allow for educational accountability. Apple argues that it is an alliance between these four groups that promotes national curricula, standards and testing and defines what education is for and whose knowledge is considered legitimate.

When considering the politics of 'official knowledge', powerful groups such as those in the alliance responsible for the rightward turn manoeuvre educational policies to promote their knowledge as legitimate knowledge. The construction of the 'right type' of neo-liberal subject as described by Davies (2005) relates to the type of knowledge that is considered legitimate and worthy in the Australian Curriculum. The knowledge selected for inclusion in the Australian Curriculum was framed by concerns of globalisation while showing recognition for diversity of cultures. While the Australian Curriculum has been described as a top-down reform that introduced a discipline based approach to knowledge organisation, the inclusion of the CCPs also showed a concern for what students "should become" in terms of culturally aware global citizens (Lingard & McGregor, 2014, p. 92). Lingard and McGregor (2014) similarly situate the inclusion of the CCPs in the curriculum as an "attempt to conceptualise part of the curriculum as preparing young people for a rapidly evolving world of new work, new cultures and new technologies, in which they will need capacities and dispositions to cope with significant global changes" (p. 106).

The approach to the inclusion of the CCPs and General Capabilities noted by Lingard and McGregor (2014) link to Apple's (2000b) assertion that: "the powerful are not *that* powerful. The politics of official knowledge are the politics of *accords* and *compromises*. They are usually not impositions, but signify how dominant groups try to create situations where the compromises that are formed favour them" (p.10). This process is necessary for the dominant groups to maintain their power and appear to take the concerns of the less powerful into account. Through the inclusion of the CCP, policy takes into account concerns for Indigenous issues in schooling while still framing the inclusion as necessary for students to be "the kind of person with the skills and dispositions required by the global millennium citizen and worker" (Lingard & McGregor, 2014, p. 90). In this way, the accords and compromises of the inclusion of the CCP still satisfy neo-liberal demands. This seemed to be expressed in the concerns of the teachers through their understanding of the social justice intent of the CCP (as expressed in the Collective Vision Statement, Chapter 6) and statements that linked to the purpose of schooling as being to 'get a job' (this Chapter).

This conflict around 'accords and compromises' impacted the practical implementation of the CCP in the project. In many ways, the tug-of-war between the rhetoric of why the inclusion was socially a good idea and concerns around the time to develop and implement practical pedagogies is directly reflective of the way in which neo-liberal framed schooling acted to confine teachers' agency. The rhetoric of becoming 'culturally aware global citizens' (Lingard & McGregor, 2014) was evident in the curriculum and teachers in the project were committed to socially just pedagogies. However, the neo-liberal characteristics of *consumption*, *individual responsibility* and being *set adrift from values* compelled teachers to focus their attention on other areas of the curriculum more directly connected to students' university or job readiness. So, in this case, the politics of official knowledge resulted in the compromise of Indigenous knowledge being included in the curriculum. The overarching systematic structure did not encourage its implementation.

The vision of what science education could be in relation to the CCP is in the educational imagination of teachers and schools and was evident in this project through the Collective Vision Statement (Chapter 6). However, as Apple (2000a) attests, "while the construction of new theories and utopian visions is important, it is equally crucial to base these theories and visions in an unromantic appraisal of the material and discursive terrain that now exists" (p. 229). It is important to recognise the "openings for counter-hegemonic activity" (Apple, 2000b, p. 10) which have been created through the compromise of the inclusion of the CCP, but the possibility of change only exists with the tactical analysis of knowledge and power relationships and what is necessary to actually bring about pedagogical change in the classroom. As Sefa Dei (2011) contends, if we fail to contest power and the neo-liberal stance, listening to diverse standpoints can only be seductive and end up actually affirming the dominance of particular forms of knowledge. In order to contest the neo-liberal position, I turn to the public record to demonstrate how the curriculum and the CCP were framed in the media and to discuss how this relates to the project and the teachers' experiences.

An example of inclusion and simultaneous marginalisation of Indigenous knowledges was apparent in statements made by the then Federal Minister for Education, Julia Gillard, after the release of the draft Australian Curriculum in 2010 (Ferrari, 2010). One science curriculum elaboration suggested that students research "historical examples of different cultures, knowledge about the national environment and living things (for example, Aboriginal peoples' Dreamtime [sic] stories that explain significant characteristics of the Earth's surface and interactions between living things)" (Ferrari, 2010). When newspaper *The Weekend Australian*, questioned the inclusion of 'Dreamtime' [sic] in science Ms Gillard replied, "While Aboriginal culture will form a part of the new curriculum, it's not appropriate that it form part of a science course, and that's why when this error was found, it was changed" (Ferrari, 2010, para. 12). Concern about the inclusion of Dreaming in science centred on the inclusion of religious or spiritual beliefs. ACARA chairman Professor Barry McGraw's concerns reported in the same article backed Ms Gillard's comments. He said:

> I think Dreamtime [sic] is a religious or spiritual interpretation of the beginnings of life. For the same reason, we wouldn't let intelligent design or creationism be included. It shouldn't be in the science curriculum and we're going to take it out. (Ferrari, 2010, para. 4)

Refusing the inclusion of Dreaming in the science curriculum may show a lack of understanding of the holistic nature of Indigenous knowledge systems. Some of the teachers in the PAR study also struggled with this aspect of bringing Indigenous knowledge to the classroom. In Chapter 5 at the beginning of the project, Isabelle expressed concern around teaching mythology in the classroom but also recognised the difficulties with removing what could be seen as scientific knowledge from the cultural context associated with the Dreaming. However, as Sefa Dei (2011) points out, "folklore and proverbs contain a profound richness of the thought processes and language of indigenous peoples. They constitute important communicative tools by reinforcing the epistemic saliency of peoples whose epistemologies are often devalued or negated in the formal educational arena." (p. 8). The importance of Dreaming to the scientific community is beginning to be recognised in academic literature. In examples

from Australia, Dreaming has been used to enhance scientific understanding of meteors (Hamacher & Norris, 2010) and sea level rises (Nunn & Reid, 2015). As such, it is not as simple as excluding Indigenous spiritual beliefs from the science classroom from a cultural or scientific perspective.

