He aha kei tua atu o te kohu kawata?

What lies beyond the silvery mist? Epistemic agency at the intersection of mātauranga Māori and biological science knowledge worlds

Brent Richard Wagner

A thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy (PhD) in Education

The University of Auckland

2020

Abstract

Within most urban mainstream secondary school biology classes across Aotearoa New Zealand are students who come from a range of ethnic, cultural, linguistic and socioeconomic backgrounds. They bring with them into the biology classroom knowledge from their life worlds. While for some, these knowledge resources are front and centre, for others their cultural knowledge remains hidden at the margins, in the shadows. In the face of dominant Western science discourse and practices, students often respond by keeping their cultural knowledge out of sight.

The purpose of this research project was to investigate the ways in which senior biology students used mātauranga Māori and/or Pacific cultural knowledge alongside biological science knowledge to justify their position on the socio-scientific issue of the use of 1080 poison to control mammalian pests in Aotearoa New Zealand – an issue of scientific and cultural importance. This research explores the potential for mātauranga Māori knowledge to be included into a mainstream, English-medium secondary school biological science course.

This research used a social constructivist ontology and qualitative-interpretivist mode of inquiry that utilised documentary analysis and semi-structured individual interviews with participants who were students in their final year high school biology course in two urban Auckland secondary schools. Three conceptual frameworks were developed for the thematic analysis of participants' written and verbal data: 1) Biological science knowledge, 2) Mātauranga Māori knowledge, and 3) Epistemic learner agency.

The findings from this research have identified how the participants used scientific and cultural knowledge when justifying their position on the 1080 issue. The application of the first two conceptual frameworks established the existence of three distinctive cultural interfaces: 1) Conflicted, 2) Parallel, and 3) Connected. Furthermore, for those students who occupied the cultural interface (Nakata, 2002), data analysis using the conceptual framework of epistemic learner agency enabled the construction of detailed representations of the theoretical space of the locale of the learner (Nakata, 2007).

The findings have highlighted the significance of epistemic learner agency in enabling culturally and linguistically diverse learners to bring forth their knowledge-worlds into the biological science knowledge domain.

Pepeha

Ko Maungakiekie te maunga	*Maungakiekie is my mountain*
Ko Manukau te moana	*Manukau is my harbour*
No Onehunga ahau	*I am from Onehunga*
Tihei Mauri Ora!	*The sneeze of life!*

Retrieved from: https://wwwmyguideauckland.com/things-to-do/one-tree-hill-domain

Whakataukī

Whāia e koe ki te iti kahurangi	*Seek that which you treasure*
Ki te tuohu koe	*Should you bow your head*
Me he maunga teitei	*May it be to a lofty mountain*

Acknowledgements

My doctoral research journey has not been a singular enterprise but one upon which I have travelled with many and to who I will be forever indebted. Without your support I would not have reached the end. This achievement is for all of us to share.

To my supervisors Associate Professor Beverly France and Professor Elizabeth McKinley ONZM go my deepest gratitude for your impeccable faith in my ability and whose advice and guidance kept me true to the research focus. Your patience and perseverance whenever I struggled to understand the way ahead allowed me the space and time to reflect and learn. Along the way, this kept alive the joys of discovery and mystery that began my lifetime in education and continue to this day. My sincere appreciation and thanks to you both; but especially to AP Bev France who kept the end in sight every step of the way. You gave me clear direction if needed, the space to learn and grow, and the freedom to take risks – always there to catch me if I was about to fall. Thank you, Bev!

My aroha and deep gratitude for the two schools who participated in the study – especially to their principals, HODs and teachers who allowed me time during biology classes to conduct the data collection phase. Thank you to the students who so freely gave me their assessment scripts and committed valuable time to share their stories and reflections as *taonga* for this study. This thesis is your voice to be heard. *Arohanui ki ā koutou katoa – ngā rangatira mo āpōpō!*

To my academic colleagues from the international CASSIS team based in Auckland, London, Southampton and Toulouse – thank you for your guidance and support of this project. To Associate Professor Azra Moeed MNZM, and my colleagues at Victoria University of Wellington – thank you for your aroha. To my friends and colleagues at the Ministry of Education in Maungawhau, I deeply appreciated your encouragement and interest in my research. Our conversations and your steadfast support inspired and motivated me onwards. I am especially grateful to Colleen Maguiness for your expert proof-reading of the final drafts.

Finally, to my family. My late parents Richard James Wagner and Dorothy May Wagner and also my late mother-in-law Toaiva Utumapu would have been so proud and happy to see me complete this thesis. My sister Marlene and brother Robert represent this pride and happiness today. Also, without the prayers, support and forbearance of the people closest to me, I could not have completed this journey.

To my sisters-in-law, Afioga Afamasaga Nona Utumapu and Puataunofo Utumapu, you are both special people in this journey. Thank you, Nona, for sparing me from one of my other passions – preparing our meals at home, which allowed me the time to drop into the University library on the way home after work to do some more writing. Thank you Pua for saving me endless hours of chores so that I could devote more time to this research. To you both, I am very grateful for your support.

To our daughters Jasmine Penina and Katie Leata Luafua go my deep love and appreciation. As my greatest cheerleaders, you were my inspiration. Your patience, encouragement and abiding belief that one day I would get there means so much to me. You turned the phrase "Are we there yet?" into "Dad, have you finished yet?" I can now answer with "Yes, I have."

To my wife Sefulu. You were there long before this journey began and remained beside me throughout the highs and lows. You were my reality check and safe harbour when needed. For your indefatigable loyalty to my research and your determination and drive for me to reach my goal goes my deepest love for all you have been throughout this journey and will be into the future. Let's share this achievement together, for without you, your prayers and unerring faith, I could not have completed this endeavour.

I share this success with you all. Thank you from deep within my heart.

Malo le onosa'i, malo le tapua'i!

Viia le Atua i mea uma lava.

Soifua ma ia manuia.

Dedications

This thesis is dedicated to the memory of

Dr Alice Mary Bush, FRACP, FRCP, MRCP

(1914 – 1974)

Distinguished paediatrician and courageous champion of children's and women's welfare.

And

Robert (Bob) Te Wharetoroa Kerr

(1918 – 2010)

(Ngāti Māhuta; Tainui)

Revered kaumatua and teacher whose stories, waiata and Te Reo Māori opened a world filled with language riches beyond my imagination.

Table of Contents

List of Tables

List of Figures

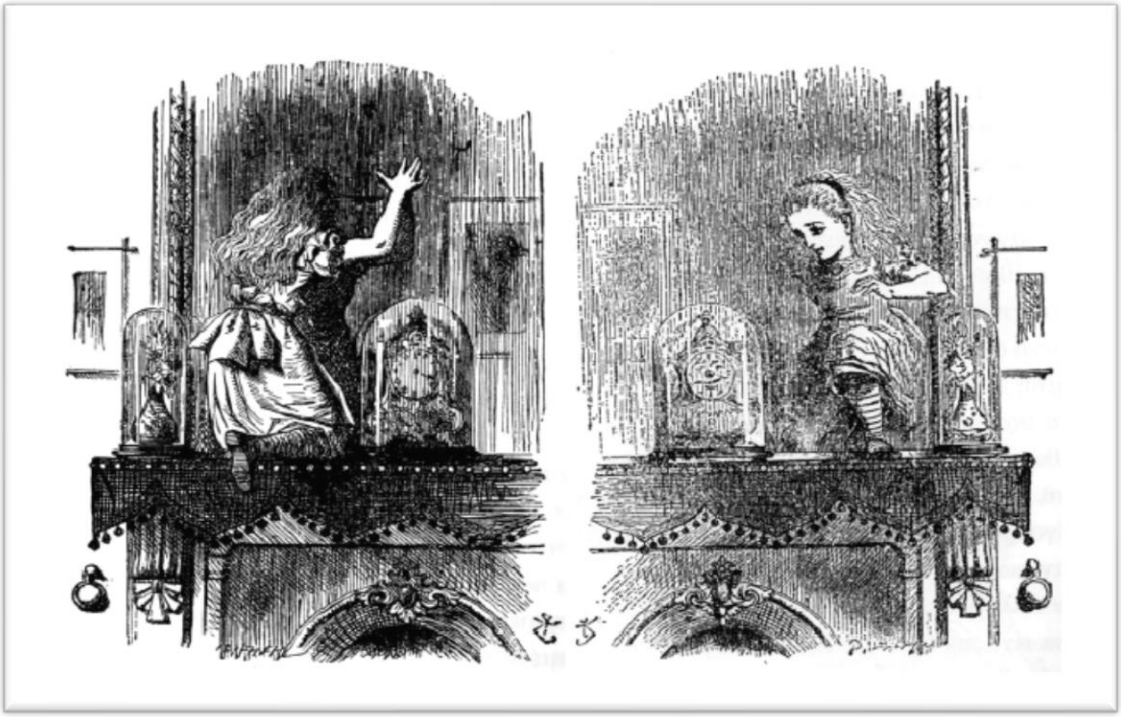
Glossary

Nga Kupu / Māori words	*Whakapākehātia / English Translations*
Aotearoa	New Zealand
aroha	Love in its broadest sense
haka	Posture dance
hapū	Clan, group of families/sub-tribe linked to a common ancestor
hauora	Health, wellbeing
hui	Gather, meeting
iwi	Tribe/federation of hapū
kai	Food
kaitiaki	Guardians
kaitiakitanga	Active guardianship (of the environment)
karakia	Prayers or ritual chant or incantation
kaumatua	Respected tribal elder
kiore	Polynesian rat
kotahitanga	Unity/togetherness/bonding
kura	School
mana	Authority, influence and dignity/prestige/power
mana whenua	Power associated with possession of land/people with customary authority over the land through whakapapa
manaakitanga	Expression of respect, kindness and hospitality
marae	Meeting area of whānau, hapū or iwi
mātauranga Māori	Māori indigenous knowledge and understanding
mauri	Internal energy of life force
Pākehā	Non-Māori New Zealander of European origin/descent
Papatūānuku	The earth Mother
Patupaiarehe	Guardian spirits
pepeha	Self-introduction
pōwhiri	Ceremonial welcome
pūmanawatanga	morale and tone
pūtaiao	Science
rangatiratanga	Self-determination
Ranginui	The sky Father
rongoā Māori	Traditional Māori healing
tangata whenua	Indigenous people or Māori
Tāne	Tāne Mahuta the Māori forest god
taniwha	Mythical creature

Nga Kupu / Māori words	*Whakapākehātia / English Translations*
taonga	Treasure(s)/anything highly prized
tapu	Restriction or prohibition
tauira	Students
te ao Māori	The Māori worldview
Te Ao Mārama	The natural world
te ao Tūroa	The world of nature
Te Ika a Māui	The fish of Māui/North Island
te reo Māori	The Māori language
Te Taiao	The biological environment
tikanga	Customary ways/correct practices/protocols
tupuna	Ancestors
waiata a ringa	Hand action songs
wairuatanga	Spirituality
whakawhanaungatanga	Establishing relationships/caring
whānau	Extended family group
whanaungatanga	Kinship
whakapapa	Genealogical descent
whakataukī	Proverb
whenua	Land

Abbreviations

AS	Achievement Standard
BTb	Bovine Tuberculosis
CASSIS	Communication About Socio-Scientific IssueS
CF	Consent Form
DOC	Department of Conservation
ES	Eurocentric Sciences
HOD	Head of Department
HS	High School
IK	Indigenous Knowledge
INT	Interview Data
IWLN	Indigenous Ways of Living in Nature
LISP	Learning in Science Project
MfE	Ministry for the Environment
MNZM	Members of the New Zealand Order of Merit
MoE	Ministry of Education
NCEA	National Certificate of Educational Achievement
NOS	Nature of Science
NZ	New Zealand
NZC	The New Zealand Curriculum
NZCER	New Zealand Council for Educational Research
NZQA	New Zealand Qualifications Authority
OECD	The Organisation for Economic Co-operation and Development
ONZM	Officers of the New Zealand Order of Merit
PCE	Parliamentary Commissioner for the Environment
PF2050	Predator Free 2050
PFW	Parent/Family/Whānau
PIS	Participant Information Sheet
PMCSA	Prime Minister's Chief Science Advisor
SAQ	Socially Acute Question
SL	Scientific Literacy
SS	Secondary School
SSI	Socio-scientific Issue
STEM	Science/Technology/Engineering/Mathematics
TA	Thematic Analysis
TEK	Traditional Ecological Knowledge
TMoA	Te Marautanga o Aotearoa
UAHPEC	University of Auckland Human Participants Ethics Committee
WMS	Western Modern Science
Y12, Y13	Year 12, Year 13
1080	Compound 1080 Pesticide



Retrieved from: https://www.researchgate.net/figure/Original-drawing-by-Sir-John-Tenniel-for-Lewis-Carrolls-Through-the-Looking-Glass_fig1_228593628

Chapter 1: Introduction

1.1 Into the Looking-glass

> "Oh Kitty, how nice it would be if we could only get through into Looking-glass house! I'm sure it's got, Oh – such beautiful things in it!" (Carroll & Oxenbury, 2005, p. 18).

Alice dreams of an adventure as she imagines the world beyond the mirror and ponders on how to get there.

> "Let's pretend there's a way of getting through into it, somehow, Kitty. Let's pretend the glass has got all soft-like gauze, so that we can get through. Why, it's turning into a sort of mist now, I declare!" (2005, p. 18).

At that, and leaving the kitten behind, Alice climbs up on the chimney piece as the glass begins to melt away, "just like a bright silvery mist" (2005, p. 18). In a moment, she was through to the other side and into a back-to-front topsy-turvy world. Eventually, Alice ventured outside the Looking-glass house and into the garden, from where her adventures begin.

The curiosity demonstrated by this well-known 19th century children's adventurer, similarly inspired this research project. I have also been curious to know more about hidden worlds beyond my own experiences shaped initially by my Pākehā (European New Zealand) family, childhood and schooling. This thesis is the culmination of some of these experiences combined with my desire to learn more about the ways people view and understand the world. In the imaginary world beyond the Looking-glass, Alice's adventures provided this research project with a starting point and a glimpse into what might lie ahead. But first, an outline of this chapter.

Following this introduction, Section 1.2 outlines the origins of my interest in exploring a scientific issue from different perspectives and explains how some of my childhood experiences have influenced this project. Section 1.3 locates this research in a scientific context by describing the threats posed to the unique biodiversity of Aotearoa New Zealand by introduced mammalian pest species. Section 1.4 details the controversial use of 1080 poison to control pest species and explains how this socio-scientific issue could provide a unique platform from which to investigate and learn more about the diverse range of views towards 1080 use amongst the general population and the scientific community in this country. Section 1.5 describes the impetus for the study, followed by Section 1.6 which brings these ideas into

a senior high school biology classroom, where students could discuss the 1080 issue as part of their biology studies. In this diverse classroom environment, knowledge worlds converge, and scientific and cultural views towards 1080 use abound. Section 1.7 concludes the chapter and describes how a classroom dilemma eventually led me towards this research project. Section 1.8 describes the overall structure of this thesis.

1.2 My background influences and interest in this topic

This past year, 2019 is significant to the choice of topic for several reasons. I vividly recall the 1969 bicentennial commemoration of British explorer and navigator Lieutenant James Cook's landing upon the shore of Aotearoa during his first voyage to the South Pacific in 1769. The primary objective of the voyage was a scientific one – to travel to Tahiti to observe the transit of Venus. A group of scientists on board HM Bark *Endeavour* included Joseph Banks and botanist Daniel Solander who collected and recorded specimens of flora and were the first people to apply Western scientific ideas to Aotearoa and document the unknown natural world (Phillips, 2014).

A secondary objective was the search for the great southern continent *Terra Australis Incognita*, supposed to lie below Lat. 40° S (Mackay, 1990), which required skilled navigation and cartography skills. Two days after Aotearoa was sighted on 6 October 1769, representatives from two cultures – Māori, the indigenous inhabitants of Aotearoa and their seaborne visitors from England and Europe – met on the land of Aotearoa New Zealand for the first time. At this first meeting and in the days following, gunfire from the Endeavour's crew cost the lives of several Māori, which made for an inauspicious beginning to the eventual colonisation of these islands by European settlers and their descendants.

For my part, thinking back to 1969 when, as a primary school pupil I remember the sketching of a chalk outline of Cook's *Endeavour* onto the bitumen netball courts to show us the amazing feat that a ship of such a relatively small size could make its way from the other side of the world two-hundred years previously. Conversely, I cannot recall any parallel discussion that year about the arrival of indigenous Māori to Aotearoa. There were certainly no chalk drawings completed of waka (a sea-going vessel) that went out to greet the arriving sailing ship nor any recollections of a celebration of the seafaring prowess of Māori tupuna (ancestors) – the first human inhabitants of Aotearoa. That's how it was. In 2019, we once again mark the anniversary of James Cook's first arrival in Aotearoa New Zealand 250 years ago. In 2019, the Tuia 250 commemoration has been greeted by some local Māori with sadness and in some

cases outright disdain as illustrated by this comment by a local Māori reported by Matthews (2019):

> It is disrespectful to my people and my whenua to revisit the main cause of the raping and pillaging of my ancestors, the stealing of our lands, the introduction of sickness and disease and the suppression of our language and culture. (p. 2)

2019 also marks the 50th anniversary of the first humans to set foot on the Moon. The culmination of the space race in July 1969 impacted strongly on me and those of us of the *Star Trek* generation who sought to follow Neil Armstrong's lead and go boldly forward in to strange new worlds and to places no human had gone before. This chapter will explain the foundations of this research, nested in yearning for adventure that characterised my early school life, which later matured into a successful career in education.

Firstly, this project has its genesis in an amalgam of childhood experiences that shaped my worldview. The single most important influence on this worldview after my own upbringing occurred less than two years after the Moon landing in 1971 where, at the age of 11, I completed my final year in Standard 4 at Onehunga Primary School in central Auckland.

My teacher that year, Wharetoroa 'Whare' (Bob) Kerr was a respected kaumatua (tribal elder) whose whakapapa (genealogy) belonged to the Tainui iwi (tribe) from the Waikato region of Te Ika a Māui (North Island) of Aotearoa New Zealand. Mr Kerr would routinely infuse into his teaching vivid stories from Māori mythology, and use cultural events and imagery from Te Ao Māori (Māori worldview) to enrich his teaching. In turn, my learning was enriched by his personal stories, waiata (songs), haka (a posture dance) and use of Te Reo Māori (The Māori language).