The media reporting of Ms Gillard and Professor McGraw's comments may reflect the 'neo-conservative' element of Apple's (2000b) 'rightward turn'. The comments seem reflective of a belief in the purity of scientific knowledge in terms of objectivity and freedom from cultural influences. This is significant for understanding the broader political climate at the time of the construction of the Australian Curriculum, that these comments were published in *The Australian* newspaper. This newspaper is the country's only national broadsheet newspaper and is part of Rupert Murdoch's News Limited group (Reid & McCallum, 2013). Hattam, Prosser and Brady (2009) argue there has been a mediatisation of Australian educational policy debate by neo-liberal actors. The importance of *The Australian* in terms of influencing the opinion of Australia's political elite has been recognised (McKnight, 2012), as have issues with its projected objectivity when reporting Indigenous issues (Reid & McCallum, 2013). The speed with which the references to Dreaming in the science curriculum were withdrawn may be reflective of the power of neo-conservative elements in Australian media as well as the ways in which the media is now used as an integral part of educational policy development (Hattam et al., 2009).

False generosity can also be seen in the gap between rhetoric and classroom implementation. While the move to include the CCP demonstrated a concern for Indigenous issues and reflected the earlier identified need for reconciliation through education in the *Melbourne Declaration on Educational Goals for Young Australians* (MYCEETYA, 2008), practical support for implementation was lacking. For instance, the removal of Dreaming from the curriculum does not take into account how teachers frame knowledge in practical terms without being disrespectful or tokenistic. At the time of implementation there was a dearth of information available to educators to assist with practical unit and lesson planning activities. Government educational body commitment to

ensuring that the CCP was successful in classrooms was minimal. In Queensland, state schools were given responsibility for organising their own professional development activities without any increase in financial resources (Lowe & Appleton, 2014). Without structural support from the state education authority and sustained commitment to providing guidance to this aspect of a new curriculum, teachers struggled to understand what was required of them.

In the PAR study, confusion around the purpose of the CCP was initially apparent (Critical Moment 1 - Chapter 6) and, even with the support of professional development activities linked to group participation, some teachers did not implement the CCP. Without appropriate training and guidance to provide clarity around new curriculum demands, teachers implement according to their existing knowledge and beliefs (Roehrig & Kruse, 2005 cited in Lowe & Appleton, 2014). In the case of the CCP in science, this may mean some teachers, such as Cristy's colleague (Chapter 5) and principal (Critical Moment 6 – Chapter 6) opt not to implement at all. So, while the rhetoric supported the inclusion of the CCP, the structural support in the education system was lacking. This is a form of false generosity that acted to retain the structural inequalities of the system thus preserving the knowledge status quo.

Policy and politics post data collection

Further supporting both the ideas of false generosity and neo-conservatism, the conservative Coalition Government established a review into the Australian Curriculum in 2014 (Queensland Studies Authority, 2014). While this announcement and review occurred after the data collection phase of the study, it is important to recognise them as part of the on-going pattern of preserving the knowledge status quo that was apparent through the implementation phase of the curriculum. The Labor Government was responsible for drafting and implementing the curriculum in ways that did not support the success of the CCP. The Coalition Government was concerned about the overall validity of an Indigenous based CCP in areas such as science and mathematics. As such, these

issues were of importance in a bi-partisan context, although they were highlighted in differing ways and with differing severities.

Early in his term after being appointed the Coalition's Minister for Education, Christopher Pyne highlighted his concerns around a focus on 'progressive causes' and a lack of direct instruction in the Australian Curriculum. As reported in *The Sydney Morning Herald*, Mr Pyne flagged his intention to review the curriculum as "my instincts tell me that a back-to-basics approach to education is what the country is looking for" also commenting that the curriculum needed to be reviewed to ensure it reflected "the whole of the Australian story" rather than a "black armband view of Australia's history" (Hurst, 2013, para 6 and 19). This type of media reporting has been described by Smyth, Down and McInerney (2015) as a politics of derision, designed to create an image of crisis in education in order to push for a return to traditional teaching methods.

The Review of the Australian Curriculum was conducted by Government appointed reviewers, conservative educationalist Kevin Donnelly and business academic Kenneth Wiltshire (Smyth et al., 2015). Criticism of the Government's choice of Donnelly centred on his clear dislike of what he himself described as "cultural-Left critique of education and society" (Donnelly, 2014, p. 10). Previous to Donnelly's involvement in the Review, Hattam et al. (2009) identified that he "frequently perpetuates a sense of education in crisis with underachieving students, liberal teachers, leftwing academics and inconsistent standards to blame" (p. 166). However, the Government identified Donnelly and Wiltshire as "expert independent reviewers" (Australian Government, 2014). Writing about the Australian Curriculum after the final report from the Review was tabled, Donnelly (2014) stated:

> Much of the justification for the national curriculum is also couched in New Age jargon and psychobabble that emphasises so-called twenty-first-century learning where the purpose of education is restricted to preparing students for an uncertain and ever-changing future instead of grounding them in the significant events, movements, ideas, and artistic and scientific achievements of the past (p. 10).

Specifically in relation to the CCPs, Donnelly (2014) stated:

> Suggesting that subjects like mathematics and science, in addition to all the other subjects, must be taught through a politically correct prism involving indigenous, Asian and sustainability perspectives clearly reflects a bias where students are given a jaundiced and tokenistic knowledge and understanding (Donnelly, 2014, p. 10).

The *Review of the Australian Curriculum Final Report* tabled 30 key recommendations to the Government "to improve and further the development the curriculum used in Australian schools" (Australian Government, 2014, p. 6). Recommendation 17 stated that ACARA should:

> Reconceptualise the cross-curriculum priorities and instead embed teaching and learning about Aboriginal and Torres Strait Islander histories and cultures, Asia and Australia's engagement with Asia, and sustainability explicitly, and *only where educationally relevant*, in the mandatory content of the curriculum. (p. 7, my emphasis)

The Government supported this recommendation stating, "while the current cross-curriculum priorities are valid areas for consideration in the curriculum, this approach is not well communicated and may warrant reconceptualisation" (Australian Government, 2014, p. 8). The CCPs were considered to add too much complexity when delivering the curriculum.

As a result of the Review and Donnelly and Wiltshire's recommendations (Australian Government, 2014), a new version of the Australian Curriculum was released on the 20th of October 2015 (Version 8) (ACARA, 2015a). Advice from the Australian Curriculum website states that, in the learning area of science, students will have the opportunity to learn about the longstanding scientific knowledge of Aboriginal and Torres Strait Islander peoples (ACARA, 2015a). However, the only identified Content Descriptions (statements to assist teachers with content elaborations) that remain in the document are for the Sustainability CCP (ACARA, 2015b).