Significantly, Mr Kerr's waiata, stories and language teachings transported me into a surreal world of imaginings and adventure. At the time, I was oblivious to the power of these experiences to influence my life-course in subsequent years. Furthermore, we regularly performed our waiata a ringa (action songs) and haka at pōwhiri (ceremonial welcomes) on Te Puea Memorial Marae in Māngere Bridge, across the Manukau harbour from Onehunga. For example, the waiata *Hoea hoea ra*, taught us the names of seven waka (ocean-going vessel) from the original great fleet during the first migration of Māori tupuna (ancestors) to Aotearoa from Hawaiki (ancestral Polynesian homeland). It goes like this:

Ngā waka e whitu	*Seven canoes*
E tau nei	*Headed this way.*
Hoea hoea rā	*Sail on, sail on!*
Tainui, Te Arawa, Matātua	*Tainui, Te Arawa, Matātua*
Hoea hoea rā	*Sailing, ever sailing!*
Takitimu, Tokomaru,	*Takitimu, Tokomaru,*
Kurahaupo	*Kurahaupo*
Aotea ra	*And Aotea*
Ngā waka ēnei	*These are the seven canoes*
Hoea ra,	*that sailed here*
E ō tātou tupuna	*with our ancestors*

Retrieved from: http://www.folksong.org.nz/hoea_hoea_ra/index.html

These experiences left an imprint on me and inspired me to learn more about the indigenous culture and language of Aotearoa New Zealand.

Mr Kerr's stories from Māori tribal folklore of taniwha (mythical guardians) from the Manukau harbour who performed miraculous deeds in the real world, fascinated and absorbed me. These experiences coincided with reading from cover to cover my first chapter book, the science fiction fantasy, *A Journey to the Centre of the Earth* by Jules Verne. As with Mr Kerr's stories, my imagination stirred again. As I turned the pages of the book, I could imagine myself in the surreal world deep below the earth's surface on an adventure into the unknown in the footsteps of the fictional medieval alchemist – Arne Saknussemm.

The second major influence on my decision to pursue this doctoral research project is a combination of experiences throughout my teaching career that have strongly linked my science and biology teaching to my personal and professional interest in Pacific languages and culture. To begin with my personal and professional interest in Te Reo Māori and Sāmoan languages, I have maintained my interest in Te Reo Māori and tikanga since my primary school experiences. My primary teacher training advanced my knowledge of mātauranga Māori and Te reo Māori and culminated in a master's thesis which explored the impact of an innovative Māori language programme on an urban south Auckland primary school community in 1984. In addition, my personal connection to the Pacific began that year with my first visit to Western Sāmoa. Following my marriage to Sefulu Utumapu four years later we were determined to raise our daughters Jasmine Penina and Katherine Leata Luafua to

become confident bilingual and bicultural individuals who could walk in both the Western and Pacific worlds with confidence and pride in their dual cultural and linguistic heritage.

Alongside my life-long interest in learning and extending my knowledge of Māori and Sāmoan language and culture has been a successful and fulfilling teaching career which began as a primary trained teacher in 1985. After three years I had moved on to a secondary school teaching position where I spent my career as a science and biology specialist. My teaching experiences added another important and influential factor to the decision to pursue this research project.

This factor can be best described in the form of a dilemma where, since my first year teaching high school science, I have encountered classroom situations that have left me wondering why, despite my personal enthusiasm for my subject and its content, and the application of what came to be known as culturally responsive and relational pedagogy, there was something missing which I could not understand. Students did not share the same enthusiasm and excitement for science/biology as I did. Upon deeper reflection, it was noticeable that students of most concern for me were predominantly those students from linguistic and culturally diverse backgrounds who are referred to and grouped as 'Māori and Pasifika' students (Hawk, Cowley, Hill & Sutherland, 2002, p. 44) in Aotearoa New Zealand. Many of these students appeared to be 'switched off' by science. I was determined to find a way to find the switch and turn it 'On'.

Having taught and observed students in multi-ethnic urban schools for my entire teaching career, I became increasingly concerned for those students who seemed to disengage with the science topic regardless my approach. I believed that I had a good comprehension of the knowledge worlds of Māori and Pacific learners and understood their worldviews. However, despite a determined effort to prepare lessons and provide resources and tasks which I thought would connect science with the students' worldviews, I became increasingly puzzled at their reluctance to engage. This was at the heart of my dilemma. What did I need to know to enable my science students to fully engage? From my teaching and research background, I was aware of the primacy of building relationships and trust, of culturally responsive and sustaining pedagogy and the importance to students of family connections to their learning which lay at the heart of working effectively with Māori and Pacific students (Averill & Hindle et al., 2014; Bishop, 2011; Bishop & Berryman, 2006; Durie, 2006; Ferguson, Gorinski, Wendt-Samu, & Mara, 2008; Gilbert & Bull, 2013; Hynds, Averill, Hindle & Meyer, 2017; Mahuika, Berryman & Bishop, 2011; McKinley, Stewart & Richards, 2005; Otrel-Cass, Cowie & Glynn, 2009).

In 2013, I became involved with a research-based project called the *Starpath Project for Tertiary Participation and Success*. The Starpath Project was launched by the University of Auckland in 2005 with the principal aim of developing evidence-based ways of raising the achievement of Māori, Pacific and other students (Hynds et al., 2015). It sought to open pathways to tertiary education and beyond for students in schools serving low socio-economic communities who were traditionally under-represented in higher education. An important element of the model was that it was designed to assist schools to set up processes to bring together students, parents, whānau and teachers in extended face-to-face academic counselling sessions that replaced the traditional 'parent-teacher interviews' mode of communication (Starpath Project, 2014). As deputy principal I had a shared responsibility as a member of the senior management team to introduce, set up and monitor the Starpath programme at my school. I discovered that the importance of creating opportunities for students to lead learning-focused discussions involving their family and teachers was central to the Starpath process. Watching this in action confirmed for me that utilising students' voices could open the way to provide evidence that may help solve the puzzle at the heart of my dilemma.

From these first-hand experiences as part of the Starpath project, I was keen to follow my hunches and investigate the hidden narratives revealed by the illuminated stories and lived experiences of the students. I was determined to find ways to uncover how students used knowledge in their science learning. I was confident that their stories could reveal this and perhaps uncover other less-obvious factors at work of which I was professionally unaware.

My determination to learn more about why some students disengaged in class eventually led me to decide to explore my hunches through this doctoral research project. The decision as to the context for this research came about in 2013 when I agreed to cover two Year 12 biology classes for a colleague who was on study leave. The ecology topics we covered that year confirmed my decision to explore a socio-scientific issue of concern to a broad cross-section of individuals. This would be an interesting context for my investigation and provide opportunities to gather rich, authentic evidence for analysis. I believed that the use of 1080 poison (sodium monofluoroacetate) as a pest control agent offered a curriculum-related issue of scientific and social interest to a broad cross-section of students.

The following two sections explain and justify the choice of the contemporary socio-scientific issue of 1080 use in pest control as the context of this research. From within this issue, the next sections also illustrate the critical importance of protecting our unique biodiversity in the face of the threats posed by introduced mammalian pest species.

1.3 Threats from pests to the biodiversity of Aotearoa New Zealand

This section examines the current state of the biodiversity of Aotearoa New Zealand, the threats to its health posed by introduced mammals and the methods used to control these species with a specific focus on the use of compound 1080.

The extended isolation of Aotearoa New Zealand from the supercontinent of Gondwanaland (Campbell, Cooke, Cass & Earl, 2004) resulted in a distinctive biodiversity (McGlone, 2007), and one of the highest levels of endemism in the world (Royal Forest and Bird Protection Society of New Zealand, 2019). Many native land animals are forest dwellers, where birds dominate, and except for two species of bats, there are no native land mammals. In the absence of mammalian predators, many native bird species such as kākāpo (*Strigops habroptilus*) and kiwi (*Apteryx*) evolved and became flightless.

The arrival of humans to Aotearoa New Zealand had a huge impact on the plants and animals of the ecosystem. First, Māori arrived from Polynesia in the 13th century and then Europeans arrived in the late 18th century. Both brought with them a range of animals, from which many of the native species were defenceless against attack (Nathan, 2013). As one of the last places on Earth to be inhabited by humans (Irwin & Walrond, 2012), Aotearoa New Zealand has been adversely affected by their poor decisions relating to the natural environment. This has resulted in significant impacts on the indigenous biodiversity under threat from habitat modification and destruction, human activities including over-exploitation and competition by invasive alien species.

New Zealand has a unique set of introduced mammals impacting on both biodiversity and primary production (Allen et al., 2014). The Polynesian rat (kiore, *Rattus exulans*) arrived with Māori while Europeans also brought other species of rats and mice into Aotearoa New Zealand. Rats kill native birds and bats and in winter they and mice eat insects that would otherwise be food for native animals. Rabbits were introduced for sport and a food source in the 1830s and around 40 years later, weasels, ferrets, stoats and cats were released to control the rabbits (Peden, 2008). These predators quickly spread to the forested areas and remain a problem because they feed on both eggs and the young of many native animal species.

Brushtail possums (hereafter the ‘possum’) were introduced from Australia in 1858 (Green & Rohan, 2012) to establish a fur industry in the new colony. They are now found in about 95% of all farmland, scrubland and bush (Brockie, 2007). With no natural predators in Aotearoa New Zealand (Potts, 2009), the ubiquitous possum occurs in native and plantation forests,

scrub, tussock grasslands, all rural habitats and in city parks and gardens (Wilson, 2004, p. 207). Possums are the main source and carrier of the highly infectious disease Bovine tuberculosis (BTb), which can infect cattle and deer herds (Parliamentary Commissioner for the Environment, 2000, p. 11), a threat to our primary production export market.

Possums cause huge damage to Aotearoa New Zealand forests on many levels. Beginning on the forest floor where they eat seedlings, saplings, fungi and tree ferns, their impact extends upwards to the sub-canopy level, where they eat perching plants, climbers and bark. Rising up still further, they eat leaves, flowers and seeds from canopy trees reducing the levels of nectar and fruit produced. This reduction robs native birds, bats, lizards and insects of their food source. Their impact continues in the forest as they also eat native insects, snails, bats, birds and their eggs and nestlings (Brockie, 2007).

Thirty-one species of exotic mammals have wild populations in Aotearoa New Zealand, and 25 of these are actively managed as pests (Parkes & Murphy, 2003). Feral animal pests are found across the range of Aotearoa New Zealand landscapes, from production, conservation, local government managed and Māori-owned land (Allen et al., 2014, p. 431).

In response to the continuing decline of our indigenous biodiversity the Ministry for the Environment (MfE) launched *The New Zealand Biodiversity Strategy* was developed (MfE, 2000) and updated in 2016 as The *New Zealand Biodiversity Action Plan* which set the ambitious goal "to rid Aotearoa New Zealand by 2050 of the most damaging introduced predators that threaten our nation's taonga (national treasures), our economy and private sector" (Department of Conservation, 2016, p. 6). In August 2019, the Department of Conservation (DOC) launched a discussion paper *Te Koiroa o te Koiora – New Zealand Biodiversity Strategy Discussion Document*, subtitled "Our shared vision for living with nature" (DOC, 2019), and invited public submissions until September 2019. These documents indicated the government's intention to promote discussion and invite feedback from communities and groups from across Aotearoa New Zealand.

Since 1960, pests have been cleared from 117 offshore islands (Hansford, 2016, p. 226). With these successful eradications of mammalian predator species from many offshore islands and signs of recovery of native species on predator-free islands, there is evidence for the dramatic impact that pest management plays in supporting biodiversity. *The New Zealand Biodiversity Action Plan* describes the Predator Free 2050 (PF2050) programme is "an integrated large-scale effort to eradicate predators by supporting new and existing conservation projects, primary sector pest control, and community groups" (DOC, 2016, p. 6). With a clear and

obvious threat posed by pests to the maintenance of our biodiversity, pest control is seen as critical to rescuing our biodiversity – the natural heritage in which every New Zealander has a stake (Hansford, 2016, p. 133). The next section discusses 1080 as a pesticide and considers how this compound and its widespread use became a controversial issue for generations past and present.

1.4 The issue of 1080 use in pest control

1080 use in pest control is a biodiversity-related and environmentally critical issue of our present and future in Aotearoa New Zealand. The controversy is prominent in communities across the country and has implications socially, economically scientifically and culturally. In the public domain, some people are angry about the use of 1080 and there are opponents in one corner and supporters of 1080 use in the other. Both groups are at odds with deeply held and passionately justified positions.

Compound 1080 is a chemical reproduction of a naturally-occurring, biodegradable poison, called sodium monofluoroacetate. This simple organic salt occurs naturally in some Australian, South American and African plants which have developed this adaptation to discourage browsing animals. It kills target animals quickly and does not bio-accumulate (The Organisation for Economic Cooperation and Development (OECD), 2007, p. 78). When 1080 is consumed, the poison disrupts the mammal's ability to extract energy from food and this leads to the animal's death from cardiac or respiratory failure. 1080 kills all mammals, not just pest animals. Dogs are particularly sensitive to 1080 and can be killed by secondary poisoning.

The latest planned response will cover one million hectares (12% of conservation land) exceeding the 840 000 hectares covered in 2016 and 600,000 hectares covered in 2014 during a pest control programme known as the 'Battle for our Birds' (Elliott & Kemp, 2016, p. 200). The results of the poison drop in 2016 indicated that areas treated with the 1080 poison saw a substantial reduction in rat abundances (Elliott & Kemp, 2016, p. 205).

The Department of Conservation (DOC) first used 1080 poison to control mammals, especially brushtail possums, in Aotearoa New Zealand in 1956 (Miller & Anderson, 1992). As the only poison registered for aerial use, 1080 distribution from the air is now the preferred method as large areas of wilderness are inaccessible and too rugged to protect in any other way (Hansford, 2016, p. 246). Most recently, in 2019 DOC expressed concerns that a mega mast (heavy seeding) event will take place in autumn, predicted to be the biggest in more than 40 years. This is reportedly responsible for an explosion in the populations of rodent and stoat

plagues which pose a serious threat to native bird species and other wildlife as predator populations build up next spring and summer (DOC, 2019).

Views about 1080 in Aotearoa New Zealand

As a young nation, Aotearoa New Zealand has 'imported' many of its attitudes to wildlife management that, since colonisation, have matured and evolved with its national identity (Russell, 2014). According to Russell (2014), eradicating mammalian pests from forests is widely supported by many New Zealanders who hold a more utilitarian than protectionist attitude to introduced wildlife. For example, a survey by Russell (2014) revealed that attitudes to small pests (such as possums and rodents) have remained negative and unchanged over the previous 20 years with most people still regarding possums as pests. They support control and extermination using a combination of trapping and poisoning.

In July 2016, Dr Wayne Linklater a researcher in Wildlife Biology and Human Dimensions Ecology at Victoria University of Wellington, commented in the *Dominion Post* newspaper that the biggest challenge to the PF2050 plan to make Aotearoa New Zealand predator-free by 2050 is not the pests themselves, but people. He explains that the success stories of eradicating pests from offshore islands overlook the fact that these places are not inhabited in any significant way by people. Conversely, on the mainland, any attempt to eradicate pests using conventional poisons requires a 'hearts and minds' shift to believing that removing all pests is a worthwhile goal that is worth participating in.

Such a shift would have to occur against the backdrop of a diverse community – a nation of people with divergent values, beliefs and behaviours. For example, Linklater points out that while there are some people who want to trade in possum fur – currently worth NZ$127 million per annum as a Merino-possum blend (Hansford, 2016, p. 223), others "will want to keep a cat." He also observes that people who consider rats as taonga (a cultural treasure) will be neighbours of people who want to kill rats, cats and possums. This is a classic recipe for environmental conflict that no amount of biological or technological expertise can solve – the people problem (Linklater, 2016).

The 1080 controversy

From the outset, 1080 use was controversial (Eason, Wright & Fitzgerald, 1992). Despite improvements in the use and targeting of 1080, its use remains embroiled in controversy (Eason, Miller, Ogilvie & Fairweather, 2011; Russell, 2014). Any proposed 1080 aerial drop to control mammalian pests, (specifically possums) in the Aotearoa New Zealand ecosystem

attracts public attention and elicits opposing viewpoints. For example, there is a view that 1080 destroys the fauna and is responsible to contaminating waterways with the potential to poison companion animals. What is undeniable is that the use of a simple organic salt poison rouses strong emotions and it has become a highly controversial issue (Hansford, 2016, p. 9).

The controversy surrounding the use of 1080 goes beyond a strictly science-based debate. For as much as those who support the continued use of 1080 can argue for this position using quantitative scientific evidence, opponents are quick to point out that there are implicit social, economic, ethical and cultural dimensions to the debate, that the calls for a predator-free Aotearoa New Zealand by 2050 overlook (Richardson, 2018). An example of this can be seen in Māori communities who have shown that they are prepared to listen to science but ultimately reserve the right to consider the data against teachings from their ancestors before arriving at any decisions (Hansford, 2016, p. 134). While the control or eradication of introduced mammalian predators has become a major conservation priority (O'Donnell & Hoare, 2012), the use of 1080 remains a controversial issue in Aotearoa New Zealand, of importance to Māori, the scientific community in general and the wider public of Aotearoa New Zealand.

1.5 Impetus for this study

This use of 1080 poison is current, controversial and important to Māori and the scientific community in general. Furthermore, the issue lends itself to study by senior secondary school biology students and falls under the New Zealand curriculum requirements for senior secondary school biology. The current controversy surrounding the use of 1080 poison to control and manage mammalian pest species – specifically, possums and rats – meets these criteria. Viewing this issue from a cultural <u>and</u> scientific perspective would give this research project the impetus to explore the zone where knowledge worlds converge.

In most mainstream secondary school biology classes in Aotearoa New Zealand, it is conceivable that there exists multiple knowledge worlds and worldviews amongst students who come from a range of ethnic, cultural, linguistic and socioeconomic backgrounds. This aim of this thesis is to grow our understanding of how linguistically and culturally diverse students use scientific and cultural knowledge resources in their science learning in mainstream high schools across Aotearoa New Zealand. With a focus on knowledge use from different knowledge worlds and by using science education research from Aotearoa New Zealand and international cross-cultural and indigenous studies as a foundation, this research project seeks to add to our research evidence and replenish our research gaps in this area.

For linguistically and culturally diverse high school students, the literature suggests that traditional science instruction that is perceived as culturally incongruent and contradictory to their worldviews may be met with resistance (Meyer & Crawford, 2011), which can manifest as disengagement and disinterest that could ultimately lead to underachievement in nationally recognised assessments. Conversely, the assumption is that a more culturally congruent science programme could see engagement and achievement measures rise.

The report by Ferguson, Gorinski, Wendt Samu and Mara (2008) produced evidence for what they refer to as a complex and incongruent educational system that impacts differentially on its participants. Yet despite this differential impact, their evidence suggests that Pacific learners have different capacities to navigate and transition between different worlds (Cahill, 2006). The question remains as to what this congruence might look like in a senior high school biology class. For example, increased cultural congruence could be achieved by acknowledging and foregrounding the multiple knowledge worlds of students. This could in turn positively influence the perception of school science as a subject more culturally aligned with linguistically and culturally diverse students' knowledge worlds.

It is proposed that a more culturally congruent science programme would require the pairing bodies of knowledge so that they can be appreciated within their respective paradigms (Durie, 2011). Historically this has not been a smooth relationship. To illustrate, Mason Durie discusses the predicament of Galileo whose theories challenged the accepted church orthodoxy as to the order of the solar system. This put him on a direct collision course with the accepted theological view of the time. This, Durie points out, illustrates how Galileo was caught between two knowledge systems. This conflict with the guardians of the religious teachings of the time subsequently forced him to retreat. This example illustrates that historically, the knowledge interface was often fraught with contestabilities (Durie, 2011, p. 103). Nowadays, by accepting that there is more than one way of looking at the world and that both ways of viewing a phenomenon have equal validity and provide alternate perspectives towards it, the convergence zone between knowledge worlds presents a new frontier of exploration and offers a source of undiscovered riches (Mercier, 2007; Durie, 2011).

For me, as a research-informed practitioner, the central question concerns the use of knowledge – specifically scientific and cultural knowledge. For example, what could this relationship look if learners who are exposed to knowledge domains at home that differ from those in the biology classroom are enabled to draw upon these knowledge resources to aid their learning? This is a particularly relevant concern if epistemological and ontological

disparities exist on a daily basis as part of the life worlds of secondary students of non-western ethnicities. With more than one knowledge world in play, how might students express themselves in an assessment situation if both knowledge domains were available for students to draw from? If this was the case, what would this look like from the students' standpoint? These and related questions drive this research.

1.6 Knowledge spaces

When we first met Alice at the beginning of this chapter, she imagined a world beyond the Looking-glass filled with beautiful things. At the interface of the mirror at the boundary between her real and imagined worlds, Alice began a journey of discovery as she learned more and more about the Looking-glass world. While physically present at the beginning of the story, Alice imagines the world beyond the Looking-glass and in her dream-state enters the world where her adventure begins. Alice's imaginings were firmly grounded in her childhood experiences and, with the aid of a story, she was able to vividly describe her imaginary world. Although the space traversed by Alice beyond the silvery mist existed in the surreal realm of her dream-state, her success depended on her ability to interpret elements of the Looking-glass world using a range of skills.

Knowledge, obtained in physical space, can also reflect an inner (cognitive) space (Paradis, Hudson & Magnusson, 2013). Paradis et al. emphasise the importance of the relationship between physical space and mental space as it is expressed in human communication (2013, p. 1). As if in homage to Alice, Paradis et al. use the spatial metaphor of a window through which we can glimpse this inner space while in search for a better understanding of the relationship between physical space and its conceptual counterpart (Paradis et al., 2013).

Furthermore, if students are required to take a position towards a socio-scientific issue and justify it by analysing and evaluating the biological and cultural knowledge related to the issue, an uncharted world may open for this research to explore how students utilise knowledge from these domains. The space where these knowledge domains converge could be viewed in several ways. For example, we could view space as a final frontier 'out of this world' or a 'somewhere up there' phenomena. Alternatively, we could view space "an inner-worldly realm of religious, spiritual or indigenous individualistic knowledge, and self-awareness" (Zieleniec, 2007, p. xii). Alternatively, from a knowledge world perspective, space could be described in terms of inclusion and exclusion, where epistemological territories are established, and over which tensions rise as "the fight for epistemological territories could be no less [ferocious] than those for land" (Teymur, 2002, p. 98). Perhaps, in this research, there

could be a glimpse emerging that show the tensions present within these knowledge-rich territories.

The ubiquitous presence in science learning of boundaries and borders exhibited by differences in cultural communicative patterns and deeper epistemological differences, present a challenge for science learners (Meyer & Crawford, 2011). They contend that Aikenhead (2006) relies on the premise that access to science learning favours student groups whose cultural ways of knowing align with scientific culture and becomes less accessible to students whose cultural ways of knowing are at variance with this way of knowing. Returning to Meyer and Crawford's notion of resistance to science learning from those students who "continually experience challenges to their world-views or every day and culturally-based understandings of the world" (2011, p. 535), it could be interesting and informative to design a research project in response to their statement "that little is known about the process of negotiating scientific understanding from the perspective of the learner – at the intersection of student cultural understandings and the culture of science" (2011, p. 535). Doing so might also enrich our understanding of how students respond to the challenges of dealing with multiple knowledge sources in our senior biology classrooms.

The concept of culture in science education has featured for many years in the scientific education literature and much has been written as to the situated and cultural nature of science learning (Carlone, Johnson, & Eisenhart, 2014). According to Klenowski (2009), the challenge is to explore ways to "make any learning-centred environment culture-fair and responsive to the needs of culturally diverse learners" (pp. 87-88). Despite the challenges this could present in a mainstream school environment, an emphasis on building on the conceptual and cultural knowledge that students bring with them to their learning could be fruitful area for this research.

1.7 Research aim

As an experienced classroom teacher of science, biology and Te Reo Māori, I have long puzzled over what lies beyond the 'bright silvery mist' at the conceptual border between the knowledge spaces of science and culture.

The increasing calls from across Aotearoa New Zealand for a more equitable and accessible education system combine with my concern to find out more about how linguistically and culturally diverse science learners can find meaning and success through the validation of their worldviews and knowledge reserves. The aim of this research project is to explore how senior

biology students use Western scientific knowledge and mātauranga Māori Indigenous knowledge to justify their support or opposition to the use of 1080 poison to control pest species in Aotearoa New Zealand. By foregrounding students' voices and interpreting explanations for their decisions to access and utilise scientific and cultural knowledge reservoirs, this proposed research might inform our understanding of how Western science and Indigenous knowledge worlds can work together to enhance student learning in senior biology.

At all stages of this research project, I acknowledged, and regularly reflected on, the ways that my background, personal beliefs, opinions and expectations as a non-indigenous Pākehā (New Zealander of European descent) teacher-researcher might influence the research process, and the interpretation of the participants' voice in the creation of the narrative. As constructivism views inquiry as axiological (i.e. value-bound), the process is very likely to be influenced by a combination of personal factors and the context under study (Bloomberg & Volpe, 2012, p. 28). Therefore, I recognise and acknowledge how my own background could have shaped my interest in this research, the choice of topic and possibly extend as far as having an influence on my interpretation of the data – however small.

Therefore, throughout this introductory chapter it was important to position myself in this inquiry by acknowledging my cultural, social and historical experiences (Bloomberg & Volpe, 2012), which, as my "lens on the world and angled ways of knowing it" (Saldaña, 2015, p. 5), both focused and filtered my perceptions of it. It was necessary for me to be aware of the ways these experiences may have directly or indirectly influenced my reconstruction of the knowing world of the participants and interpretations made of participant voice and action. It was, after all, the participants' stories and not my own that this thesis reports.

1.8 Thesis structure

In Chapter 1, the three strands from my lifeworld experiences brought together in this project were outlined: the development and use of knowledge/learning; culture and science. My interest in the topic, its significance and the rationale for this study are described.

Chapter 2 presents a review of the literature to situate the study in the context of previous research and scholarly material on the topic of scientific and cultural knowledge use which is contextualised within the discussion of a socio-scientific issue by senior secondary school biology students. It also presents and justifies how this study identifies the gaps in the current research and literature which leads to the presentation of the research questions arising from

this research literature analysis along with the conceptual framework for the study (Bloomberg & Volpe, 2012).

Chapter 3 situates the study within a research paradigm. The qualitative research design of this study methodology is founded and justified based on a social constructivist ontology and interpretivist epistemology. The qualitative methodology approach gives the data generation, collection and interpretation a flexibility which allows the data to reveal the ways the participants used their cultural and biological knowledge and positioned themselves within an examination of a socio-scientific issue. A description of the context, setting and participants is provided. The various ways the verbal and written-phase data were generated, collected and analysed using thematic analysis are described. The chapter concludes with a discussion of the steps taken to ensure the trustworthiness and authenticity of the data and ethical considerations and critically important culturally appropriate practices are outlined.

Chapter 4 develops and presents the conceptual frameworks used for the analysis of participants' data. Using these conceptual frameworks Chapters 5 begins with an analysis of the participants' use of biological science knowledge, followed in Chapter 6 with a similar analysis of the participants' use of mātauranga Māori Indigenous knowledge. If used by the student participants, Pacific cultural knowledge is referenced where appropriate to the specific research question.

The final set of findings are presented in Chapter 7. Analysis of the data presented in Chapters 5 and 6 identified ten participants who drew information sourced from <u>both</u> knowledge worlds – biological <u>and</u> mātauranga Māori. A further analysis begins to reveal *how* these 10 participants used these concepts to justify their view on 1080 use.

This was done by applying firstly, the theoretical concepts of the cultural interface (Nakata, 2007), which incorporates the sub-concept of the locale of the learner (Nakata, 2007), and then second, the theoretical concept of student agency (Lindahl & Linder, 2013; Kirch & Ma, 2016). Both concepts are used to create an expanded description of epistemic student agency (Zimmerman & Weible, 2018) for use as an analysis framework to interpretively analyse and describe the participant students' data. Chapter 7 presents the interpretive stories of a selection of the 10 participants whose interface worlds and learner locales are described and depicted diagrammatically.

The final chapter of this thesis, Chapter 8 presents and discusses the significant findings and conclusions of this research in line with the three research questions. It also presents a set of

recommendations for teachers, suggests further research within our high school biology classrooms and concludes with some final reflections.

Chapter 2: Literature Review

2.1 Introduction

> Classrooms… need to be places of interaction and dialogue where students of diverse cultures can bring who they are, what they know and above all, how they understand and make sense of the world to the conversations that generate learning.
>
> (Bishop, 2019)

This comment by Emeritus Professor Russell Bishop ONZM comes at a time of potential generational change in the educational landscape of Aotearoa New Zealand as the government initiates several significant changes proposed to the entire education system under their Educational Work Programme (EWP) as part of the Ministry of Education's latest *Four-Year Plan 2016 – 2020*.

Three main areas of the education system are currently under discussion and consultation as part of the review process. The first is the reform of vocational education, the second is the review of the national secondary school qualification for school leavers – the National Certificate of Educational Achievement (NCEA) and finally, the third area of reform is the review of school governance, administration and management – the Tomorrow's Schools Review, which the comment by Bishop is in response. As part of the review process, the government has initiated a series of public educational conversations about the future of education in Aotearoa New Zealand. Thus, Bishop's call for classrooms to be places where students from culturally and linguistically diverse backgrounds can bring 'who they are, what they know and above all, how they understand and make sense of the world to the conversations that generate learning' (Bishop, 2019) deserves our attention and investigation.

Across Aotearoa New Zealand, within the majority of urban mainstream secondary school biology classes, are students who come from a range of ethnic, cultural, linguistic and socioeconomic backgrounds. Consequently, there is a view that as our knowledge of the natural world is culturally and socially constructed, it follows that the contribution to learning of the culture and identity of students and the knowledge and worldviews they bring to their [science] learning should be recognised and validated (Carlone, et al., 2014; McKinley, 2005; Waiti & Hipkins, 2002). In Aotearoa New Zealand today, the cultural and linguistic diversity of our urban secondary schools offers the opportunity for a research project to recognise Indigenous knowledge from a mātauranga Māori (Māori Indigenous knowledge) worldview.

Internationally, Indigenous people, such as First Nations communities of Canada, are revitalising and renewing all aspects of their cultures and reclaiming the traditional knowledge and legacies of their ancestors (Turner & Spalding, 2013). Here in Aotearoa New Zealand, Indigenous Māori are reclaiming 'ngā taonga tuku iho a ngā tūpuna' (the bequeathed treasures of the ancestors) (Royal, 2009, p. 11). Indigenous Māori taonga includes te reo (language), tikanga (customary practices) and mātauranga (Indigenous knowledge). Macfarlane, Macfarlane and Webber (2015) call for educators to look through the lenses of others and see, experience and produce awarenesses and understandings that acknowledge the taxonomies of conventional [scientific] knowledge and Indigenous epistemologies. They suggest that this shift could result in the rediscovery of a narrative that was previously hidden that will enable them to reclaim a space where Indigenous knowledge systems are expressed without fear or prejudice.

While for some students, these knowledge resources are front and centre of their consciousness, for others their cultural knowledge often remains hidden at the margins – in the shadows. In the face of a dominant Western science discourse and practices, students respond by keeping their cultural knowledge in the shadows and out of sight. For this reason, the challenge laid down by Bishop (2019) to tackle this situation could be worthy of further research. Therefore, it would be pertinent to investigate how students use knowledge when there is an issue that is of cultural importance to them. For example, the Indigenous Māori concept of mauri illustrates this importance. Mauri is described as an internal energy or life force sustaining all forms of life (Harmsworth & Awatere, 2013) that also permeates all living and non-living things. Take, for example, a native forest which has mauri as a signifier of its health and vitality. From an Indigenous Māori perspective, mauri would be violated by the introduction of the chemical poison 1080. This type of disturbance to the mauri of the forest would be a very strong reason for the use of 1080 to be vigorously opposed as a threat to the continued health and vitality of the forest and its living and non-living elements.

Following this introduction, Section 2.2 discusses the use of compound 1080 and illustrates the range of views people hold towards its use in pest control. This section also outlines the controversial nature of 1080 use as a major contemporary socio-scientific issue in Aotearoa New Zealand environmental and biology education. Section 2.3 discusses how expressions of scientific literacy and how the identification of knowledge worldviews connects to students' understanding of the 1080 issue. Section 2.4 traverses the perspectives of the epistemological debate and tensions within the science education community concerning issues related to multiculturalism and Western science knowledge. Section 2.5 discusses the importance of

worldviews and how they shape our understanding of the natural world. Section 2.6 presents a comparative analysis of Western scientific and Indigenous worldviews in science followed by a critique of mātauranga Māori and Western scientific knowledge within Aotearoa New Zealand in Section 2.7. Section 2.8 explores the common ground concept in relation to these two knowledge worldviews and then leads on to Section 2.9, which discusses the literature relating to spaces that have been theorised as places, where both knowledge worlds converge. The argument will demonstrate that these theoretical spaces provide fertile grounds for research into the collaborative potential of Western scientific and Indigenous knowledge worlds to enhance learning for linguistically and culturally diverse high school students in biological science.

The penultimate section, 2.10 discusses the advantages of using learner agency as a descriptor for student activity within the knowledge space at the cultural interface. Specifically, the discussion will show how by aligning the concept of epistemic agency with the aims of this research it enables space to explore how students could utilise knowledge from two knowledge worlds in a biology context. The final section, Section 2.11 concludes the chapter and presents the major research issues, key research questions and the central arguments emerging from this literature review.

2.2 Justifying 1080 use as an SSI context

Is the controversial use of 1080 sufficiently complex to qualify as a contemporary socio-scientific issue? According to Sadler's criteria (2011), the context of 1080 use is a good example of a socio-scientific issue (SSI) in that it is open-ended, controversial, science-linked and is affected by economic, social, political, cultural, environmental and ethical factors. Furthermore, the 1080 context provides the debate with a robust variety of viewpoints on the issue, offers many plausible solutions and guarantees passionate support and opposition in equal measures. In this context, views can range from complete eradication of the pest at one end of the continuum – to their management as part of our national ecosystem at the other – where our native wildlife could possibly co-exist in harmony with the introduced pests (Hansford, 2016). Within this broad continuum, how might the 1080 controversy fit with the goals of Western science/biology education?

As one of the goals of science education is to assist students to more effectively contribute to debates and decisions about important societal issues (Morin, Simonneaux, Simonneaux & Tytler, 2013), the socio-scientific issue of 1080 use is a relevant context for students as it provides the space where both debates and decisions can take place. Sadler and Zeidler (2004)

describe such issues as “societal dilemmas with conceptual, procedural, or technological links to science” (p. 5) and support the introduction of SSIs into science education because of their prominence and their scientific and cultural significance.

Since the mid-1980s, according to Zeidler (2014, p. 697), socio-scientific issues have proven to be “a viable way to connect science to matters of social importance”, as they can be built into the curriculum around several broad themes. Three themes in particular are potentially relevant to the focus of this research project in that SSIs provide:

- Opportunities for epistemological development and their impact on reasoning – SSIs provide opportunities for the development of worldview beliefs and how these impact reasoning and argumentation concerning conceptual understanding of content knowledge (2014, p. 712).
- A context for illustrating the nature of science – SSIs can provide a framework allowing for the expression of contextualised Nature of Science (NOS) elements (2014, p. 715).
- Opportunities for character development and citizenship responsibilities – SSIs can provide the opportunity to situate personal viewpoints on the issue into broader community perspectives, worldviews and overarching ecological outlooks (2014, p. 719).

Consequently, SSIs can also bring authenticity to the science classroom when students deal with real-world problems and controversial issues (Åkerblom & Lindahl, 2017). On this point, it is important to remember that there will always be the need to cater for those students who find science an interesting but difficult subject at school that, for them, lacks relevance. It is argued that these topics can serve as a useful context for learning specific science content knowledge, understanding the Nature of Science and addressing citizenship education (Ottander & Ekborg, 2012, p. 1149).

The controversial use of 1080 to control pests provides just this type of authentic, real-world problem which could go some way towards answering the question posed by Ottander and Ekborg (2012) as to how students might use a socio-scientific issue “to learn better” (p. 1161). What then might ‘learning better’ look like? Through the context of socio-scientific issues, students could extend their learning and demonstrate their use of content knowledge and their understanding of the Nature of Science with the added dimension of a cultural worldview. Further still, students could express their scientific literacy as described by the conceptual

knowledge they call upon and use when discussing the 1080 controversy in this instance. Interestingly, this knowledge may not necessarily be exclusively scientific in origin but could include knowledge from other sources such as cultural knowledge and the worldviews of other groups.

From a wider reading of the literature, the question arises as to whether it is more appropriate to refer to the 1080 controversy as a Socially Acute Question (SAQ) as opposed to a socio-scientific issue (SSI). Recently, Birdsall and France (2018) referred to science as practised in the public domain by the acronym SAQ. The term "Socially Acute Questions" (SAQ) was coined by L. Simonneaux as an alternative to the traditional SSI terminology (Birdsall & France, 2018, p. 1550). This alternative terminology represents a French orientation for the teaching of SSIs. It refers specifically to science decision-making in the public domain – where scientific knowledge is turned towards the discussion of what they term 'messy' problems that are controversial and 'acute' (Simonneaux & Simonneaux, 2012) – with acute referring to an issue's potential for controversy both at a societal and classroom level (Birdsall & France, p. 1550). On this basis, at least superficially, the 1080 controversy would appear to satisfy the criteria for an SAQ – it is a controversial issue with social implications (Simonneaux, Panissal & Brossais, 2013, p. 2379).