The number of Aboriginal and Torres Strait Islander Histories and Cultures CCP identified Content Descriptions had been drastically reduced in versions of the curriculum prior to the Review. There were 10 such elaborations in the first version of the curriculum, occurring from grade 1 to grade 8 (ACARA, 2011b). While there are no identified Content Descriptions remaining, the CCP is still officially part of the Australian Curriculum for Science albeit with a much reduced emphasis. The public political debate around the legitimate place of the CCP in the discipline area of science, what elements of Indigenous knowledges were appropriate for inclusion and the ever-reducing number of identified Content Descriptors has likely influenced school administrations in terms of how the initiative was prioritised. In the project, these concerns were evident in moments such as Cristy's principal's agreement in principle but lack of commitment to her planned professional development activities (Critical Moment 7, Chapter 6). The political and institutional context of the teachers' work confined and constrained their abilities to enact the Collective Vision Statement (Chapter 6).

The call for the Review of the Australian Curriculum and the rhetoric of a 'back to basics approach' (Hurst, 2013) as well as derision of a 'cultural-Left critique' (Donnelly, 2014) speak to a politics of backlash. Where teachers such as Allen feel comfortable in presenting Dreaming stories in synergy with scientific understandings of the natural world, there is potential, from a neo-liberal perspective for the knowledge status quo to be disrupted. Indeed, when prominent educational experts contend that this type of teaching promotes "a jaundiced and tokenistic knowledge and understanding" (Donnelly, 2014) of scientific knowledge, the educational validity of the approach is questioned. However, this may be a neo-liberal response to the accords and compromises enacted in ways that promote values connected to the common good.

Faludi (1991) first identified backlash in terms of reactions against feminism and described how insidious politics framed the issues of women's rights in its own language (cited in Gutierrez, Asato, Santos, & Gotanda, 2002). Darder (2011) identifies "the response to losing power as a consequence of shifting entitlement

and privilege within schools can elicit a feeling of threat or displacement" (p. 152). In the case of the Australian Curriculum and the CCP, moves to be more inclusive of Indigenous issues, knowledges and ways of knowing threatened the legitimacy of a purely Western way of considering the world. Darder also argues that these types of biased and uncritical responses are rooted in racialised notions of intelligence, extending in this case to the legitimacy of knowledges produced by minority groups. In this way, the renormalising of the reproductive function of schooling is achieved (Hattam et al., 2009). In addition, policies that aid in "expanding institutional opportunities to diverse populations" (Darder, 2011, p. 153) threaten the neo-liberal system through potential positive class and economic impacts for marginalised populations. In these ways, a context was created that did not value teachers' implementation of the CCP as being equally important as other curriculum areas. This was apparent in both the teachers' attitudes, particularly those who did not progress to implementation, and the school administrations not valuing the teachers' efforts.

Through the politics of backlash, inequalities based on race and the knowledge status quo are maintained. While some direct attacks on the perceived legitimacy of Indigenous knowledge in the classroom have been made, most objections were framed in terms of Indigenous ways of knowing being incompatible with the purity of disciplines such as science. This denies science as a culturally framed product of the Western imagination, allowing the removal of the racial bias from the argument. The 'back to basics' rhetoric also leaves the unanswered question of whose 'basics' are being referred to. The ethos of returning to direct instruction and teacher-based approaches denies approaches to learning from non-Western sources. This leaves the knowledge status quo of the curriculum to stand and become the colour-blind, uncontested baseline of educational reform (Gutierrez et al., 2002).

Conclusion

This chapter has shown the influence of the *Grand Narrative* of neo-liberalism on the participation of teachers in the project. Of particular importance is the process of naming the context and influences of the neo-liberal education system so the impacts on teachers and teaching can be recognised. As outlined, the ways in which neo-liberalism constitutes subjectivities and suggests that the purpose of education is to 'get a job' had great impacts on the perceptions and actions of the teachers in the project. Whether impacts were recognised, such as in the case of accountability measures reducing time available for professional development, or invisible, as in the case of understanding the purpose of education, they had profound impacts on teachers' individual experiences around implementation.

The rhetorical acceptance and promotion of the CCP combined with the practical constraints on implementation speak to the politics of official knowledge (Apple, 2000b), false generosity (Freire, 2009) and backlash politics (Darder, 2011). While the outward intent of including different ways of knowing in the curriculum was apparent at the outset of the project, the reality of implementing the CCP under the *Grand Narrative* of neo-liberalism meant that the knowledge status quo was largely maintained. In order to enact agency around the construction of knowledge in their own classrooms, teachers first needed to be willing to be seen as acting politically.

However, there is still hope. While the impact and visibility of the CCP has been much reduced through successive versions of the curriculum, particularly after the Coalition Government's Review (Australian Government, 2014), it does still remain part of the curriculum. The possibility is still present for teachers to be agentic, to resist the neo-liberal discourses and to implement different ways of knowing in the science classroom. This thesis, in part, acts as recognition of how difficult that these moves can be in the face of an educational system that outwardly supports, but in practice marginalises, the initiative. The thesis also

shows the possibilities, hopes and changes a re-interpretation of the legitimacy of knowledge can have for both teachers and students.

Chapter 9: Concluding Reflections

Teachers and students (leadership and people), co-intent on reality, are both Subjects, not only in the task of unveiling that reality, and thereby coming to know it critically, but in the task of re-creating that knowledge. As they attain this knowledge of reality through common reflection and action, they discover themselves as its permanent re-creators.

(Freire, 2009, p. 69)

Introduction

As outlined in Chapters 1 and 2, this study was conceptualised as a response to the mandating of the *Aboriginal and Torres Strait Islander Histories and Cultures Cross-Curriculum Priority* (CCP) in the Australian Curriculum. It was located temporally in the period when schools and teachers were considering draft documents and implementing the first version of the new curriculum. The research recognised that the inclusion of knowledges and perspectives from a non-Western epistemic base may be problematic for teachers. It was considered that it might be particularly challenging in a canonical subject such as science as it is often understood as culturally neutral and operating from an objective position.

Given this context, the study aimed to gain some insight and understanding into how teachers went about engaging with unfamiliar content and epistemologies in their teaching. In particular, the research aimed to add to the understanding of what processes are necessary for teachers to be able to implement lessons with Indigenous content and perspectives in classrooms. The study hoped to assist in moving beyond the rhetoric of why such inclusions are educationally important to the practical implementation of socially just pedagogies inclusive of Indigenous content and ways of knowing for all students.