In terms of teacher pedagogy, Simonneaux et al. (2013) introduce the idea that SAQs/SSIs are positioned along a continuum from 'hot' at one end to 'cold' at the other. Interestingly, at the cold end, the focus of SAQs/SSIs is on pedagogies that serve to motivate students in learning science while at the hot end of the continuum, the focus of SAQs/SSIs is on pedagogies to nurture activist commitments within citizen science that extends beyond the purpose of developing science conceptual and procedural knowledge (p. 2380). This 'hot/cold' pedagogical approach could be adapted to an examination of students' responses to the socio-scientific issue.

From a knowledge perspective, an adaptation of the SAQ continuum could provide space for students' expression of their biological knowledge and very likely also allow for their expression of a cultural perspective that could enhance the development of students' critical thinking skills through the learning of underlying scientific concepts in tandem with a range of relevant cultural concepts. This focus has the aim, in a French context, of promoting a more engaged citizenship. If investigated in a local context in Aotearoa New Zealand, the addition of a cultural knowledge perspective would go some way towards addressing the authors' question as to the likely impact that culture would have on the enfranchisement of students

into scientific citizenship (Simonneaux et al., 2013, p. 2403). This leaves open the opportunity for this research project to investigate how to provide evidence for this claim by broadening the knowledge continuum to include both science and cultural knowledge.

Further evidence supporting an SAQ analysis of the 1080 controversy comes from the interdisciplinary nature of an SAQ approach, which requires the consideration of interdisciplinary knowledge of which there are four attributes outlined by Simonneaux and Simonneaux (2012) and referred to by Birdsall and France (2018, p. 1552) as:

- **Universal** knowledge – which is set from within traditional scientific knowledge, gleaned from scientific papers;
- **Plural** knowledge – which acknowledges that different paradigms may be used as evidence to substantiate the best resolution of an issue;
- **Engaged** knowledge – that is a response to controversies and signals an awareness of the complexity of knowledge sources employed; and,
- **Contextualised** knowledge – that relates to knowledge constructed in a specific situation that is interdisciplinary and can integrate local knowledge that could be produced by stakeholders.

With a growing number of science-based dilemmas and controversies occurring across the world, there are increasing calls for students as citizens to have a level of scientific literacy that enables them to make well-informed decisions about problematic SSIs (Saunders & Rennie, 2013, p. 253). Quite often, the ability of students to contribute to the public debate is often constrained by them not having the requisite scientific knowledge to enable them to join the debate (Abd-El-Khalick, 2003, p. 43). It would be interesting to explore these views of knowledge.

In the United Kingdom, Lewis and Leach (2006) reported on the relationship between science knowledge and the ability to engage in reasoned discussion of the social consequences of science. They researched over 200 school students aged 14 – 16 who were involved in paired and small-group discussions and whole-class activities. They found that the ability to engage in reasoned discussion was strongly influenced by the ability to recognise key issues and that this requires some understanding of the relevant science but is also influenced by the specificity of the context under discussion and students' personal experiences (p. 1267). It appeared that bringing SSIs into the science classroom engages learners in the sort of "real-world" problem solving in which scientific knowledge and other ways of knowing are brought

to bear on discussing and making decisions regarding issues that are immediately relevant to students' lives (Abd-El-Khalick, 2003, p.43).

With a dearth of local research in this space we must therefore rely on overseas studies such as these previously quoted to gain a picture of the research space. This enhances the potential for this project to add a uniquely Aotearoa New Zealand perspective to the international research. Further still, it would be interesting to see if a research project could provide data about an SSI context. The next section discusses this important issue using an SSI perspective.

2.3 Scientific and biological literacy within an SSI context

The socio-scientific issue of 1080 use in Aotearoa New Zealand, in relation to students' discourse, is more than an issue of acknowledging opposing knowledge systems and positions. At a deeper level, it is the expression of students' scientific/biological literacy when seen through a Western science and/or an Indigenous knowledge lens. For example, one could look at how the participants who are engaged in discussing this issue use language that positions them either in the science world, in the Indigenous world or in both. The OECD provides the following definition of scientific literacy as:

> The capacity to use scientific knowledge to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity (2000, p. 12).

According to Hansford (2016), the value of being scientifically literate is that it enables the active involvement and contribution by citizens in…

> Coherent conversations that require a grasp of the language and principles of science in order to be able to join in and understand the conversation, to grasp the problem and to contribute constructively to the debate towards finding a solution (Hansford, 2016, p. 133).

To do this requires a basic level of "scientific literacy skills for their understanding of, and active engagement with, issues of local and global importance" (Gluckman, 2011, p. 8). Bull, Gilbert, Barwick, Hipkins and Baker (2010) observe that while the ability of students to debate and confidently engage with science-related [socio-scientific] issues relies primarily on their knowledge of and about science, it also requires of them an interest in science and for them to see its relevance to their world (2010, p. A30). They suggest that a way forward might be an emphasis on scientific literacy that would focus on the Nature of Science (NOS) knowledge

with a specific emphasis on what makes science 'scientific', how science knowledge develops and how scientists think and work. Critical and ethical thinking, skills in constructing scientific argument and problem solving would also be emphasised and, because students could do this through the exploration of [socio-scientific] issues, they would also learn some key scientific concepts (Bull et al., 2010, p. A17).

The central position of NOS in the realm of scientific literacy (Lederman, 1992) is supported by Heap and France (2012) who reinforce the connection between the two with reference to the important role NOS plays in authentic learning situations (Jones & Baker, 2005). A focus on real-world issues that are authentic which demand that students "develop informed views on issues, a robust understanding of NOS is widely regarded as a key element of scientific literacy" (Heap & France, 2012, p. 2). Heap concludes that this will "lead to deeper understanding of scientific concepts which will give students a better understanding of the natural world and the ability to contribute to debate as members of a scientifically literate student population" (Heap, 2014, p.4).

An interesting example of this is the view expressed by Jenkins (2013), that discussions by students of SSIs highlight the importance of promoting scientific literacy through their engagement with informed debate (Jenkins, 2013, p. 142). By socially contextualising scientific knowledge it becomes more accessible to the wider population – especially for minorities. This, "places scientific knowledge in the realm of social contexts. … The ultimate goal of SSIs is for students to develop functional scientific literacy in which scientific inquiry processes aid decision-making" (2013, p. 142). Perhaps scientific literacy could be examined in a context that is relevant to young people; for example, 1080 use in pest control.

The next section discusses the core ideas relating to the teaching and learning of science to illustrate the tensions within socio-scientific issue/scientific literacy (SSI/SL) debate. It provides a commentary of the central ideas that have exercised the minds of international researchers for over a generation as to how science education might tackle these issues and the likely success of such efforts to do so.

2.4 Epistemological tensions in science education

There are epistemological tensions in science education which have been documented in the international literature. For example, a special issue of the journal *Science Education* in January 2001 was devoted to a discussion of the important issues of the time related to

multicultural science education. For the purposes of showing this context is relevant for this research project, these arguments deserve our attention and are discussed next.

As it is generally accepted that "all systems of knowledge about nature are embedded in the context of a cultural group" (Lewis & Aikenhead, 2001, p. 3), it follows that "all systems are, therefore, culture-laden; and that [Western] science is the system of knowledge about nature that is predominant in Western culture" (Lewis & Aikenhead, 2001, p. 3). A question to ask at this point concerns the role of and acknowledgement of non-Western Indigenous knowledge systems in the English-medium mainstream science curriculum.

The classical debates in the literature as to the role and contribution of Indigenous knowledge systems are best illustrated by the divide between universalism and multiculturalism. Irzik (2001) illustrates the divide between both camps over the question of characteristics embedded in the Nature of Science. The universalist position maintains that scientific knowledge has a universal essence and leads to Western Modern Science (WMS) providing epistemologically, in their view, a more superior form of knowledge than any other. This is cast as a Eurocentric perspective born of a belief in the superiority of Western European culture against which all other cultures should be judged (Lewis & Aikenhead, 2001, p. 3). The implication from this is that non-Western cultures (and their knowledge systems) are inferior. This view also characterises Eurocentric notions of science which are perceived as superior epistemologically and methodologically and that the non-Western ideas by implication were inferior and deficient when measured against these criteria.

In stark contrast is the position held by multiculturalists who hold that there are as many kinds of 'science' as there are cultures. Here, the dispute centres on whether non-Western cultures have systems of knowledge about nature that could be considered science (Stanley & Brickhouse, 1994). Therefore, can the exclusivity represented by the universalist approach to Western science and the myth of scientism that is associated with this position withstand the challenge from the multiculturalist position? Regardless of response it is held for the purposes of this literature review – and agreed by scholars, that any knowledge system, Indigenous or Western Eurocentric, holds a view of the natural world that is culture-laden.

Notwithstanding the classical divide, this research literature review further maintains the position that it is important to consider the ways that the two knowledge systems (non-Western, Indigenous knowledge and Western science knowledge) can describe an understanding of the natural world. Going still further is to consider how these two systems might coexist, as well as the implications and the challenges of such a coexistence. One

possible approach to understanding this coexistence is that proposed by Snively and Corsiglia (2001) who introduce the term Traditional Ecological Knowledge (TEK) into the debate as they advance the notion that Western science alone is too narrow for today's science education classrooms, and they challenge us to include TEK in the canon of school science (Lewis & Aikenhead, 2001, p.4).

This position is subsequently challenged by Cobern and Loving (2001) who argue that the inclusion of TEK into the canon of Western science would firstly, see it lose its distinctiveness and become absorbed by the dominant discourse of Western science and secondly, lose status – being seen more as a token of cultural inclusiveness rather than a serious participant in the scientific discourse (p. 5). The solution proposed by Cobern and Loving is to advocate instead for "epistemological pluralism", where TEK exists in the science classroom as a domain of knowledge with equal value to Western science (2001, p. 5). Although this illustrates the variation of approaches towards the issues, it does not provide supporting empirical evidence which could be sourced from within-school contexts that could back these assertions.

The publication of the special issue of *Science Education* in 2001, sparked an ongoing debate amongst educational researchers who challenged the binary notion of the universalist – multiculturalist divide. For example, Van Eijck and Roth (2007) called the debate about the status of TEK as "the juxtaposition of two incompatible frameworks" (p. 926) and called for a different epistemology to break the deadlock. Their view of the incommensurability of TEK and scientific knowledge however did not prevent them from supporting the idea that TEK can contribute to the discussion about and the possible solutions to localised environmental problems as students learn to solve 'real life' problems and perhaps by doing so "experience that science is not all that glitters" (2007, p. 944).

Carter (2008) continued the debate with her exploration of the ideas of borders and "border epistemologies" as she sought to "further articulate what had become a vexed and messy area of multicultural science education" (Carter, 2008, p. 429). For example, Carter set out to reconceptualised border and border spaces as places of "epistemological diversity" and knowledge plurality (also referred to as the ecology of knowledge). The key to Carter's reconceptualisation was her contention that the border zones are transient and by privileging these zones, they generate new hybrid forms of "decolonized knowledge" (2008, p. 442).

To offer some clarity and structure to the complex tensions within the debate, and to show the range of differing views of knowledge development amongst the research community, Lee and Buxton (2011) identified <u>three</u> major theoretical perspectives researchers have used to

address issues of meeting the learning needs of culturally and linguistically diverse students in science. The three perspectives – cognitive, cross-cultural and socio-political – illustrate the different ways that school science programmes could provide students with equitable learning opportunities. A brief discussion of each perspective begins with the cognitively based perspective.

Firstly, the cognitively based perspective focuses on students' scientific reasoning, problem solving, inquiry and argumentation (Lee & Buxton, 2011, p. 278). This perspective highlights the continuity between students' views of the natural world and the way science is practised in scientific communities and emphasises the importance placed on students' cultural and linguistic experiences as intellectual resources to enable students to 'think and act as members of a scientific community' (Lee & Buxton, 2011, p. 279). An example of this research is that by Warren, Ballenger, Ogonowski, Rosebery and Hudicourt-Barnes (2001) who examined the relationships between scientific practices and everyday sense-making of children from diverse cultures and languages and showed how these students successfully resolved the tension between their scientific and cultural resources to their advantage.

They call for an integrative and reflexive examination of what is meant by science on the one hand and diversity in cultural and linguistic practices on the other. They see this as a way of reframing the tension between the knowledge, values and practices of science on the one hand with the knowledge practices and values of children from racial, ethnic and linguistic minority communities on the other. Doing so could open up "possibilities that build on diversity as an intellectual resource rather than a problem or tension in science learning" (Warren et al., 2001, p. 548). It follows that there is a need for further research into the mechanisms by which diverse knowledge systems and Western science knowledge can coexist.

To illustrate how this might be envisioned, Lee and Luykx (2006) describe how a group of culturally and linguistically diverse students alleviated the epistemic tensions and brought about a congruence of their cultural worldview with [Western] scientific practice (Ballenger, 1997). The students achieved this by using a range of strategies and sense-making practices such as deep questions, vigorous argumentation, situated guesswork, embedded imaging, multiple perspectives and innovative use of everyday words to construct new meanings. These activities would indicate the potential advantages of harnessing the intellectual resources that students of diverse cultures bring to science and invites further research to examine the intersections between students' linguistic and cultural experiences and scientific practices (Lee & Luykx, 2006, p. 56).

Secondly, the cross-cultural perspective provides a multicultural perspective on students' cultural patterns of communicating, interacting and ways of knowing. As another source of tension, the literature acknowledges that students from diverse cultural backgrounds may come to school with knowledge and experiences that may be 'discontinuous' with (Lee & Luykx, 2006) what the literature refers to as Western Modern Science (WMS) (Irzik, 2001). This cross-cultural perspective opines that since students from culturally diverse backgrounds are not from the culture of power (WMS), their cultural practices and beliefs are sometimes discontinuous with the way science is taught in science classrooms. By practising this view, students could learn to argue and justify their knowledge claims based on the empirical testing of evidence in school science, while still respecting decisions based on cultural authority and decisions at home. Thus, students gain exposure to the high-status knowledge of WMS, without feeling they must choose between school success and the beliefs and practices of their own cultural group (Lee & Buxton, 2011, p. 281). For example, research by Aikenhead (2001) and colleagues with their notion of border-crossing at the boundary separating students' cultural environments from the culture of Western science and school science illustrates an attempt to acknowledge and show a way through this tension from a cross-cultural perspective.

Finally, the socio-political perspective places prominence on issues of power, prestige and privilege. Socio-political research questions the relevance of science to students who have traditionally been underserved or even oppressed by the education system (Lee & Buxton, 2011, p. 281). This perspective challenges the usefulness and relevance science education driven by externally imposed standards, rather than by the intellectual resources and experiences of the learners, which they argue should be placed at the centre rather than at the margins. Research from this perspective foregrounds issues of poverty, as well as cultural and linguistic diversity and rejects the notion that external standards can make science learning more equitable for students who have been marginalised from science and science education (Lee & Buxton, 2011, p. 281). A good example of this research perspective is the work of Calabrese Barton (1998) who examined the tensions in science learning for diverse learners as a socio-political process. The essential approach of this perspective reverses the question from focusing on how to bring students' worldviews in line with the views of Western science to focusing on how science, itself, can be reconceptualised to better relate to and learn from the worldviews of people from marginalised groups (Lee & Buxton, 2011, p. 282).

Thus, these three perspectives highlight the breadth of the theoretical approaches that could focus on cognition, cultural patterns of communication or the reconceptualisation of science through the addition of cultural knowledge worldviews. While these perspectives frame the

SSI/SL debate, the question that needs answering is how best science education can meet the learning needs of a diverse student population in science programmes. How might this play out within the context of a high school Western science/biology class of culturally and linguistically diverse students?

Add to this mix the uniquely defined issue of pest control using the 1080 toxin and we could explore how students navigate the knowledge-world landscape composed of two distinctive epistemologies – Western biological science knowledge and traditional mātauranga Māori Indigenous knowledge systems. More than debating the question of which approach is arguably best fitted to the learning needs of a diverse student population, it would provide an evidential basis to deepen our understanding of how diverse students cope with choices in the face of a smorgasbord of knowledge worldviews at their disposal – some they own, some they may borrow and some they may reject.

Of the four attributes of interdisciplinary knowledge described by Simonneaux and Simonneaux (2012), the attribute of contextualised knowledge is a key component of the principal issue of 1080 use in pest control. Specifically, this relates to the issues at the intersection of Western scientific knowledge and Indigenous cultural knowledge. Accepting that science is about explaining the world culturally and scientifically, literature will now be considered regarding the different ways these two knowledge systems are constructed, followed by a discussion about how these two knowledge systems can be used to explain the natural world based on one's respective ontological and epistemological positions.

Contextualising knowledge in Aotearoa New Zealand

Returning to the possible tensions this creates for diverse learners in science, it is necessary to differentiate and define the different types of knowledge that exist in relation to the learning discipline of biological science within which discussion of the 1080 issue could take place in a senior secondary school biology course. For example, tensions may exist within the three distinctive types of curriculum knowledge: declarative, conceptual and epistemic. All three could provide a useful roadmap for this research project. However, to alleviate any potential for the tension and unwelcome distraction this would generate, it is therefore necessary to focus on <u>one</u> of the three types of curriculum knowledge. Of the three types, epistemic knowledge appears the most promising – as indicated by this definition provided by Johnston, Hipkins and Sheehan (2017):

> Epistemic knowledge relates to the disciplinary inquiry processes used to construct and test new theories. An emphasis on epistemic knowledge promotes understanding of the process of knowledge production in a discipline; for example, how we know what we know, and on what basis certain knowledge claims might be judged more valid than others. (p. 81)

Therefore, with a focus of the debate primarily on epistemic knowledge and the tensions amongst the various ways that knowledge of the natural world is constructed, the controversial issue of using 1080 to control pests in Aotearoa New Zealand has the potential to contribute to our understanding of the source of these tensions. This contemporary issue has the potential to enable research to uncover the ways Western science and Indigenous knowledge systems can be used to explain the world.

More importantly, an exploration of views about an issue can reveal the different ways we can view knowledge and understand the inherent tensions within a particular context. For example, Hansford (2016) reports the views of local Māori towards an aerial drop of 1080 to control possums in 2007. The comments quoted illustrate how views towards an issue indicate the importance that an individual can place on the knowledge that they hold. This can be seen in the comments by a local resident in response to the 1080 drop who saw this as:

> "A direct attack on me as a person, on Māori culture, on tikanga (customary practice). They are trying to poison Māori directly, because they are poisoning mauri (life force). They are affecting the life force, that energy" (Hansford, 2016, p. 96).

The speaker in this instance expressed no faith and took no comfort from [scientific] research:

> "The whole basis for me is tikanga…you are supposed to care for the environment…with trees the children of Tāne" (Hansford, 2016, p. 96).

The speaker continued:

> "It's not that the possum is a bad thing, he's another child of Tāne. All living things are to be respected. We have a duty of respect to them, because they are all living entities…it's not the possum's fault. Poison is disrespectful to animals. If you are going to kill them, trap them… then eat them" (Hansford, 2016, p. 97).