This chapter draws together the work of the project and summarises the process and findings of the thesis. The research questions set out in Chapter 1 are directly addressed. The contribution the work has made to knowledge of the topic is discussed, as are the limitations of the study. Lastly, some suggestions of future research directions are made and future directions discussed.

Revisiting the thesis

In Chapter 2, critical theory and pedagogy were identified as conceptually framing this study. The research sought to understand the engagement of teachers with the CCP from the position that education can be an act of liberation (Freire, 2005), making contributions to overcoming the oppression of Indigenous peoples, knowledges and cultures. The research also drew on Apple's (2000b, 2004) work to understand how curriculum positions some knowledges as 'official knowledge' while marginalising other ways of knowing. With this in mind, the recognised status of Indigenous knowledges as 'subjugated knowledge' (Langdon, 2009; Maurial, 1999; Shiva, 1993) and the often presumed superiority of Western science needed to be considered in teachers' engagement with the CCP.

Chapter 3 situated the study in relation to other literature that considers how teachers engage epistemologically with the knowledges that they teach. In particular, it considered the importance and practical application of Indigenous knowledges in education broadly and in the subject of science. The issue of teachers' epistemologies is described in literature across several education related discipline areas. A post-formal approach to understanding epistemology was suggested in order to produce a multilogical understanding of the topic. Following Kincheloe (2006), the inadequacy of one paradigm to describe a process as complex as the interactions between epistemology and teaching was suggested. The post-formal lens allowed the imbrication of personal epistemology, scientific and critical perspectives.

Chapter 3 also highlighted that the complexities of Indigenous knowledges in education are multiple and contested. As Semali and Kincheloe (1999) assert, the study of Indigenous ways of knowing can put educators on 'dangerous ground' but the potential for the disruption of the ways in which knowledge is produced is profound. Given Apple's (2004) description of education as one of the major institutions though which power is maintained and challenged, the inclusion of Indigenous knowledges and perspectives in the Australian Curriculum offered a way of contesting taken-for-granted assumptions about the legitimacy of particular ways of knowing. The challenges this presents for teachers are often identified in pedagogical terms. Questions around what such inclusions 'looks like' and how the CCP could be embedded in meaningful ways were still existent from similar past curriculum initiatives (Nakata, 2011). Chapter 3 also identified a dearth of literature around teachers' attitudes and beliefs. While some studies reported teachers' concerns (such as Burridge & Evans, 2012; Harrison & Greenfield, 2011), it was identified that the voices of teachers are rarely addressed in research (Kanu, 2012).

Methodologically, the gaps in the literature called for a participatory approach that sought to allow teacher participants to direct the topics and process of the research. To allow this, Chapter 4 outlined a participatory action research (PAR) approach. The methodology also needed to take into account the cultural sensitivities of non-Indigenous people working with Indigenous knowledges. To this end, an exploration of Indigenous methodological standpoints informed a Tree of Life metaphor for the project. The metaphor was used through the project to guide the work in meeting its critical aims.

In this project, PAR was defined by its complexities and 'messiness'. Due to the five teacher-participants working across different schools, it was at times difficult to keep to structured group cycles. Instead, each teacher completed cycles, common to the work of the group, at their own pace as their commitments and context allowed. The group meetings still informed the work all teachers did but not all teachers attended all meetings. This meant that as the researcher-participant I needed to keep each group member connected to the

group and its progress; it also allowed each participant the autonomy to engage on their own terms.

Data were analysed to engage both the *Little Stories* of teachers' participation and the *Grand Narrative* that influenced their efforts. In Chapter 5, Teacher-participants were situated in terms of their previous experiences, attitudes and beliefs about the inclusion of the CCP in the curriculum. The initial interviews indicated that they were hopeful that the CCP would lead to improved intercultural understanding between non-Indigenous and Indigenous people and improve educational and societal outcomes for Indigenous students. Teacher-participants also hoped that the CCP would lead to socially just pedagogies that provided engaging lessons for all students. In defining their vision for the CCP, the importance of the knowledge systems working together with input from local Indigenous communities was highlighted. There was also a vision of a uniquely Australian perspective being brought to science lessons. However, these hopes and visions were not held without trepidation about 'stepping on cultural toes', how scientific and Indigenous epistemologies might be merged and having the time to engage with the initiative. The data analysis suggests that there is an interconnected relationship between teacher-participants' confidence, epistemological concerns and perceived lack of time. At the beginning of the project the competing demands of the neo-liberal education system meant that little time was available for teachers to develop the necessary epistemological understandings. This meant that they were less confident in their own abilities to successfully engage with other ways of knowing in the classroom.

The project consisted of four PAR cycles, as described in Chapter 6, that moved from conceptualisation of an approach to working with the CCP to implementation and forward planning. All teacher-participants contributed to the first two cycles where the Collective Vision Statement was produced to define what it was that we wanted to achieve and where there were spaces in the curriculum where Indigenous knowledges might 'fit'. The Collective Vision statement aligned with the hopes and visions described by teachers in their

initial interviews. While a plethora of places was found as potential teaching areas, both Cristy and Isabelle suggested a physics unit on forces that presented a pedagogically, culturally and epistemologically safe space for them to begin to work in. Cristy and Allen went on to implement their teaching ideas in Cycle 3. Cristy formulated a unit called *Forces of the Past*, while Allen taught a geology unit *Rock Never Dies* and a unit on scientific and Indigenous ways of naming the natural world. Both Allen and Cristy formulated future plans in Cycle 4 but only Allen was successful in implementing his plan. Cristy was prevented from enacting her plan through her principal's withdrawal of support.

Chapter 7 also focused on the *Little Stories* of participation and described three emergent positions taken by the teacher participants. Position 1 was where teachers were interested in the CCP, and related it to social justice intent, but did not proceed to classroom implementation. Position 2 was identified as Indigenous knowledges being included as content to support Western scientific understandings. Position 3 was described as Indigenous knowledges and perspectives being presented as different but equally valid ways of understanding the natural world.

Teacher-participant positions were related to differences in and interactions amongst their epistemologies, pedagogies and political positions. Position 1, taken by Sue, Isabelle and Karl, was characterised by some epistemological concerns around merging different ways of knowing; less critical discussion of how power differentials operated; a pedagogical reliance on more transmissive approaches; and being challenged by being seen as acting politically. Position 2, taken by Cristy engaged Indigenous knowledges as science, but identified structures of power surrounding knowledge systems; took a critical pedagogical approach encouraging some co-creation of knowledge between students and the teacher; and showed a political concern about equity for all students. Position 3, taken by Allen, identified Indigenous ways of knowing as different to, but as equally valid as, scientific knowledge; took an approach of learning with his students using critical and constructivist base pedagogies and politically showed a concern for a broadly conceived purpose of education.

It is suggested that the extended engagement of PAR approach assisted in teacher-participants developing an understanding of their epistemological, pedagogical and political positioning. Implementing such strategies for professional development more broadly may allow teachers to renegotiate their professional identities in ways that allow them to take pedagogical and professional risks. Participatory approaches may allow teachers to have a greater sense of agency in relation to mandated curriculum change.

In Chapter 8, neo-liberalism was identified as the *Grand Narrative* most influential to teacher participation in the project. Davies' (2005) characterisation of the neo-liberal subject provided an analytical framework to understand how the educational policy environment defined teacher engagement. The simultaneous rhetorical support and practical marginalisation of the CCP was theorised. False generosity (Freire, 2009) and the politics of backlash (Darder, 2011) were also identified as constraining teacher-participants' efforts to enact the CCP. While the rhetoric surrounding such curriculum inclusions was aimed at improving intercultural understanding, education system support to assist teachers in implementing the initiative was lacking or absent. In these ways, the system created the environment where less emphasis and value was placed on the mandated curriculum initiative. This meant that the knowledge status quo was largely maintained.

Overall, this thesis highlighted the challenges and possibilities teacher-participants found in implementing Indigenous knowledges and ways of knowing in science education. Despite the marginalisation of the CCP, due to the *Grand Narrative* of neo-liberalism, both Cristy and Allen implemented lessons with Indigenous content and/or perspectives that they described as enhancing the educative experience for themselves as teachers and for their students. The analysis of all of the teacher-participants' experiences through the course of the project highlighted the importance of allowing teachers the time to engage epistemologically, pedagogically and politically in order to enact their agency in the light of the curriculum reform and the neo-liberal educational system.

Answering the research questions

The structure of this thesis was formed from my experience of the PAR process as the researcher-participant. So far, through my narrative of the project, the chapters formed around the research questions and they have been addressed in-directly. Rather than interrupt the project's narrative, I have chosen to address the questions specifically here. This means that much of the information that answers the questions is presented in previous chapters. This section acts to draw this information together, specifically framed by the research questions.

Research Question 1

What are participating teachers' attitudes and beliefs around the possibilities and problems of including different ways of knowing in the science classroom?

Teacher participants volunteered to participate in the project because they all held an interest in the inclusion of Indigenous knowledges in science education. This interest stemmed from their positive views of the potential of the mandated curriculum change to promote different ways of thinking in their students. Pedagogically, the CCP allowed an approach to teaching science that transcended an image of scientists as White Western men in lab coats, opened space for implementing engaging lessons, centred on Australian content and perspectives; and promoted other ways of thinking about the natural world. When classroom implementation took place, the constructivist lessons undertaken promoted co-creation of knowledge between teacher and students.

Also highly valued were the social justice possibilities of lessons inclusive of Indigenous knowledges and perspectives. Increasing intercultural understanding in their students was a high priority for teachers. The need for non-Indigenous students to have a better understanding of Indigenous knowledges/cultures/peoples was recognised and held as a primary reason for implementing the CCP. Teachers also recognised the benefits in engagement and outcomes in teaching and learning for Indigenous students. While all teachers were in contexts where non-Indigenous students substantially outnumbered

Indigenous students, they did not see the CCP as any less important for their teaching. They held hope that through their praxis they could contribute to broader social change.

Although teacher-participants approached the CCP with hope, they also recognised potential impediments to their implementation. It was important to give voice to these perceived impediments in order to be able to address. Concerns about acting and teaching in culturally appropriate ways were prominent. Teachers recognised the need to address Indigenous concerns around what knowledges were appropriate for the classroom and the ways in which these were delivered. They were weary of taking approaches that may be seen as tokenistic. This led to a desire to have a deeper understanding of Indigenous knowledges, cultures and peoples in order to ensure they were developing lessons that were valuable, worthwhile and useful.

All teachers expressed concern about the complex and busy nature of their professional lives and the resultant impact on their ability to engage with the mandated curriculum. Teachers recognised an investment in time was necessary for conceptual and pedagogical change. Achieving socially just, culturally appropriate and pedagogically challenging lessons required research, consideration of how to merge epistemologies and personal investment. Where their efforts were not supported by their school's administration, other teaching staff, or not prioritised by the teachers themselves, the time necessary to develop knowledge, understanding and teaching approaches became problematic.

While all teachers expressed hope around the social justice possibilities of teaching inclusive of Indigenous knowledges, some found it challenging to enact their pedagogies. In schooling environments where little emphasis was being placed on the CCP, some teachers were reluctant to put their plans into place for fear of being seen as acting politically. Despite the mandated nature of the curricular change, some teachers feared being challenged by their students, and other staff, about the place of Indigenous knowledges in science teaching.

In summary:

- The CCP offered an opportunity to implement engaging, Australian-based science lessons that promoted intercultural understanding between non-Indigenous and Indigenous people.
- Concerns were held about ensuring lessons and teachers' actions were culturally appropriate and non-tokenistic.
- It was recognised that an investment in time was needed to develop appropriate approaches to, knowledge and understandings of, Indigenous knowledges and ways of knowing.
- Some teachers found it challenging to be seen as acting politically by peers, school administration, parents and students through implementing science lessons inclusive of Indigenous knowledges and ways of knowing.

Research Question 2

What processes do teachers engage with when incorporating Indigenous knowledges into their conceptualisation of science education?

Teachers engaged in reflexive processes in order to position themselves in relation to the curriculum initiative and be able to consider classroom implementation. With the potential to challenge professional identities, the implementation of different ways of knowing in the classroom required careful consideration of the teachers' beliefs about the purpose of the inclusion, the nature of education and their own roles in challenging ingrained perspectives of what science education should be. Teachers' engagement with the CCP was complex and related to their personal epistemological, pedagogical and political positions.