While comments such as this would be shared by many Māori who live in rural areas, Hansford argues that there is no pan-Māori position on 1080 use any more than there is a pan-Pākehā (non-Māori of European origin) one (Hansford, 2016, p. 99). As with any controversy, there

is both support and opposition to 1080 use amongst Māori communities. This in itself is a source of tension that can divide a community and an extended family. Hansford quotes an example of Māori who regard their customary role as kaitiaki, responsible for looking after the health of the forest, supporting 1080 use in that "it's a plant-based poison. The forest is full of all sorts of chemicals that plants make …. That are poisons too." (2016, p. 99). For some, 1080 is seen as just one of many plant-based poisons produced naturally by the forest – 'just like a chemist's shop'.

Hansford reports that Māori reticence is sourced in their beliefs that for many, nature is still butcher, fishmonger, greengrocer and pharmacist (Hansford, 2016, p. 101) and that the notion of dropping poisons into your provisions cuts across the essence of hauora (well-being) (Hansford, 2016, p. 101). According to Hansford, Māori communities have shown that they are prepared to listen to science but reserve the right to critique teachings from the data based upon that received from their ancestors before arriving at any decisions (Hansford, 2016, p. 134). Hansford then draws an interesting distinction by noting that "There's a vast and deeply unsettling disconnect between the way people like to conduct their arguments and the way science goes about settling them" (Hansford, 2016, p. 136). Importantly, these views illustrate that in addition to considering how people view an issue, it is also indicative of how they view knowledge and that the veracity of their knowledge claims are deeply rooted in the person's culture and worldviews developed over a lifetime and upon which the validity of these claims rest.

While to some, the knowledge systems of Western science and mātauranga Māori are disparate, irreconcilable and fraught with tension, there are others who see these two systems as complementary, even to the point of potentially integrating. This was evident in the recent comments from the newly appointed Prime Minister's Chief Science Adviser (PMCSA), Professor Juliet Gerrard reported in the *New Zealand Education Gazette* in November 2018.

> In mātauranga Māori, we have a framework of knowledge that is more integrated and holistic so there is value in incorporating greater integration of Māori values and knowledge in areas such as research and resource management, and policy development in areas such as health and education as well as science…it must be integrated from the beginning, not added on at the last minute.

It remains unclear as to how the integration of a mātauranga Māori knowledge framework into science education might look in practice. We currently have insufficient evidence to be able to fully understand the realities of culturally and linguistically diverse learners as they deal

with these potentially tense and conflicting knowledge worldviews in science. However, the call by the Prime Minister's Chief Science Adviser provides a likely avenue for further research into this possibility especially in the context of the issue of 1080 use in pest control. On this basis, the next section takes a closer look at the knowledge worldviews of Western science and Indigenous epistemologies in general before discussing their relationship with science education.

2.5 Worldviews as knowledge of the natural world

> Science is our formal contact with nature, our window on the universe…. It is a very special way that humans have devised for looking at ordinary things and trying to understand them (Shamos, 1995, p. 20).

This definition of Western science speaks to an audience that believes the nature of Western science and its central purpose to understand the world through seeking to provide explanations of the natural world and its phenomena. But is it the only way? Is it any more of a formal contact with nature than an Indigenous way? Some would argue to the contrary. Is a Western scientific 'way' any more special of a way to look at ordinary things to understand them? Again, many would take the contrary view. A discussion such as this echoes the 'either/or' approach that has vexed the issue of pest control using 1080 since its introduction to Aotearoa New Zealand. The coincidence is that these dualisms, these polarities exist both in the issue and exist between the ontological and epistemological positions of the two knowledge worlds.

Therefore, this section discusses Western science from an ontological perspective and describes a scientific epistemology while offering a critique in terms of classroom expression and understandings of scientific concepts based on differing worldviews. Furthermore, the discussion continues to explore how, separately and together these worldviews contribute to our understanding of the natural world. It is proposed that a consideration of how people from two differing worldviews might look at and understand the issue could reveal the origins and subtleties of their conceptual understanding as the two knowledge worlds converge. While the degree to which this may or may not take place is yet to be fully demonstrated, the tentative and changing nature of scientific knowledge as "the product of human imagination and creativity" (Schwartz & Lederman, 2008) affirms that scientific knowledge is socio-culturally embedded as it is "influenced by the society and culture in which science is conducted" (2008, p. 728).

Therefore, the possibility exists for people of differing worldviews to potentially illuminate each other's understanding of the natural world. An important element to this discussion is the use and meaning of the term 'worldview'. To the layperson, worldview is the way people experience and make sense of the world – the way they see, interpret, understand, experience and react to the world around them (Aikenhead & Michell, 2011, p. 26). Worldviews interest science educators because teachers are constantly trying to engage students whose worldviews often differ profoundly from the scientific worldview conveyed in the science classroom (Aikenhead & Michell, 2011, p. 26). The anthropological meaning of worldview is the one most commonly found in science education and described as 'a set of assumptions and beliefs that form the basis of peoples' comprehension of the world' (Cajete, 2000, p. 62). For example, Cobern (2000, p. 8), defines a worldview as:

> The culturally dependent implicit, fundamental organisation of the mind. This implicit organisation is composed of presuppositions that predispose one to see, think and act in predictable patterns.

From this viewpoint, worldview provides a person with presuppositions about what the world is really like and what constitutes valid and important knowledge about the world (Cobern, 1996, p. 584).

But before this potential is realised, we must first illustrate how one's ontology and epistemology are related to the understanding of a concept or phenomena. Take for example, the biological idea within a Western science paradigm of an ecosystem. Jelemenská and Kattmann (2008, p. 29) ask the relatively straightforward question, "Is an ecosystem real or conceptually constructed?" Consider the meaning of the term ecosystem. As a concept, one's ontology specifies what is inherent and important in the empirical phenomenon represented by the concept – the intrinsic, necessary defining attributes of the concept (2008, p. 29). This ontological claim about the real world has epistemological implications. It refers to differences in the beliefs about the quality of our knowledge because the answer depends on one's epistemological beliefs about science knowledge formation (Jelemenská & Kattmann, 2008, p. 29). For example, our knowledge of the ecosystem concept of the 'flow' of energy and the 'cycling' of minerals is based upon empirical data gathered through rigorous experimentation (Odum, 1971). Therefore, it is interesting to anticipate what student views of environmental concepts reveal about their understanding of the Nature of Science.

The research literature indicates that student conceptions of the environment can differ in quite contrasting ways (Loughland, Reid, Walker & Petocz, 2003). Their survey found that whereas

most young people surveyed saw the environment as something 'out there' – a place but essentially separated from themselves; one in eight students, saw the environment from a relational point of view – something that supports and enhances their living and requires in turn their care and support (2003, p. 14). They conclude that environmental education needs to be based on childrens' understandings of the environment rather than on assumptions of what children know and believe. The point to be emphasised here is that there appears to be two quite distinctive, but equally valid ontologies regarding the environment expressed by these students.

The notion that children's understanding of concepts is central to their 'knowing' about the natural world hints at the importance of another question which asks, "Is knowledge constructed or found?" The answer lies in the classical dualism of 'constructivism – that knowledge is constructed' versus 'positivism – that knowledge is found'. As Benson (1989) points out, the constructivist position is an epistemological view that stands in contrast to a positivist position as a form of reasoning in science where knowledge is understood to exist in the world, and it is confirmed or refuted by an empirically-based search (p.329).

Consequently, whereas a positivist perspective views the curriculum as a body of knowledge or a collection of skills to be transmitted to students (a naïve view) (Benson, 1989, p. 329), the constructivist perspective of knowledge creation and learning acknowledges that meaning is actively constructed by individuals in ways that are coherent and meaningful to that person (Driver & Oldham, 1986). The implications of this view flow from the experiential, idiosyncratic nature of the knowledge creation process.

How might this play out in a senior biology classroom comprised of culturally and linguistically diverse learners who are required to provide justifications for their position towards the use of 1080 to control mammalian pests? One acknowledges that diversity brings with it diverse worldviews and understandings that students bring with them into the science classroom (Lee & Luykx, 2006). As the culture of Western science is foreign to many students regardless of their backgrounds, Lee and Luykx argue that this creates a challenge for science learning which may be especially greater for students whose cultural, epistemological and discursive traditions are 'discontinuous' with the 'ways of knowing' characteristic of Western science and school science (Lee & Luykx, 2006, p. 45).

If we accept that Western science is concerned with developing a 'truthful' explanation of the natural world (France & Compton, 2012, p. 3), it is highly conceivable that the ontological and epistemological assumptions that Western science communities hold as their 'truth' – their

‘epistemic competence’ (France & Compton, 2012, p. 4) could be at odds with those students who come into science with their Indigenous cultural worldviews. Students who hold these worldviews would find that their ‘epistemic competence’ is challenged in class to the extent that they may perceive themselves to be ‘epistemically incompetent’ to a larger or lesser degree. This perception could manifest in their silence and withdrawal from full and active participation and engagement in the learning activity. The consequence would be to leave their epistemic potential unrealised as their knowledge is kept at the periphery rather than foregrounded at the centre. Therefore, it would be interesting to investigate the ways diverse learners interact with potentially contrasting worldviews to demonstrate their epistemic competency.

The next section looks at how Western science and Indigenous knowledge systems could provide ways of explaining and understanding the natural world in the context of this socio-scientific issue as they appear pitted against each other amid the 1080 controversy. However, before discussing these two worldviews in detail, it is first necessary to consider the literature about Western scientific and Indigenous knowledge in science. This begins by highlighting the different ways that scholars using Western science and Indigenous knowledge systems explain the natural world.

2.6 Indigenous knowledge and Western science knowledge

Descriptors provided by Aikenhead and Michell (2011) characterise Western scientific knowledge as: noun-rich and impersonal; something that can be given, taken, accumulated, banked and assessed by paper and pencil examinations and; something that exists independently of people – it exists separately from the knower. The authors also detail the characteristics of Indigenous knowledge, which they describe as action-rich and personal, intimately and personally interconnected with the knower and, an intermingling of mind and matter (Aikenhead & Michell, 2011, p, 68). These contrasting characteristics open the opportunity for this section to explore through their commonalities and differences “knowledgeable *perspectives* on scientific and Indigenous content” (Aikenhead & Michell, 2011, p. xii) and demonstrate how both systems portray and explain nature. Also, it is very important at this stage of the review to remind ourselves of the issues confronted by students who experience what it is like to dwell at the confluence of two knowledge systems.

Conventional science programmes taught in schools are usually couched in terms of Western/Eurocentric Sciences (Aikenhead & Ogawa, 2007) and represent a Eurocentric worldview of canonical knowledge, techniques and values (Aikenhead & Elliot, 2010, p. 322).

These science programmes aim to encourage students to think like a scientist, behave like a scientist and believe what scientists are purported to believe (Eisenhart, Finkel & Marion, 1996). Students from diverse linguistic and cultural backgrounds come into Eurocentric Sciences programmes in mainstream schools and encounter a raft of expectations about what most scientists do (Aikenhead & Michell, 2011) as practitioners of the scientific culture of their discipline. For example, they are confronted with technical language, the standards that define achievement, and the beliefs they (hold about reality. With respect to knowledge, students encounter the knowledge that characterises their discipline, the assumptions they make about that knowledge, and the methods that produce their knowledge including the technology they typically use (Aikenhead & Michell, 2011, p. 19). While on the surface these conventional aims appear admirable, the research literature indicates that many students do not feel comfortable taking on this type of 'school science identity' (Aikenhead & Elliot, 2010, p. 323).

Some authors have attempted to redefine science to include its cultural basis. For example, Ogawa (1995) viewed science as encompassing several empirically-based ways of knowing nature. The strength of this proposition according to Aikenhead and Michell (2007) is that it establishes an equitable perspective towards the two knowledge worlds, very much in line with McKinley's term "pluralism" (2007). This view of science also encompasses both Western science and Indigenous knowledge. Critically important is that a pluralist perspective allows the acceptance of multiple ways of knowing nature (Aikenhead & Michell, 2011, p. 31).

Researchers reported in the literature have wrestled with how best to conceive of a world where the culture of Western science meets the culture of students from diverse linguistic and cultural backgrounds. There is classroom-based research literature that demonstrates this. For example, in the early 1990s a study by Phelan, Davidson and Cao (1991) examined the negotiated space between students' family, peer and social worlds, and how they combined to affect students' engagement with schools and learning. Their report on the Students' Multiple World's Study identified four types of boundaries (1991, p. 228):

Type I: Congruent Worlds/Smooth Transitions

Type II: Different Worlds/Boundary Crossings Managed

Type III: Different Worlds/Boundary Crossings Hazardous

Type IV: Borders Impenetrable/Boundary Crossings Insurmountable

These findings helped to provide teachers with a way to view students more holistically and came with a call for teachers to think about how school features can impact students' lives. "Students must acquire skills and strategies to work comfortably and successfully with different people in divergent social settings,… where differences are valued rather than feared" (1991, p. 246).

This study contributed to the collateral learning theory developed by Olugbemiro Jegede (1995) to explain how non-Western learners attempt to cope with science learning within a classroom environment not very receptive to their Indigenous knowledge (1995, p. 97). For those learners who can hold two explanations within a worldview, collateral learning occurs when non-Western learners grapple with the need to resolve their understanding of a concept common to two domains and which are often in conflict (Jegede, 1995, p. 117). This ability to hold a 'duality of personal worldviews' defines a 'collateral learner' (Jegede, 1995, p. 118).

To illustrate the collateral learning continuum, which contains four typologies (parallel, simultaneous, dependent, and secured), (Sutherland, 2005, p. 599) contrasts the two extremes of the continuum by firstly referring to parallel collateral learning as characterised where conflicting ideas do not interact at all and where Indigenous learners will switch, in a Western science context, between placing value on knowledge provided by science textbooks (in school) and knowledge received from experienced elders (in the community) (2005, p. 599). At the other end of the continuum, secured collateral learners are able to resolve the conflict between the two knowledge worlds and create a convergence of ideas by being able to provide explanations for maintaining both ideas and combining them together (2005, p. 599).

To gain an insight into the collateral learning aspects of science learning in Cree students, Sutherland (2005) carried out a study involving interviews with junior high school students aged 11-15 years to explore, through a series of critical incidents, how students negotiated boundaries with science and personal experiences. The findings suggest that the 30 percent of participants who are secured collateral learners were able to resolve conflicts between science information found in their textbooks and knowledge from their fathers and grandfathers and to then include both in their science reports. According to Sutherland, this ability afforded them a degree of protection. Interestingly, Sutherland comments that it would be highly likely that a secured collateral learner would be academically penalised in an assessment for combining Western and Indigenous knowledge. It would be interesting to explore how students in Aotearoa New Zealand were able to use the knowledge they gained from their

tupuna (grandparents) to make the links between their cultural heritage knowledge and Western science knowledge in this research.

Sutherland's call to "incorporate teaching strategies that enhance student decision-making around their own education" (2005, p. 611) with less dependence on the teacher could prove a fruitful avenue in this research to develop pedagogical knowledge.

Redefining science to include a fresh pluralist perspective could provide space for a coexistence within science of multiple worldviews. It could be argued that enabling multiple worldviews in science would provide a transformative approach and thereby effectively reduce tensions which are a daily occurrence for Indigenous students and who are somewhere along the collateral learning continuum (Jegede, 1995; 1997). Aikenhead (2006) argues that the source of this tension for Indigenous students lies in two oppositional knowledge traditions at work in their science classroom. On the one hand, they are presented with knowledge in Western/Eurocentric sciences expressed as an 'individual' intellectual tradition of thinking (individual cognition), while on the other exists Indigenous knowledge expressed as a 'wisdom' tradition of thinking, living and being (Aikenhead & Michell, 2011), that emphasises group-oriented *ways of being* as practised by living in harmony with Mother Earth for survival (Aikenhead & Elliot, 2010, p. 325). With both knowledge worlds simultaneously competing for prominence and legitimacy, research by Jegede (1995) demonstrates how Indigenous students as collateral learners develop strategies for coping with the latent tension between these two knowledge traditions this situation creates.

For Indigenous students, learning is "a personal part of who they are and what they do – their self-identity" (Aikenhead & Michell, 2011, p. 69). Therefore, any tension students may feel arises as their school science identities and their self-identities collide. Unless teaching strategies are developed along the lines called for by Sutherland (2005), this ongoing tension will continue to alienate students from conventional science programmes where they are observed as disengaged, quiet and disinterested in a very similar way as described earlier because of the students' epistemic competence and self-identity being challenged by the ubiquitous presence of a Eurocentric worldview that dominates the science classroom discourse.

Despite the convincing arguments for the oppositional nature of science and Indigenous knowledge, and the negative impact on student identity and students' perception of science learning as "too hard," the two knowledge systems do share several features in common (Aikenhead & Michell, 2011). Eurocentric Sciences and Indigenous knowledge share some

fundamental features (e.g., both are culture based, empirical, experimental, rational, communal and dynamic), and although both embrace common values (e.g., honesty, perseverance, open-mindedness, curiosity, aesthetic beauty, repeatability, and precision), their worldviews tend to be ontologically and epistemologically, and axiologically incommensurate (Aikenhead & Michell, 2011). This is exemplified by the metaphorical contrast which states that "scientists *see* the world, whereas Indigenous elders *inhabit* the world" (p. 326).

These contrasts support the observation made by Gondwe and Longnecker (2015) who point to the highly contested nature of science and Indigenous knowledge concepts along a continuum from viewing Western science as dominant and universal at one extreme to a multicultural, relativistic view at the other which holds that all cultures possess knowledge and beliefs concerning the natural world (2015, p. 118). Acknowledging this continuum, Aikenhead and Ogawa (2007) discuss the two distinctive ways of knowing from their respective knowledge systems, giving the Eurocentric Sciences the acronym (ES) and introduce the term Indigenous Ways of Living in Nature (IWLN).

The use by Aikenhead and Ogawa (2007) of the 'ES and IWLN' dualism is quite deliberate. They justify this terminology on the basis that the expression 'Indigenous knowledge' is problematic because the word 'knowledge' is embedded in a Eurocentric epistemology and should be replaced by other expressions that more authentically capture an Indigenous worldview, such as "Indigenous ways of knowing, living, or being" (Aikenhead & Elliott, 2010, p.322). Furthermore, the Eurocentric meaning of 'to learn' becomes 'coming to know' in most Indigenous contexts, a meaning that signifies a personal, participatory, holistic journey toward gaining wisdom-in-action. The verb 'to learn' fits a Eurocentric context, whereas the action 'coming to know' assumes an Indigenous perspective, with both terms interchangeable (Aikenhead & Elliott, 2010, p. 322).