When negotiating such complex issues, teachers needed the ability to develop understandings and approaches at their own pace. The individual needs of the teacher in terms of what knowledge, understanding and pedagogical skills they

had when starting to consider such an initiative, seemed to drive the professional development experience. It took more time to consider teaching approaches for a teacher who is challenged epistemologically, by the merging of Indigenous and scientific knowledges to develop understanding and pedagogical approaches, than it does for a teacher who sees Indigenous knowledges as science. The asynchronous participatory approach allowed teacher participants to identify their own needs and enact their own agency to develop understandings and pedagogies at their own pace.

Teachers' positions epistemologically, pedagogically and politically seemed to influence how they negotiated an approach to the curriculum. As shown in Chapter 8, these factors were interconnected and operate to produce different interpretations of the curriculum in the classroom. Epistemological conflict seemed to cause an atrophy of good intentions. Where teachers were clear about how they regarded Indigenous knowledges in scientific terms, epistemological curiosity was apparent resulting in critical and constructivist pedagogies. Where points of potential political conflict with students, other staff or the schooling system are identified, it can be seen as risky for a teacher to proceed with implementation. In these cases, school leadership, particularly by the school principal, had the potential either to enable or restrict teacher implementation. How implementation took place pedagogically depended on the epistemological and political risks perceived and teachers' willingness to engage with them. Teachers' ability to engage with perceived risk may also be limited by their autonomy. Where pressures internal or external to their school limit their actions in the classroom, pedagogical risks are less likely to be engaged.

This study showed that it is important to consider the relationship between epistemology, pedagogy and politics when new curricular initiatives are being implemented. Professional development opportunities around such initiatives are most likely to be successful when these elements are engaged. It is also important to recognise that there is not one particular set of epistemologies, pedagogies and politics that are necessary for success. What is important is allowing teachers to engage in developing understanding, knowledge and

pedagogies that are aligned with their positions. In particular, the collaborative engagement and learning from and with peers has the potential to assist teachers to develop their positions. These factors speak to the importance of teacher-led curricular reform rather than the imposition of top-down approaches.

In summary:

- Complex interactions between teachers' epistemologies, pedagogies and politics influenced how and if the CCP was implemented.
- Different epistemological, pedagogical and political positions resulted in different approaches to science lessons inclusive of Indigenous knowledges. However, there was more than one position in relation to these elements that allowed successful implementation.
- Epistemological conflict thwarted classroom implementation.
- The opportunity to engage with professional development that was collaborative and teacher-led allowed teacher agency in developing understanding, knowledge and pedagogies for including Indigenous knowledges in science lessons.

Research Question 3
What happens when teachers engage with Indigenous Knowledge as part of their practice in science education?

In this study some of the teachers reported that implementation of Indigenous knowledges and perspectives in science education led to lessons that were engaging for students and professionally rewarding for teachers. It seemed that students and teachers developed an increased awareness and understanding of the value of Indigenous ways of knowing. Teachers were impressed with the way students engaged and their interest increased in both Indigenous and scientific concepts. More than this, teachers described the benefits of the CCP in science as promoting critical and holistic ways of understanding the world. Pedagogically, working in an area where they did not have a large knowledge

base promoted more constructivist lessons where teachers and students made meaning together. Constructivist pedagogical approaches allowed teachers to build their knowledge and understanding to keep developing their epistemological and critical approaches while engaging students in the mandated curriculum and building intercultural understanding. Lessons with Indigenous knowledges and perspectives sat comfortably beside more familiar approaches to learning science such as laboratory experiments. Not every lesson on a particular topic necessarily needs to contain Indigenous content. Teachers included the CCP in a targeted ways to increase student engagement while working from their own epistemological, pedagogical and political positions.

It is important to recognise the political and educational contexts that influence the implementation of curriculum reform. The rhetoric surrounding the introduction of the CCP seemingly promoted the national importance of reconciliation in education, as had past state based curriculum initiatives. However, this project showed how narratives related to neo-liberalism acted to define the purpose of education in terms of participation in the market place. In this policy and educative environment, support for curriculum initiatives based around the collective good was quickly overshadowed by other concerns. This meant that only teachers who were not concerned with being seen to act politically were confident enough to enact their critical pedagogy.

In this study it became clear that teachers effectively needed to work against the neo-liberal system that confined and constrained them. Opposition to successful implementation came from fellow staff members, school administration and rhetorically through political and policy debates in the media. Such opposition can be explicit, like the discourse questioning the position of Indigenous content in subject areas such as science, or implicit, through a refusal to prioritise the initiative. Teachers were successful in implementing classroom lessons where they had some support from their schools, or at least the autonomy to be agentic in their own classrooms. Even then, it was necessary for individual teachers to make a personal commitment to perusing the curriculum change, as institutional support from within or outside of schools is minimal.

In summary:

- The inclusion of Indigenous knowledges in science classrooms resulted in engaging and rewarding lessons that promoted intercultural understanding for both teachers and students.
- Lessons were taught using critical constructivist pedagogies where teachers learnt alongside their students. This approach assisted teachers to progress to implementation despite limited knowledge bases.
- The *Grand Narrative* of neo-liberalism acted to overshadow critical concerns about teaching for the 'common good'. This confined and constrained teachers' efforts to implement lessons that included Indigenous knowledges and ways of knowing in the science classroom.

Contribution to knowledge

Through this thesis I have contributed to the body of research that recognises teachers' voices speaking about their engagement with Indigenous knowledges, content and perspectives in science education. Important theoretical understandings about the importance of (a multilogical perspective of) epistemology, pedagogy and politics to the process teachers undertake to proceed to implementation have been presented. Methodologically, this work contributes to understanding how PAR may be enacted asynchronously to assist participants to engage in meaningful ways when they are not situated in the same context.

This study showed the importance of multilogical perspectives of epistemology, enacted through a post-formal lens, in understanding science teachers' engagement with Indigenous knowledges. Rather than focusing on the influence of scientific epistemologies alone, taking a multilogical approach allowed a nuanced understanding of teachers' epistemological engagement. The imbrication of critical, personal and scientific epistemologies allowed the

connections to be made to pedagogical and political factors influencing teachers' positions. While teachers' scientific epistemologies played an important role in determining their teaching approach, it is shown that other epistemological frames are also useful in investigating approaches to science education inclusive of Indigenous knowledges.