By using a series of fundamental presuppositions claimed by scholars to be inherent in both knowledge communities worldwide, they based their analysis on the worldviews, metaphysics, epistemologies and values integral to their respective knowledge systems from which they were able to compare elements from both. Aikenhead and Ogawa (2007) suggest that "both IWLN and ES could be recognised as ways of thinking that are co-existent, incommensurate, and culturally valid" (p. 552) and would break away from the fallacy of the binary opposite to frame an anti-hegemonic post-colonial discourse.

In further development of this idea, Aikenhead and Michell, (2011) discuss the potential for Indigenous Ways of Living in Nature (IWLN) and Eurocentric sciences (ES) to coexist in

educational spaces based upon their "common features" and "different but complementary" ways of dealing with nature that coexist – like the coexistence of yin and yang in Eastern philosophies (Aikenhead & Michell, 2011, p. 99). This leads to an important consideration of how this could occur in school science as well as in out-of-school situations. When dealing locally and globally in the classroom with issues such as sustainability and ecosystems, it can be argued that the knowledge systems together are more versatile and effective for students than one knowledge system alone (Clark & Dickson, 2003; Snively & Corsiglia, 2001). For out-of-school situations, it is proposed that ES might help solve a local community problem, when appropriate, while local place-based knowledge (IWLN) can help ES achieve a much richer understanding of a geographical place and a much broader understanding of our planet (Aikenhead & Michell, 2011, p. 114).

Directly relevant to the discussion, which is the focus of this literature review, and to demarcate the boundaries between ES and IWLN, Aikenhead and Ogawa (2007) offer their critique of traditional Western-based school science, gripped by "positivism". This sees school science failing "to rise out of a false sense of security and the naïve bliss of realism. It also fails to rise above the scientific method" (2007, p.551). In their view, the result of this is that school science fails to enlighten students about authentic sciences that for most permeate their everyday lives and instead "continue to portray mythical images of realism and positivism" (2007, p.551). Aikenhead and Ogawa (2007) further point out that the meaning of Indigenous knowledge is pluralist (rather than relativist) and far more complex than simply the binary opposite of Western knowledge.

The ability of people who are familiar with both knowledge systems to uniquely combine the two in various ways to meet a challenge or task at hand is referred to by Aikenhead and Michell, (2011, p. 114) as having a "two-eyed seeing". In the context of environmental crises alone, a combination of both systems seems essential and advantageous. For example, they concur with van Eijck and Roth (2007) who contends that "Multiple ways of understanding the environment encourages 'two-way learners' to create knowledge hybridised from Indigenous and Eurocentric knowledge systems and to take sustainable action" (Aikenhead & Michell, 2011, p. 114).

What is clear from the literature is that there is a need for science education to take a deeper and more challenging approach to an understanding of growing knowledge and that this could succeed within the mainstream of science education provision. This could be achieved by using research to distinguish between knowledge sources that students use when justifying

their position about a socio-scientific issue which could have both cultural and scientific impact.

Moving away from the global perspective on this issue of scientific and Indigenous knowledge coexisting within a conventional programme, the next section moves towards the literature focused on the two knowledge worlds that are central to this research project – mātauranga Māori (Aotearoa New Zealand Indigenous knowledge) and Western scientific knowledge. From a pluralist perspective, this next section firstly discusses how these knowledge worlds exemplify their individual epistemic capacity and then looks at the potential for both to contribute to and coexist in a mainstream biology programme.

The following section foregrounds the potential contribution each knowledge world could provide to a biology programme where learners could demonstrate their epistemic competence in a science/ biology sense and in a cultural sense through a scientifically literate, equitably justified position on the use of 1080 in Aotearoa New Zealand.

2.7 Mātauranga Māori and Western scientific knowledge in the classroom

The focus of this section is to explore the potential for a pluralist approach to science learning in current mainstream biology classrooms utilising Mātauranga Māori and Western scientific knowledge. According to Bell (2005), the study of a science or biology topic in Aotearoa New Zealand, especially in formal education opens a rich trove of knowledge resources from both mātauranga Māori and Western scientific knowledge that are potentially available to the learner (Bell, 2005, p. 61). To illustrate, Bell refers two twin studies carried out independently by Haami (1993) and Roberts (1993) who looked at the kiore (Polynesian rat, *Rattus exulans*) from their contrasting knowledge worldview perspectives, with Haami taking a mātauranga Māori perspective while Roberts presented a brief historical outline of the cultural attitudes of people of European descent, Pākehā, towards rodents (1993, p. 23).

The aim of doing so was to highlight how different cultural histories may influence our attitudes towards a particular species. The aim was to highlight the inadequacy of our knowledge base when solely reliant on either one of these two perspectives. Significantly, the papers highlight "the importance of cultural as well as scientific knowledge and the "need – and indeed the right – of all New Zealanders to have access to both perspectives" (Roberts, 1993, p. 23).

In a commentary offered by Bell, notes that the inclusion of both Māori and Pākehā scientific and cultural knowledge as part of a bicultural approach towards ecological management in this instance has been criticised as primarily serving the interests of non-Māori ahead of Māori as the Indigenous people of Aotearoa New Zealand (Bell, 2005, p. 162). Bell cautions that more than serving to raise cultural awareness and sensitivity of non-Māori, approaches to include a mātauranga Māori perspective would need to primarily serve the cultural and educational needs of Māori. At the very least, the inclusion of both Māori and Pākehā scientific and cultural knowledge would need to be on an equal basis to avoid the accusation of cultural appropriation of Indigenous knowledge by the dominant Western scientific community (Bell, 2005).

Bell also observes that both Haami (1993) and Roberts (1993) contrast Māori views of NOS with the Making Sense of the Living World strand of the New Zealand Curriculum (NZC). Whereas the NZC strand represents the realist, objectivist, positivist view of science, the Māori view of the origins of the universe and the personification of natural phenomena through whakapapa (genealogy) see the supernatural and the natural as holistic, dynamic and part of the unified whole (Bell, 2005, p. 167). In pointing out this contrast I am reminded of the position taken by Cooper (2012) whose challenge to the Western science community was stated as: "The consequence of a failure of science education to recognise the 'epistemic capacity' that Māori students possess" (Cooper, 2012, p. 70), is to delegitimise Māori knowledge (other than what science defines as being suitable to science content) (Bell, 2005, p. 167) that pathologises Māori in deficit (McKinley, 2003).

With the importance of context both for motivation and learning (Bell, 2005, p. 167), research from the University of Waikato as part of the Learning in Science Project (LISP) investigated the pedagogical importance of context in science teaching. For example, an intervention study by Gribble (1993) investigated the use of Māori myths and legends as a teaching aid in earth sciences. Gribble used the contexts of Māori myths and legends, and specifically the two legends of 'The Warrior Mountain' by Katerina Mataira and the Legend of Whakaruamoko, in four lessons of the usual teaching of a 3-week unit on volcanoes and earthquakes to two year 9 classes (an intervention and a comparison class) (Bell, 2005, p. 168). This study found that students used Māori cultural knowledge alongside newly learnt scientific knowledge and by doing so, linked them (Bell, 2005, p. 172). As one of the few examples of research into the potential these two knowledge worlds have to enhance learning, it invites research focused on how students use these knowledge world resources to support their justified position on a socio-scientific issue when given authentic contexts.

The socio-scientific issue of 1080 use to control pests presents an opportunity to explore Māori knowledge spaces in science described by Cooper (2012) as "paradoxical theoretical" (p. 67). To illustrate, Cooper contends that in science classrooms, Māori encounter an epistemic wilderness, barren of Indigenous knowledge where wisdom in the form of mātauranga Māori (Māori knowledge) is invisible. He surmises that classrooms are places where mātauranga Māori and epistemology should exist and thrive (Cooper, 2012). The challenge laid down by Cooper invites science educators to explore this epistemic wilderness to discover an unexplored world free from "the epistemic normativity of Western modern science, which has, for so long, questioned the validity of mātauranga Māori" (2012, p. 67). With respect to this research project, there emerges an opportunity to do so in a mainstream science and biology classroom where the 1080 controversy is discussed which might offer some answers to this dilemma.

Mercier, Stevens and Toia (2012) remark that worldviews have validity within their own particular cultural setting. Importantly, people perceive reality differently because they see the world through a filter that is a product of their cultural paradigm (Mercier, Stevens & Toia, 2012, p.108) and therefore, can exhibit a form of "observational prejudice" (p. 109). For example, Durie (2011, p. 100) observes that Indigenous people in particular rely more on the nature and quality of relationships and consistency with local tribal traditions and values. This observation supports the notion posed by Penetito (2015) that authenticity of a proposition is dependent on the cultural setting in which it exists, where diverse cultures hold different forms of 'situated' knowledge (2015, p. 42).

Mason Durie and other scholars note that while mātauranga Māori is distinct from other knowledge bases such as science, both are equally valid as ways of viewing, describing and understanding the world. Therefore, a necessary first step would be to gain a deeper understanding of their respective worldviews which could uncover the potential for these disparate yet equally valid knowledge worlds to unleash their epistemic potential. Māori scholar Te Ahukaramū Charles Royal (2004), highlights the contrast between the two knowledge worlds by pointing out that the single-most important aspect of an Indigenous worldview is the universal notion that the world is alive, conscious and flowing with perennial energy. In fact, the natural world is not so much the repository of wisdom but rather is wisdom itself, flowing with purpose and design (Royal, 2004, p.218). This view closely aligns with Durie's assertion that indigeneity represents a fusion of Indigenous peoples with their customary environment (Durie, 2005, p. 151), in a reciprocal and mutually sustaining relationship.

Royal offers a vivid example of how, from a mātauranga Māori worldview, the natural world is a *mind* to which all minds find their origin and indigenous knowledge is the fruit of this cosmic stream (Royal, 2004, p.218). The example he uses refers to the belief about where God resides. In the Judeo-Christian West, God is thought to be residing outside of the world. It is thought that the world is not God 'himself' but rather a manifestation of 'his' creative power. This contrasts with an Indigenous worldview that sees God residing in the world – in the deserts, in the waters, in the forests and in the human person as well. And when [Indigenous people] mean 'God' [they] mean the foundation or 'root cause' of all things, eternal and paradoxically, immanent and ever-present (Royal, 2004, pp. 218–219).

This distinction illustrates how two worldviews can perceive of a situation in quite different but equally valid ways. Royal reminds us that when we think about Indigenous worldviews and knowledge…we are to be mindful of the great yearning of the natural world to speak through human creativity. That is, "human cultural production is a natural organic expression arising from the contours, shapes and colours of the environments in which we dwell" (Royal, 2004, p.219).

This knowledge dichotomy could possibly point the way towards an analysis of how students who can access different knowledge worlds integrate this knowledge as they justify their position on the use of 1080 to control mammalian pests. If two knowledge worldviews can coexist in the hearts and minds of human thought, it remains to be seen how this might manifest and contribute to the formation of new knowledge and ways of understanding within the Western science/biology context of a socio-scientific issue of pest control using 1080?

2.8 Knowledge worlds and educational spaces

It is generally accepted that even though there are multiple worldviews, cultures and sciences, school science has become standardised. It has arisen from its presentation of canonical knowledge, techniques and Eurocentric worldviews (Kim, 2017, p. 606). Although sparse, recent overseas research literature has explored the potential for Western science knowledge and Indigenous knowledge to coexist in an integrative fashion within a Western science/biology programme (Gondwe & Longnecker, 2015; Handayani, Wilujeng & Prasetyo, 2018; Kim, 2017). Research of this nature indicates an area of potential opportunity for this research project to explore within the controversial issue of 1080 use here in Aotearoa New Zealand.

Researchers agree that the meaning and relation of the concepts of science and Indigenous knowledge is highly contested and debated (McKinley & Stewart, 2009; Snively & Corsiglia, 2001); yet, despite differing worldview perspectives and epistemologies, the possibility exists that under certain conditions and circumstances one knowledge world could show something that is beyond the reach of the other in a form of cross-cultural hybridisation (Mazzocchi, 2018, p. 29). The research literature is unequivocal on the importance of learning about the culturally diverse lifeworld experiences students bring into the science classroom. Whereas historically, science knowledge for many was inaccessible and culturally irrelevant, there is increasing evidence in recent studies of a sustained movement taking place in science education worldwide towards making science knowledge more accessible and increasingly relevant to students (Kim, 2017, p. 607).

Another approach to aid our understanding of these shared spaces was the 'common ground' concept proposed by Stephens (2001). Widely accepted in the research literature, this concept reinforces the proposition for the existence of a buffer region, an intermediate zone that appears to be a form of shared space populated by similarly expressed concepts and equally valid notions <u>shared</u> by <u>both</u> knowledge worlds. Regardless of the debate surrounding the meaning and relation of the concepts of Western science and Indigenous knowledge, it is hoped that students will develop and express their own meanings of Indigenous knowledge and Western science in this common ground (Gondwe & Longnecker, 2015, p. 118).

A common ground approach could also help to deepen our understanding of how the concepts at the intersection of the Western science and Indigenous knowledge worlds could 'generate the unexpected' as students construct their own meanings as expressions of their scientific literacy. For example, the common ground is a space where new, 'modified' knowledge could come from the assemblage of concepts and ways of thinking sourced from Indigenous knowledge <u>and</u> Western science knowledge. Stephens (2001) observes that the common ground has powerful implications for students for three reasons: Firstly, that a student might conceivably develop all the common ground skills and understandings while working from and enhancing a traditional knowledge base. Secondly, that the acquisition of the common ground, regardless of route, is a significant accomplishment. Thirdly, that exploration of a science topic through multiple knowledge systems can only enrich perspectives and create thoughtful dialogue (Stephens, 2001, p. 10).

Within the 1080 controversy there exists two distinctive knowledge worlds whose perspectives and underlying explanations and understandings of the natural world differ – that

is, temporally and philosophically from each other. As people from both knowledge worlds seek to explain the same observed natural phenomena and, coupled with a "human tendency to view things from one's own spot in the world" (Stephens, 2001, p. 11), a thoughtful consideration of these two knowledge systems could reveal more about their 'common ground'.

Despite the apparent optimism expressed by Stephens (2001) for this common ground and the support for this concept by Aikenhead and Ogawa (2007), the integration of Western science and Indigenous knowledge through a common ground approach does not guarantee a smooth, trouble-free journey. Mazzocchi (2018) points out that there are quite serious obstacles standing in the way of a successful integration. For example, power imbalances which exist in education systems can serve to expropriate Indigenous knowledge. According to Mazzocchi, by far the greatest difficulty to overcome occurs epistemologically where a dominant Western narrative works to counter an accommodation with any different, and possibly conflicting interpretations of reality and knowledge criteria, and instead create a "globalized monoculture" where only a single type of knowledge and science is genuinely recognised (Mazzocchi, 2018, p. 20).

Therefore, Mazzocchi contends that one must caution against an integration that becomes the "scientification" of the non-scientific epistemology by isolating and decontextualising bits of information from the overall sociocultural setting – a form of 'methodological reductionism'. The final caution offered by Mazzocchi is to be aware of evaluating the Indigenous knowledge system by the criteria of the competing system (Western science) – all of which would "sterilise" (Mazzocchi, 2018, p. 20) the epistemic diversity that the two knowledge systems can contribute. Therefore, the common ground concept appears to provide a useful framework from which we can consider the views of students towards the use of 1080 to control pests. Such a framework could be applied to questions nested within the central issue of 1080 use to control mammalian pests in Aotearoa New Zealand.

Despite the concerns for the apparent disparate nature of these two knowledge worlds, the research literature has focused on the use of these two knowledge systems to inform and strengthen environmental and biodiversity management in Aotearoa New Zealand. For example, two recent studies demonstrate the potential for joint contributions by Western science and mātauranga Māori knowledge-world components to populate a 'common ground' space to enhance decision-making for the holistic, integrated management of biodiversity resources (Dencer-Brown, Alfaro, Milne & Perrott, 2018) and integrated forestry management

for a sustainable future (Lyver, Timoti, Gormley, Jones, Richardson, Tahi & Greenhalgh, 2017). However, these examples only illustrate the use of Indigenous knowledge in applied contexts and problems in the commercial world beyond the science classroom. The demonstrated potential of two knowledge worlds to coexist and benefit large-scale biodiversity management in these examples points to space for research to investigate the potential of a coexistent knowledge scenario, albeit a similar but scaled-down version appropriate for a high school biology classroom. The 1080 debate context offers the opportunity for this research project to do just that. It is proposed that a classroom-based research methodology that acknowledges the plurality of knowledge sources and the diversity of student identities would be appropriate.

As the 1080 debate ranges across the public and scientific domains, the next section considers the spaces of the controversy where these two distinctive knowledge worlds contest for prominence, where challenges to the validity of these knowledge worlds take place and positions are justified. It is argued that it is important for this research project to explore these spaces, both real and imagined, to reveal any untapped learning and pedagogical potential.

2.9 Space and the knowledge interface as a pedagogical opportunity

The public nature of the 1080 controversy through news broadcasts, online forums and open-air demonstrations has seen the public domain as the predominant space occupied by those groups opposed and supportive of 1080 use.

There seems to be the need to find a discussion space for people to articulate their perspectives based upon their worldviews. The dominance of Western scientific discourse appears to have crowded out alternate worldviews which may have their origin here in Aotearoa New Zealand – specifically from within an Indigenous mātauranga Māori worldview.

There is a need to find a space for the articulation of voices from across the knowledge-world landscape where views on 1080 use can be expressed and heard.

Up until this point, we have considered the characteristics of the two predominant spaces for the expression of views and articulation of knowledge – Western science knowledge and Indigenous mātauranga Māori cultural knowledge.

Our search for a space at the interface of these knowledge worlds which began with a consideration of Stephen's (2001) concept of 'common ground' could be explored by looking at the different ways this theoretical space has been characterised and described in the

literature. By its very nature the socio-scientific issue of pest control using 1080 sits within the 'common ground' (Stephens, 2001), in a 'third' space (Bhabha, 1994), between the boundaries of the two knowledge worlds (Aikenhead & Ogawa, 2007), at the cultural interface (Nakata, 2002). With these various ways of describing knowledge spaces, it could be fruitful to compare these descriptions.

The prospect of crossing a border from one knowledge world into another invites a consideration in the next section, of how the literature represents this theoretical space that has been entered. Homi Bhabha (1994) proposed the theoretical concept of the Third Space and education as a place for collaboration, sense-making (Gutierrez, 2008) and innovation. Well traversed by scholars, it appears closely related to the common ground concept with respect to a shared space but goes further towards realising and describing a space of active collaboration, agency and knowledge generation, in a locality far beyond the colonial binary.

According to Gutierrez (2008, p. 152), third spaces are constructed through education practices that provide and mediate rich learning opportunities within complex and often conflicting social contexts. Furthermore, this space can be thought of as a collective where new and shared understandings and practices evolve through coordinated activity. The metaphorical collective third space offers students opportunities to grapple with and discuss issues with others in the community, thereby enhancing the potential for integration and expansion of knowledge (2008, p. 300). The space is transformative and is where the potential for an expanded form of learning and the development of new knowledge are heightened (Gutierrez, 2008, p. 152). It is, as Brandt (2008, p.703) suggests a "location of possibilities."

A decade previously, New Zealander, Paul Meredith (1999), expressed his concerns for the binary of Māori (the Indigenous colonised) and Pākehā (the European colonisers) representing an oversimplified and essentialised portrayal of the dynamic relationship that has been at play since colonisation began 250 years ago. Meredith called for a move away from the "us/them" dualism towards a mutual sense of 'both/and' through Bhabha's third space concept which he says offers "a central place for post-colonial discourse" (Meredith, 1999, p, 13). He agrees with Bhabha's (1994) representation of cultural difference as positioned in between the coloniser and colonised and "where hegemonic colonial narratives are disrupted and displaced" (Meredith, 1999, p, 13).

It is proposed that this liminal, in-between 'Third Space' is "a productive space that engenders new possibility – an interruptive, interrogative and enunciative space of new forms of cultural meaning and production. It is where the limitations of existing boundaries are blurred at an

ambivalent site where cultural meaning and representation have no primordial unity or fixity." (Meredith, 1999, p. 13). Therefore, the Third Space provides a useful framework for "going beyond the colonial binary and dualistic categories and into a realm of space and inclusion (rather than exclusion) that initiates new signs of identity, and innovative sites of collaboration and contestation" (Bhabha, 1994, p. 1). More so, Meredith sees the potential for the third space concept to provide a fluid environment where there is a free-flow of information between cultures as a precursor to the re-articulation of negotiation and meaning, as a new hybrid identity emerges within this space. For Meredith, Bhabha's concept of hybridity and Third Space contribute to an approach that develops inclusion through an acknowledgement of the multi-faceted patterns of cultural exchange and maturation (Meredith, 1999, p. 14).

Within the issue of 1080 use, the Third Space concept creates an opening within which the expression of student views and justifications could be analysed. Wallace (2004) notes that narratives provide innovative spaces for expression with a focus on 'moments of articulation' analogous with Bhabha's notion of 'in-between spaces' and provide a zone for new interpretations and meanings (2004, p.907). Here, Wallace contends that dialogue creates hybrid and authentic meanings as multiple discourses are woven together without sacrificing the importance of the student's experiences or ways of knowing the world.

Importantly, this hybrid space could offer much to this research project in terms of the understanding of knowledge use and learning within the context of a socio-scientific issue such as 1080 use.

Wallace (2004) implies that to become scientifically literate, learners must be willing to enter the third space and collaborate in the construction and expression of scientific meaning. Wallace contends that students engage with ideas in the third space and integrate the concepts into their knowledge base in authentic, meaningful and useful ways (2004, p.912).

For science learners, how they engage when in the third space as they read critique and write scientific text and use language in scientific argumentation could be fruitful for this research project as it is proposed to focus on student discourse and voice from within the socio-scientific issue of 1080 use. This could confirm the opportunity for this research project to explore the integration of Western scientific and mātauranga Māori knowledge within this space by students who use knowledge concepts in an authentic and meaningful way.

Socio-scientific issues can offer authentic tasks to bridge across to the third space between the first space of the child's everyday knowledge and the second space of the school/disciplinary

knowledge, where discourses may be interlaced (Åkerblom & Lindahl, 2017, p.206). Therefore, having established the important contribution of the Third Space concept to this research, the discussion now turns to the third and potentially most significant theoretical representation of the learning spaces between the Western science and Indigenous knowledge worlds – Martin Nakata's cultural interface (Nakata, 2007) that provides an opportunity to populate this space.

With the argument that Indigenous ways of knowing and Western ways of knowing are epistemologically and ontologically disparate and being careful to avoid the dualism described by Aikenhead and Ogawa (2007) as the "colloquial dyad", the Indigenous research scholar researcher Martin Nakata (2002, 2007) theorised the formal learning space he termed the cultural interface. Nakata describes this interface as "the place where we live and learn, and relationships develop, the place that conditions our lives and shapes our futures, where we are active agents in our own lives and where we make decisions – our life world" (Nakata, 2002, p. 285).

This experiential, interstitial and neutral third space, offers much to this research as there exists a free-flowing interaction between the knowledge worlds which awaits discovery – a place where the validity of both knowledge systems is taken for granted and where neither one is set above the other, nor used as a means of measuring the value of the other (Mercier, 2007, p. 22). This multi-layered, multi-dimensional space of dynamic relations where different systems of thought and different knowledge systems converge (Kahu & Nelson, 2018) remains largely unexplored. It is proposed that the 'cultural interface' offers to this research this positive metaphor, emphasising the importance of drawing on both ways of being, rather than focusing from a deficit view on any lack of alignment between cultures or positioning the student as in deficit.

It is argued in the literature that the cultural interface connects Indigenous knowledge worlds and non-Indigenous knowledge worlds and knowledge economies (Minniecon, Franks & Heffernan, 2007, p. 24). The cultural interface also recognises the importance of personal agency where people are active agents as decision-makers in their own lives. It is our life world (Nakata, 2002), where students negotiate 'the expanse in between'. Finally, within this space resides the theoretical concept of the 'locale of the learner' (Nakata 2007), which describes where and how Indigenous individuals position themselves and are positioned by others at the interface, and how they experience and navigate different knowledge systems in their everyday lives and relationships (Nakata, 2007).

By assuming that a dichotomous relationship between two knowledge worlds exists, Nakata's cultural interface theory provides this research with a useful framework for thinking about how we might engage and analyse these potentially conflicting approaches within the context of the socio-scientific issue at the place where these knowledge domains intersect (Kearney, McIntosh, Perry, Dockett, & Clayton, 2014; Nakata, 2007). With respect to the use of 1080 to control mammalian pests, the cultural interface could provide a fertile space within which there are possible positions, contexts and experiences for analysis (Kearney et al., 2014, p. 341), as well as providing an interpretive lens through which to examine the differing positions that occur towards the use of 1080 to control animal pests in Aotearoa New Zealand.

The way that this might be approached is to adopt the notion of the cultural interface as an agentic space. If this position is explained, one could extrapolate this definition to encompass students' approach to knowledge use. This would require the assumption that students are decision-makers who by the exercise of their agency are able to view knowledge worlds as a resource base from which they decide to draw information from to support their justified position on the socio-scientific issue at hand.

The next section explores the literature on learner agency to assess this possibility.

2.10 Learner agency, SSIs and scientific literacy

The significance of Nakata's reference to the cultural interface as an agentic space offers this research an opportunity to investigate further the literature on the concept of learner agency and the ways it has been conceptualised and used to describe learning and knowledge resource utilisation in science education. How might these notions of agency as a socio-cognitive process where people are proactive rather than reactive and are shaped by internal drivers and their actions (Bandura, 2006) rather than by external events (Bandura, 1999) inform our discussion of knowledge use at the cultural interface in the context of a socio-scientific issue?

As a general concept closely related to self-efficacy, agency is rooted in the desire to fulfil basic human needs and refers to the ways people act and interact within socio-cultural settings (Blair, 2009). Learner agency implies learners moving from powerlessness to a sense of control and a hope for the future – their own future (Blair, 2009, p. 180). One of the more descriptive definitions by CORE Education in Aotearoa New Zealand emphasises that for students, agency is about choices, which implies an element of decision-making followed by purposeful actions to intervene in the learning process as 'agents' who take control of their learning journey (CORE Ten Trends, 2017).

In an educational setting, learner agency in and of itself has potential to be explored as an essential element of the cultural interface (Nakata, 2007) and, is therefore, a viable concept to utilise in this research project. Because of its importance, it is essential to apply a tightly operationalised definition of learner agency as it relates to knowledge use. This will enable the concept to apply unambiguously to the development of a conceptual framework for the analysis of participants' data (Arnold & Clark, 2014, p. 736).

A useful definition of agency is offered by Varelas, Settlage and Mensah (2015, p. 439) in which agency is seen as "a person's capacity to engage with cultural schemas and mobilise resources in ways that did not exist before, creating new contexts and practices."

As the focus of this research are the spaces where students use biological and cultural knowledge, this definition is appropriate for an investigation of how learners engage with and utilise their knowledge resources in an authentic situation in ways that are new for them. It is therefore timely to consider how might socio-scientific issues provide us with this authentic context wherein learner agency is foregrounded?

Socio-scientific issues (SSIs) as previously discussed in Section 2.2 are defined in the science education literature as "open-ended, ill-structured, debatable problems, which are susceptible to multiple perspectives and solutions" (Lindahl & Linder, 2013 p. 2302). Following this definition, Lindahl and Linder (2013) assert that SSIs provide opportunities for individuals to engage in informal reasoning as they try to negotiate possible solutions to the problems encountered. They argue that by doing so, they gain experiences that are believed to support future participation in democratic decisions about the particular issue under discussion (2013, p. 2302). Lindahl and Linder (2013) also found that an SSI was deemed an appropriate context for the study of the development of agency and reasoning by students (Lindahl & Linder, 2013, p. 2300).

Going still deeper, Woods-McConney, Oliver, McConney, Maor & Schibeci (2013, p. 250) found that SSIs allow a high degree of student control (through autonomy and agency) and provide relevancy (authenticity) of science content which together are important factors to building science engagement. Notwithstanding this pre-eminence, this research focuses on students' engagement with knowledge and their decision-making with respect to the use of knowledge resources – that is, biological and cultural.

Kirch and Ma (2016) note that agency is a combination of both the capacity to act as well as the intentional engagement with the world [and its resources – which includes its knowledge

worlds] (p. 1107). The capacity to act and engage with an issue are the central tenets for a discussion of SSIs which ties together the close relationship between agency and the opportunity it provides to debate and argue a position on a controversial issue. This leaves one final connection to make – that is the connection between SSIs, learner agency and scientific literacy.

A few studies have shown the advantage of using SSI contexts to enable students to participate in democratic discussion as a part of their scientific literacy development (Driver et al., 2000; Kolstø, 2000). According to Lindahl and Linder (2013, p. 2302), students who exercise agency by developing a critical stance towards knowledge claims and participating in discussions and logical arguments are congruent with a modern definition of scientific literacy (Aikenhead, 2007; Zeidler & Sadler, 2010). Lindahl and Linder (2013) further point out that the role of science education in society has shifted over time (p. 2302). The changes include norms and how these are conveyed to students, the societal use of science and how to participate in societal discussions about science and technology (Lindahl & Linder, 2013, p. 2302). They argue that gaining a sense of and developing learner agency adds another element to a modern science education setting (Lindahl & Linder, 2013, p. 2327) and extends and deepens the classical definition of scientific literacy.

This could provide the opportunity in this research to seek evidence to extend our understanding of the role learner agency plays when students use knowledge to support for their positions on a socio-scientific issue.

While Willis (2017) highlights some ethical concerns arising from the pedagogical freedom afforded by agency in learners (p. 317), as a possible threat to their ontological security (Lindahl & Linder, 2013, p. 2299), McLaughlin (2018) supports the call to reposition young people as actors in their social worlds – as "agentic people" (p. 286).

For this research, the concept of agency operationalised for this research project and chosen is that which relates explicitly to decisions made by students to include biological science knowledge <u>and</u> cultural knowledge. From this, the operationalised concept that could be most appropriate for this study is 'epistemic agency' (Zimmerman & Weible, 2018) as it refers to decisions surrounding knowledge use and knowledge claims.

In essence, epistemic agency is defined as students' confidence that they could build knowledge related to science and their community (Zimmerman & Weible, 2018, p. 894). Specifically, epistemic agency differs from meaning-making in that learners are not only

making sense of new information, but they are engaged in inquiry practices in which they are building disciplinary knowledge. Epistemic agents, conceived of thus, are "capable and confident knowledge-builders in the environmental sciences" (Zimmerman & Weible, 2018, p. 895).

This definition builds from prior conceptions of agency in educational settings, defined as the learners' beliefs that they have access to use, or resist using, various resources in formal or informal learning spaces. Some researchers have advanced the idea of 'learning as agency' and domain dependent (agency in biology is different than in history) and that agency is also based on learners' socio-historical interactions with cultural institutions, social practices and socially-authored identities. Their study contributed to the growing area of work that investigates how adolescents become epistemic agents (i.e. competent and confident knowledge-builders) as they learn to engage in environmental sciences across settings – in this case the science classroom, an online public wiki space and a community field study (Zimmerman & Weible, 2018).

To conclude this section, epistemic learner agency has the potential to be used to demonstrate how students can venture beyond simply meaning-making from scientific information; they are competent and view themselves as capable of developing scientific explanations that are worth sharing with others (Zimmerman & Weible, 2018). By taking a holistic perspective, epistemic agency could be reinterpreted in such a way as to provide this research project with some core elements (such as engaging with, critiquing and interpreting knowledge) from which to create a conceptual framework for the analysis of learner epistemic agency at the cultural interface. Applying this framework to the analysis of participant data could also extend our understanding of how students (as epistemic agents) express their scientific literacy as they access knowledge from the biological science and cultural knowledge worlds to justify their position towards the socio-scientific issue of pest control using 1080 poison.

This is an area of multicultural science education research that awaits a full and comprehensive investigation.

2.11 Justification and identification of research questions

It has been established in this literature review that an under-researched area of science education is how students within English-medium mainstream high school science classrooms in Aotearoa New Zealand use their resourceful wealth of cultural knowledge, worldviews and understandings of the natural world. There is a pressing need for science educators to learn

more about how students use their scientific and cultural knowledge resources to enhance learning. This literature review confirms that the controversial socio-scientific issue (SSI) of 1080 use to control possums is a contemporary example of Western scientific practice in a multicultural context which is suitable for an investigation into how students use their knowledge resources in their biological science learning.

In addition, the context of an SSI could provide for this research a pathway to explore students' expression of their biological literacy and reveal the different ways the participants view knowledge. We currently have insufficient research evidence to be able to understand the realities of culturally and linguistically diverse learners as they deal with these potentially conflicting knowledge worldviews in science and how they respond to this.

Consequently, for the purposes of this research, scientific literacy will not be restricted to a Western scientific paradigm alone – instead, it will be viewed as open to receiving equally valid and literate expressions of knowledge concepts from an Indigenous worldview. Therefore, it would be interesting to find out more about how students use interdisciplinary, contextualised knowledge from both knowledge worlds.

For example, Cooper (2012) describes Māori encounters with an epistemic wilderness in mainstream science classrooms barren of Indigenous knowledge and where wisdom in the form of mātauranga Māori (Māori knowledge) is invisible. In response, this research aims to explore how classrooms can become places where mātauranga Māori and biological science knowledge could exist and thrive, and to discover an unexplored world free from "the epistemic normativity of Western modern science" (Cooper, 2012, p. 67).

Although sparse, recent overseas research literature has demonstrated the potential for Western science knowledge and Indigenous knowledge to coexist within a Western science/biology programme. If so, two critical questions require further investigation.

Firstly, how do students **use** scientific and cultural knowledge explanations of the natural world as they demonstrate their scientific literacy? Secondly, how do students **express** the features and presuppositions that these knowledge worlds have in common on one hand and those that contrast on the other? The 1080 controversy offers this research project an opportunity to do so in a mainstream English-medium science and biology classroom where the 1080 controversy is discussed.

As a relatively new focus, there have only been a handful of studies reporting on student agency in science education (Sutherland, 2005; Arnold & Clarke, 2014).

For this research, the concept of agency is operationalised as 'epistemic agency' (Zimmerman & Weible, 2018). This is possible as it is based on my understanding and interpretation of the definition of epistemic agency I have presented in this literature review by combining elements from the definitions sourced from; Kirch and Ma (2016), Lindahl and Linder (2013) and Zimmermann and Weible (2018). Therefore, my interpretation of epistemic agency is the way in which students engage (experience), critique (position) and interpret (navigate) knowledge (see p. 56). This analysis will enable the examination of different knowledge systems within the cultural interface "in a non-oppositional way" (Goff & Veresov, 2015, p. 626).

Here, epistemic agency relates explicitly to decisions made by students to include biological science knowledge and cultural knowledge and to critique their knowledge claims. Having established that learner agency and scientific literacy are linked, this research could extend our understanding of the role learner agency plays when culturally and linguistically diverse students provide justifications for their positions on a socio-scientific issue.

Finally, this literature review has opened a fruitful avenue for this research to apply the concept of epistemic agency (a subset of learner agency) to explore how students, as epistemic agents utilise their biological science knowledge and mātauranga Māori knowledge resources at the interface of these knowledge worlds.

Therefore, within the context of the socio-scientific issue of the use of 1080 to control mammalian pests in Aotearoa New Zealand my interpretation of the cultural interface and epistemic agency within this space has enabled me to conceptualise and define a convergence zone for cultural and scientific knowledge. To explore the use of these two knowledge domains by senior biology students, the following significant questions will guide this research project:

1. What biological science concepts are identified? And:
    - How do the participants use biological science concepts to justify their position within the socio-scientific issue?

2. What mātauranga Māori concepts are identified? And:
    - How do the participants use mātauranga Māori concepts to justify their position within the socio-scientific issue?

3. How do participants integrate mātauranga Māori concepts and biological science concepts as they develop and present an informed, justified response to the socio-scientific issue?

Chapter 3: Methodology

3.1 Introduction

The purpose of this research project was to investigate the ways in which senior biology students used biological science knowledge and mātauranga Māori and/or Pacific knowledge to justify their position within the socio-scientific issue of the use of 1080 to control mammalian pests in Aotearoa New Zealand.

This chapter explains and justifies the methodology and research design elements that will enable the three research questions to be investigated. Section 3.2 presents the research paradigm for this project and justifies the ontology, epistemology and methodological approaches taken to answer the research questions presented below. Section 3.3 presents the timeline of the data generation and collection period followed by Section 3.4 which describes the context for this study. A description of the participants, their sampling and selection is outlined in Section 3.5. Section 3.6 describes the two techniques used for data generation and collection. The ways the data were analysed is described in Section 3.7. Section 3.8 discusses the issues of trustworthiness and the penultimate section 3.9 concludes the chapter with a discussion of the ethical considerations pertinent to this project prior to a chapter summary in Section 3.10.

Research Questions: Three significant research questions emerged from the literature reviewed in Chapter 2. They are:

1. What biological science concepts are identified? And:
    - How do the participants use biological science concepts to justify their position within the socio-scientific issue?

2. What mātauranga Māori concepts are identified? And:
    - How do the participants use mātauranga Māori concepts to justify their position within the socio-scientific issue?

3. How do participants integrate mātauranga Māori concepts <u>and</u> biological science concepts as they develop and present an informed, justified response to the socio-scientific issue?