Epistemology alone, even from a multilogical perspective, is insufficient to describe the processes teachers engaged with in developing their teaching approaches and understandings. The interconnectedness of epistemology, pedagogy and politics is integral to understanding how teachers engaged with Indigenous knowledges. It is important that epistemology, pedagogy and politics are engaged in professional development activities for teachers to proceed past the rhetoric of why such inclusions are important to practical classroom implementation. This approach is even more important in light of this study's findings about how the neo-liberal system acts to confine and constrain teachers' efforts at implementation.

While PAR is recognised for its fluidity of process, this project extended this to show that asynchronous participant engagement in cycles can provided rich data and experiences. All participants do not need to be engaged in the same cycle at the same time to contribute to the group's work and their own professional development. In this project, allowing participants to engage in cycles within their own contexts and at their own pace resulted in them having the autonomy to direct the work in ways that assisted their individual understandings and praxis.

Limitations of the study

There are a number of factors that limited the scope and findings of this work. These related to the focus, participants and methodological considerations. The project exclusively focused on teacher participants who expressed an interest in the CCP in science education and involvement in the project. It would have been

a very different project had it engaged teachers, such as Cristy's colleague, who refused to teach the lessons Cristy had planned. In a sense, I chose to work where I thought I had a great chance of seeing successful implementation in the classroom. The scope of the project was also limited in that it only considered the implementation of the CCP in the subject area of science.

Limitations can also be described in relation to the teachers who participated in the project. All teacher participants identified as non-Indigenous. The addition of Indigenous teacher participation may have offered a different perspective on how the CCP could be implemented and data surrounding the interactions of participants. The small number of teachers involved also constrained the diversity of data possible, which may have limited the identification of themes for analysis.

Methodologically, data collection was sometimes limited by my ability as the researcher-participant to capture particular aspects of the work. Ethical clearances did not allow the collection of data from students of the teacher participants, for example. Also, I was not able to capture a complete picture of the complexities surrounding implementation within any particular school. Some gaps were also apparent in data such as where I was unable to get in contact with particular individual during busy work periods.

Future research

The findings of this study could be used to inform several different research directions. The scope and limitations of this research means several avenues of research present as possibilities:

1. This study was partly limited by its small number of participants. Future research could considering similar participatory, teacher-led research investigating Indigenous knowledges in science education in several different schools. The opportunity may exist for increasing

participant numbers within each school, and overall, and allowing the comparison of teacher processes across different contexts to see if similar themes are emergent.

2. This study focused on secondary school teachers' engagement with the CCP. An exploration of primary school teachers' implementation would add to the contextual understanding of how teachers engage with such curricular initiatives and highlight any differences between the contexts.

3. Teachers in this study described the CCP as promoting intercultural understanding in their students. Future work could explore the student experience of lessons with Indigenous content and perspectives and explore how intercultural understanding might develop through teaching inclusive of Indigenous ways of knowing.

4. The importance of epistemology, pedagogy and politics was shown in this study. Future work could explore if these factors are also important in teaching about other areas that may be considered counter hegemonic or controversial.

5. This study highlighted the confining and constraining impact of the neo-liberal education system. Further research could explore the ways in which teachers can remain agentic in the face of pressure to produce the right type of neo-liberal subject.

Where to next?

Australia is in challenging educational times. The Review of the Australian Curriculum (Australian Government, 2014) seemingly stripped many opportunities to engage with Indigenous knowledges in science classrooms. However, the curriculum reforms based on this Review stopped short of removing the CCP from the science curriculum all together (at least for now). This means there is still space for teachers to engage their critical pedagogical praxis and teach Indigenous knowledges and ways of knowing in science. Indeed, this project shows that this can be a possible, productive and positive

experience for teachers. The opportunities teacher participants saw for this type of teaching were not defined or constrained by curriculum content specifically identified as appropriate for the CCP. In fact, once they started considering the possible spaces, most branches of science were seen as viable options.

It is clear, however, that this type of teaching will not be prioritised or privileged in the curriculum in the near future. This means that issues of promoting teacher agency are imperative to keep the political project moving forward. Through projects such as this one, it is hoped that the rhetoric surrounding initiatives aimed at increasing Indigenous knowledges and ways of knowing can be moved from being just 'a good idea' to being practical reality in classrooms. By naming and recognising the political context it is hoped that false generosity (Freire, 2009) and political backlash of neo-liberal educational policy can be seen for what they are and strategies put in place to overcome them.

Questions around the purpose of schooling in contributing to the 'common good' need to be asked and addressed by politicians, State and Federal education systems, school administrations and teachers. While the neo-liberal *Grand Narrative* operates, often covertly, to direct what schooling is 'for', it is difficult for teachers with socially just concerns to move forward with their praxis. This begs the question - How can teachers be enabled to speak back to a system where their autonomy and trust in their professionalism is being questioned?

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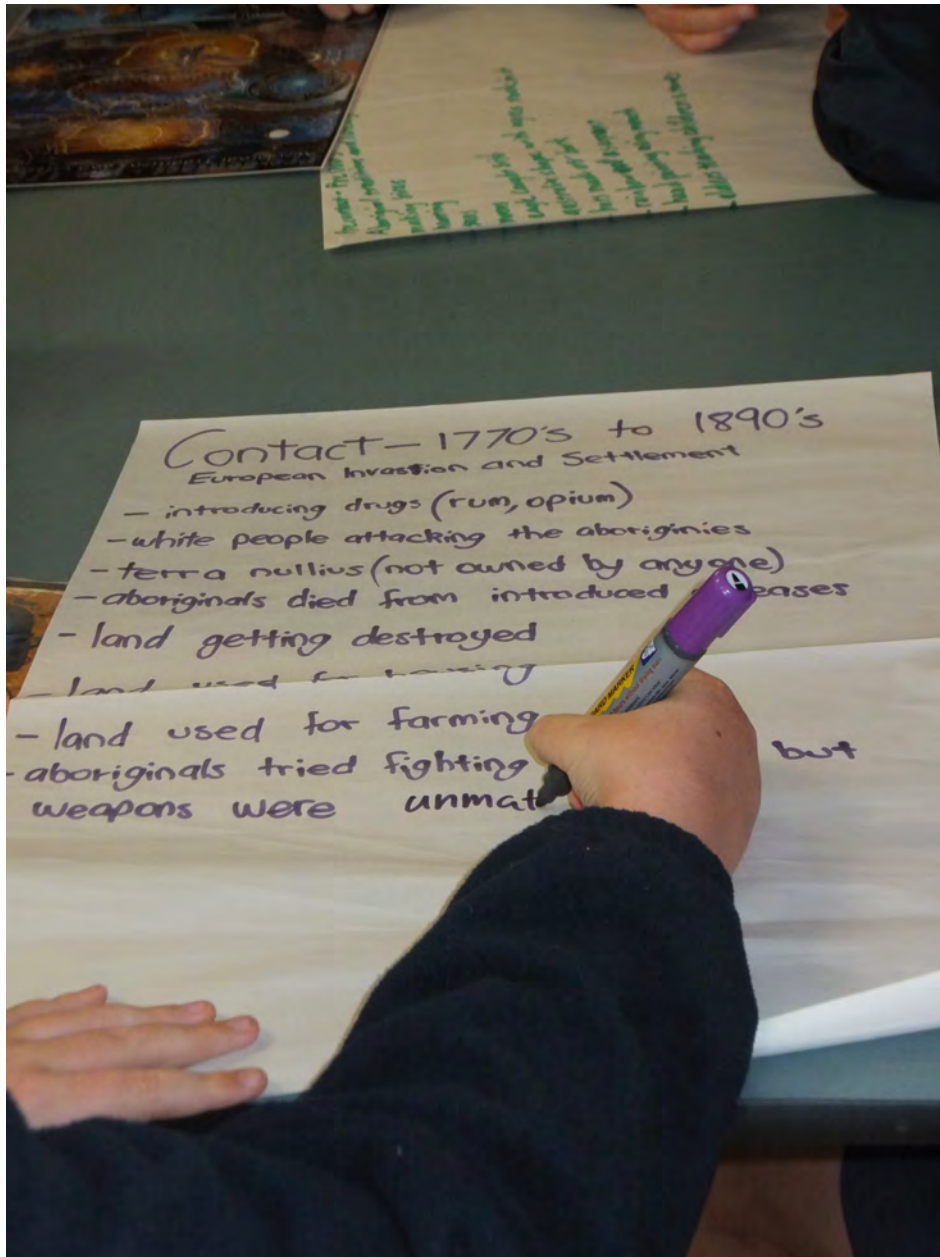
Appendix 1 – Allen's Project

Figure 32: Student activities as part of Allen's future planning project

A Place of Understanding

West Street, Darling Heights

Queensland has the second largest Aboriginal and Torres Strait Islander population in Australia, after metropolitan Sydney. USQ has a Centre for Australian Indigenous Knowledges. The main purpose of the centre is to encourage and assist the further education of Aboriginal and Torres Strait Islander people and facilitate teaching and research in Indigenous topics. In future the USQ will also develop a garden called 'Gumbi Gumbi' to promote a better understanding of Indigenous women and health. It will show awareness of the present circumstances of Australia's Indigenous peoples and celebrate the contributions of Indigenous Australians to our community. The garden will be developed as a source of bush tucker and will also provide medicine. It will be located on the northern side of the University. These events remind us of the Indigenous ways and their presence will never be forgotten.

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Toowoomba State High

Woomba Woomba
Water underneath

Toowoomba: an Indigenous tour
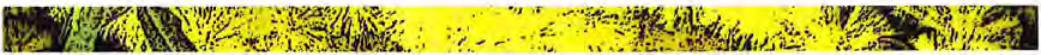
The Champion

Montana St – Jerry Jerome Oval, Miranda Park

The boxer and stockman, Jerry Jerome, claimed the Australian middleweight boxing crown in 1912. He was the first of many Aboriginal title holders. His speed and powerful punches delivered him numerous victories by either knockout or through the exhaustion of his opponents.

Jerry Jerome was a world class fighter by any standards and his sporting history has been well documented.

He died in 1943 at Cherbourg amongst his people.

On the Edge

Corner of McKenzie St. and Coventry Ct., McKenzie street Lookout

Walk out onto the Lookout and look back to the new smart housing of Mr Lofty. You are very much on the edge of Toowoomba. In the late 1800s this was the position of Aboriginal people. During the day Indigenous people would come into town to look for jobs so that they may survive. Work included, chopping wood, cleaning houses, sewing and nursing children. Some Aboriginal people would be paid in money and others in rations, such as tobacco, meat, food and blankets. If Aboriginal people could not find work soon enough, often they would be found homeless and in poor health, begging on the streets. Indigenous people in the evenings would find themselves moved to the edge of town. Just try to imagine what it would be like to be an Indigenous Australian in these times.
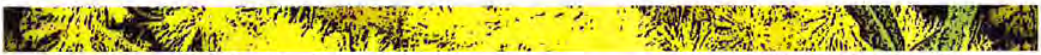
The Stand

Corner of Leslie and Collier Streets Duggan Park

If you take the path to the North-East corner of the park, there you will find Multuggerah's plaque to honour the defence of his people, their spiritual sites and their land. Multuggerah led his men to blockade the range crossing and this action led to the Battle of One Tree Hill. From the park you can see Table Top Mountain which is where the Battle of One Tree Hill occurred. Take a walk along the paths to reflect on Multuggerah's bravery. The park is a reserve for birds, small marsupials and if you are lucky, Red-necked Wallabies.

A Land of Plenty

The Murry Clewer Environmental Reserve, Spring St.

The creeks of Toowoomba provided a rich source of food for Indigenous people who spent their time spearing mullet, catching crayfish, turtles and roasting the roots of Cam-booya which when boiled are quite equal to asparagus. The surrounding grasslands and trees would attract many native animals like kangaroos, possums, flying fox, koalas, emus and wallabies just to name a few. The trees surrounding the creek provided bark for gunyas and tools. If you visit west creek could you still live off this land? Today this is still a great place for families. Ride your bikes along the path and you will catch glimpses of the bird and animal life that still clings to the creek.

Fires in the Night

Corner of Dippel and McStay St-Hell Hole Gorge Track

There are a lot of stories that about how Hell hole Gorge was named. To some it was a description of the hellish toil it took to drive a bullock team to the top of the range from the valley below. Others describe the view in the dark night, from the top of the range, of the many camp fires lining the creek. This inspired a view into hell.

The enclosing arms of the range and the creeks would have provided comfort and security to the Indigenous people. Possibly mothers cradling their children, families and friends around the fire, sharing a story or a song. What was their name for this place?

Figure 33: Brochure on an Indigenous perspective of the local landscape

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