3.2 Research paradigm justification

Ontology

The ontology that frames this project is social constructivism (Sarantakos, 2013). It proposes that the social world is a human creation and reality is constructed (rather than discovered) by people actively engaging and interacting with their world (Kukla, 2000). For this project, a social constructivist ontology accepts the premise that the research participants presented socially and culturally constructed realities and that they provided subjective meanings for their knowledge concepts based upon their own personal experiences (Bloomberg & Volpe, 2012) that is unique to each of the participants (Sarantakos, 2013).

To uncover these knowledge concepts, the research required a nuanced approach to understand these multiple realities and discover their meaning as they were used by the participants to express their understanding of and justification for their position towards 1080 use. Consequently, this ontology enabled me to take an empathetic approach which revealed the participants' lifeworld experiences (Sarantakos, 2013) from their perspective and worldview.

By using a social constructivist approach, it is anticipated that my ontological approach, which was foregrounded in Chapter 1, will enable me to understand and interpret how the participants engaged in meaning-making in the sociocultural context of this socio-scientific issue (Sarantakos, 2013). Using the qualitative methods of interviews and conceptual thematic analysis (Flick, 2007), could enable me to better understand the perspectives and experiences of the participants and how meanings of concepts are built up and represented. It is presumed that the constructivist approach and qualitative research design is an effective combination for this project as it will enable me to take a flexible, creative approach (Bloomberg & Volpe, 2012) to the collection and interpretation of data from a small sample, in a natural, real-world context (Sarantakos, 2013).

Epistemology

According to Schwandt (1998), the goal of an interpretivist approach is to understand the complex world of lived experience (Merriam, 1998) from the point of view of those who live it. As this project involves the reflective assessment of the reconstructed impressions of the world, it is anticipated that interpretivism will enable me to connect culturally derived and historically situated interpretations of the social life-world (Sarantakos, 2013). Therefore, it is proposed that it is an appropriate epistemological position for this research project.

With an abiding concern for the life-world, insider point of view (Schwandt, 1998), the interpretivist researcher seeks to grasp the actor's definition of a situation through an empathetic understanding of human behaviour. The actors in this project are the participants whose world of lived reality and situation-specific meanings constructed by them constitute the general object of this project (Schwandt, 1998). Interpretivism focuses on the intersubjective understanding of people, with the aim to comprehend peoples' norms, values and symbols – and to make sense of people on their own terms and how they experience their world (Remler & Van Ryzin, 2015). Consequently, interpretivism is appropriate epistemology for this research. Furthermore, as it is ideographic, with the emphasis on the details to understand the particular (Willis, 2007), the content is foreground; the context and situation are background (Stake, 2010).

The underlying epistemology of the interpretivist paradigm accepts the existence of multiple perspectives towards social phenomena and that our social agency enables us to act on our own initiative and construct reality shaped and defined by the filters of language and culture (Willis, 2007). With the emphasis in this project on the use of cultural and scientific knowledge concepts, an interpretivist epistemology accommodates the filtering role that both language and culture play in shaping and defining our constructed realities (Willis, 2007).

Interpreting the subjective meanings individuals place upon their justifications (Walliman, 2005) in a way that portrays their 'sense-making' (Thorne, 2008., Richards & Morse, 2013), the interpretation will be extended beyond the tangible and real of the study and into the conceptual and abstract (Saldaña, 2015). This focus is central to this project as its purpose is to explore the conceptual worlds of Western scientific and mātauranga Māori cultural knowledge used by the participants to justify their positions towards 1080 use.

Qualitative research design

Based on the theoretical foundations of a constructivist ontology and interpretivist epistemology, the central tenets of the qualitative research design used in this project are that reality is subjective, constructed, multiple, diverse, experienced internally and resides in the minds of those who construct it (Sarantakos, 2013). Consequently, all participants are actors who are active creators of the world and create their own subjective realities upon which they ascribe meanings they create that are used to make sense of the world.

As a situated activity that locates the observer in the world, the qualitative research practices applied in this project attempt to produce a series of representations by using an interpretive

naturalistic approach (Sarantakos, 2013) to study the participants' use of cultural and biological knowledge in the natural setting of a secondary school biology assessment. The research design reflects this classroom-based focus where students' interpretation of the issue and their responses are foremost.

The representation of this knowledge by the use of concepts was investigated by relying as much as possible on the participants' subjective views towards 1080 use and the multiple subjective meanings they developed for these concepts. The qualitative tools applied to the generation, collection and interpretation of these subjectivities allowed me to gather and present evidence to answer the three research questions and uncover the concepts used by the research participants to justify their position towards 1080.

3.3 Timeline

The data generation and collection period of this project aligned with the four school terms in 2015 (February - December). Table 3.1 provides a framework, resulting timeline and summary of the research activities and data generation methods related to the research questions.

Table 3.1
Timeline of field engagement, data generation and collection

Timeline	Research Questions	Research Description	Data Generation and Collection
Term One 2015 February-April		Obtained ethics approval Recruitment of interested schools Advertised for potential participants in the Science newsletter to secondary schools' science departments Contact with respondents and visits to discuss the planned research with Principals Project introduced to students and invited to participate PIS & CFs handed to students and a PFW PIS	
Term Two 2015 April-July	Research questions 1, 2 and 3: 1. What biological science concepts are identified? And – How do the participants use biological science concepts to justify their position within the socio-scientific issue? 2. What mātauranga Māori concepts are identified? And– How do the participants use mātauranga Māori concepts to justify their position within the socio-scientific issue? 3. How do participants integrate mātauranga Māori concepts and biological science concepts as they develop and present an informed, justified response to the socio-scientific issue?	In-class activities covered extinction / kaitiakitanga and socio-scientific issues Out of class excursions to Murphy's Bush and TiriTiri Matangi Island.	Commencement of participants' NCEA summative research paper Researcher obtained the completed, unmarked summative written assessment scripts from participants for copying and analysis
Term Three 2015 July-September	Questions 1, 2 and 3 (See above)	Preparation of interview schedule and questions Individual interviews with the participants	Individual interviews with the participants at their schools Transcription of interview recordings
Term Four 2015 October-December	Questions 1, 2 and 3 (See above)	Conclusion of engagement phase and acknowledgement to the schools and participants for their contributions	

3.4 Context

The context for this research project is centred on the educational journeys of two classes of Year 13 biology students in their final year of secondary education at two urban Auckland high schools in 2015 as they completed a 3-credit internal assessment for their NCEA Level 3 qualification (Madjar & McKinley, 2013). Specifically, the participants completed their internally assessed achievement standard AS91602 that focused on the contemporary socio-scientific issue of the use of 1080 poison to control mammalian pest animals in Aotearoa New Zealand.

The requirements of the Achievement Standard AS91602 (Version 1, 2012) provided the context within which the data generation and collection process occurred. Key to the participants' approach was the requirement that they *'integrate biological knowledge'* as they developed an *'informed response'* to the socio-scientific issue in this case the control of possums using 1080 poison. The assessment specifications required students to state a personal, justified position and present an informed response to a socio-scientific issue …by presenting a justified personal position and proposed action(s) by analysing and evaluating the biological knowledge relating to the issue." (Appendix E).

The flexibility of the internal assessment process enabled the teachers at both schools to design an assessment task tailored to meet the needs and interests of their students. Therefore, the tasks set by each school varied in the contextual elements and format of the final submitted assessment paper whilst maintaining the appropriate level of the New Zealand Curriculum for the subject and reflective of the required standard of performance in line with national requirements for consistency.

To illustrate this flexibility, the assessment task at 'Secondary School' (pseudonym for school 1, coded as SS) was specifically contextualised and focused on a proposal by local authorities to drop 1080 near water catchments in the Hunua Ranges, south-east of Auckland. This focus was topical at the time and aroused intense public interest from those groups on either side of the 1080 debate (see Appendix F). A slightly different approach took place at 'High School' (pseudonym for school 2, coded as HS) where the assessment task required students to research and write a speech of a generalised nature about the use of 1080 to control possums in New Zealand (see Appendix G). For students at High School, the material submitted for final summative assessment comprised the participants' written speeches. At Secondary

School students were required to research and write their summative assessment paper and submit it for marking.

3.5 Participant sampling and selection

In early Term One of 2015, I placed a notice in a regular newsletter to schools from the National Co-ordinator of (Science) for the Secondary Student Achievement Contract based at the Faculty of Education and Social Work at the University of Auckland. Soon after, replies were received from two interested science departments who wanted to learn more about the proposed project. The advertisement mentioned that the proposed project would look at a socio-scientific issue from a cross-cultural standpoint (see Appendix A).

The participants in this research came from two secondary high schools in the Auckland urban area using a purposive sampling method (Flick, 2014). The two high schools who had initially expressed interest eventually became the participating schools in this research. Both schools were selected as they matched two criteria set at the outset of this investigation that would have been used to decide the participating schools if more than two schools had expressed interest in participating in the project.

The first criterion was that the composition of the school's population consisted of sufficiently large numbers of students who fall under the New Zealand Ministry of Education's classification of priority learners and who were predominantly, though not exclusively, of Māori and Pacific ethnicity.

Level 3 biology is offered in most Aotearoa New Zealand secondary schools and is an optional subject for students at Year 13. Across the country, the Year 13 biology course for the National Certificate in Educational Achievement (NCEA) qualification can vary in content as schools can choose to offer a range of topics under the *New Zealand Curriculum* (NZC) some of which are internally assessed in schools and others assessed externally as part of the national examination system. As the topics offered by schools within their biology programme can vary in content, and as biology is not a nationally prescribed programme common to all schools, the second criterion required that in addition to offering biology at Year 13, the students as part of their biology programme study the topic of animal pest control which also included, as the final summative assessment, the specified internally assessed biology achievement standard AS91602 (Biology 3.2).

Description and identification of sample

This section describes the research sample participants from the two urban Auckland high schools; one in the Central Auckland area, given the pseudonym 'Secondary School' and the other in the South Auckland area given the pseudonym 'High School'. Both schools had ethnically diverse student populations and roll numbers above 1000 students from Years 9 to 13 (see Table 3.2).

Both schools had either a bilingual English/Māori language unit or a Whānau (extended family) Unit designed to enrich student learning opportunities and for expanding Te Reo Māori (Māori language) and tikanga (Māori customary practices) within the school and as a way of promoting mana tauira (student pride) amongst those students who identified as Māori. These whānau units are named using the Te Reo Māori word for family to reflect their inclusive and extended nature of the support offered students akin to an extended family model.

Table 3.2
School roll and ethnic composition data (Percentage of school roll)

Ethnicity	**High School (Years 9–13) Roll 1,280**	**Secondary School (Years 9–13) Roll 1,427**
Māori	47%	24%
Pacific	42%	40%
Pākehā (NZ European)	4%	12%

Source: https://www.ero.govt.nz/review-reports/

Table 3.3 details the numbers of students from each biology class who consented to participate in the data collection phases.

Table 3.3
Participants consenting

Participating School	**Biology class roll**	**NCEA summative assessment scripts**	**Interviews**
High School	25	21	19
Secondary School	26	18	15
Total	51	39	34

The data generated and collected from participants was required to be coded in a way that preserved their anonymity whilst at the same time enabling the efficient tracking and identification of the data source and its location within the data evidence.

Participants were identified by the allocation of a code which included the following information:

- Name: Participants were invited to create a self-chosen pseudonym for themselves to be used whenever they are quoted in the text of the analysis.
- School: Secondary School indicated by the letters SS and High School indicated by the letters HS.
- Data Source: A reference to the type of data from which the quotation was taken. That is:
    - Data which originated from participants' written summative NCEA assessments collected prior to being marked were given the letters AS (Achievement Standard).
    - Data which originated during the semi-structured one to one interviews were given the letters INT (Interview).
- Page number: Assigned to either an interview transcript or their written summative assessment script.

Therefore, a complete code that appears adjacent to a quotation by a student participant sourced from the written transcript of their interview will look like this. For example, 'Nadia SS/INT/p. 42' indicates:

- Name: Nadia (Chosen pseudonym)
- School: SS (Secondary School)
- Data source: INT (Interview transcript)
- Page number: p. 42 (Transcript page number)

3.6 Data generation

Documentary data and individual interviews with the participants generated the two distinctive types of data collected for subsequent analysis in this study. The qualitative methodology employed enabled me to adopt an open and flexible approach to the selection and choice of tools for the generation of data and evidence (Sarantakos, 2013) which comprised the data set for the subsequent conceptual thematic analysis. Furthermore, to triangulate the data, students were asked at interview to discuss their position as stated in their written summative assessment script. This process allowed me to explore the participants' thinking and decision making as they discussed evidence to support their position towards the use of 1080 poison to control possums. The qualitative research design is displayed in Table 3.4, where the research

questions and the strategies to generate and collect data show alignment with the analysis approach.

Documentary data

If studied in isolation from their social context, documents and texts are deprived of their real meaning (Punch, 2014). If, however, they are grounded in the context of the research investigation, the analysis of documentary data lends to contextual richness and helps to ground an inquiry in the milieu of the writer – real world issues and day-to-day concerns (Merriam, 1998, p. 126).

Documentary data in the form of personal writing (including written transcripts) can reveal 'the inner meaning of everyday events' and are 'a reliable source of data concerning a person's attitudes, beliefs and views of the world.' While highly subjective, 'they reflect the participant's perspective' important to a qualitative research project such as this (Merriam, 1998, p. 116).

The documentary data sourced for this research project originated from three primary sources. Firstly, the participants' written summative assessment scripts were collected, copied and returned to them prior to being marked and returned by the teacher (see Appendix M). The transcripts of the recorded interviews with individual participants provided the second source of documentary data.

Table 3.4
Qualitative research design

Research Questions	Methods for Data Generation and Collection	Methods for Data Analysis	Data Presentation
1. What biological science concepts are identified? And – How do the participants use biological science concepts to justify their position within the socio-scientific issue? 2. What mātauranga Māori concepts are identified? And– How do the participants use mātauranga Māori concepts to justify their position within the socio-scientific issue? 3. How do participants integrate mātauranga Māori concepts and biological science concepts as they develop and present an informed, justified response to the socio-scientific issue?	**Documentary Data** 1. Participants' unmarked summative **NCEA assessment scripts.** 2. **Transcripts** of the individual participant interviews. 3. **Research journal** kept throughout the study period. **Interviews** **Individual participant interviews** digital audio-recorded and transcribed.	**Analytical Frameworks** (Ritchie et al., 2003, Boeije, 2010; Flick, 2007). Three were developed: • Biological science knowledge • Mātauranga Māori • Epistemic agency **Thematic Analysis** (Braun & Clarke, 2006) The six phases were adapted for the conceptual analysis of participant data. These were: 1. Data familiarisation. 2. Generating initial codes 3. Searching for themes 4. Reviewing themes **5.** Defining and naming themes 6. Producing the report	**Research questions** answered from the conceptual analysis of participant data. **Visual representations** of the distinctive **cultural interfaces** will be presented and discussed. **Individual narratives** described from **five** participants at the cultural interface using the concept of **student agency** to honour the **'locale of the learner'**. **Visual representations** of **epistemic agency** and **scientific literacy** at the **cultural interface** will be presented and discussed.

Third, a journal I kept throughout the time the participants were engaged in the research project completed the documentary data set. The journal entries provided an "on-going narrative account of the process of the study" (Hacker, 2008, p. 90), and enabled me to keep track of decisions made and recorded new insights that occurred along the way. The journal recorded my reflections regarding trends in the emerging story (Scott & Garner, 2013). A sample of the journal contents appears in Appendix I. I noted any adjustments that were made during the research process (such as the timeline) to accommodate the unforeseen such as times when I could either not attend a scheduled class or visit for a variety of unforeseen reasons. It also contained written reflections on important elements of the research process such as any preconceived notions I may have held concerning the subject matter and responses to occasions when this was challenged or revealed.

Interviews

Data were generated and collected in a series of face-to-face semi-structured interviews with individual participants which took place after the completion of the assessment period and the handing in of their completed summative assessment script to their teacher for marking. Individual interviews were arranged to take place at times which minimised the disruption to the participants' school day. Therefore, interviews were held in a quiet room on the school premises either during their biology class or immediately after school. A set of pre-prepared, mostly open-ended questions guided the interviews (Scott & Garner, 2013) and covered the basic aims and the central focus on the participants' use of cultural (specifically mātauranga Māori) knowledge and biological science knowledge and the research questions. The use of these pre-prepared, mostly open-ended questions were best suited to the aims of this research project in order "to explore the participants' interpretations and meanings of events and situations, and their symbolic and cultural significance" (Punch, 2014, p. 147). This format enabled the interview to take on a conversational tone in the spirit of 'talanoa' (a shared conversation) (Ministry of Education, 2001), whilst preserving the uniqueness of the participants' worldviews and perspectives (Merriam, 1998).

To this end, the interview questions were broadly framed to elicit the participants' recall of events from their researching the topic and their significance (Flick, 2014). Directly related to the aims of this research, the participants were able to elaborate on their decisions to include elements of biological and cultural knowledge through invitations and opportunities throughout the interview for the respondents to elucidate and expand on statements from their summative assessment script. For example, participants were invited to point out sections

which held for them a special significance and meaning to their argument or justified position. Questions also asked for 'abstractive reflections' by using wording such as "In your opinion…." and included the following: "Please tell me about …." (see Appendix H). Central to the research questions and overall focus of this study, participants who had included specific examples of cultural knowledge and biological science knowledge were asked to elaborate on their decision to include this knowledge and to discuss its importance to their justified position.

The individual interviews with the participants were audio-recorded to capture the full details and nuances of wording and emphasis. Over a two-week period, each student's transcript was given back to them for validating and editing before being returned to me.

3.7 Data analysis

The research questions were answered using an analytic tool of conceptual thematic analysis (Braun & Clarke, 2006), who describe the tool as offering the researcher flexibility – theoretically but also in terms of research question, sample size and constitution, data collection methods and approaches to meaning generation (Clarke & Braun, 2017, p. 297). The goal of making sense of data by using a qualitative, interpretivist approach, according to Thorne (2008), is two-fold: Firstly, to generate outcomes in line with the aims of the research that reflect a strategic synthesis of new understanding, and second, to see beyond the obvious (p. 142). As the intricate process of 'sense-making' unfolds, findings emerge because of a strategic, constructive and active conceptual analysis of the data (p. 155), which can take the form of refining the meanings sifted from a either text, an object or slice of experience (Denzin, 2004).

Thematic analysis enabled the detailed reporting of "experiences, meanings and reality of participants" (Braun & Clarke, 2006, p. 79). As the aims of the project, guided by the research questions, delved into the use of scientific and cultural knowledge, thematic analysis enabled these sub-concepts to be revealed and quantified from the data which comprised the participants' summative assessment scripts and interview transcripts. Following Braun and Clarke's six phases of thematic analysis (2006, p. 87), the data were interpreted in accordance with this structure as follows:

Phase One: Data familiarisation. Following the completion of the participants' summative assessments their scripts were copied and prepared for analysis. Also, the data comprising the transcripts from the individual face-to-face semi-structured interviews with the participants along with the interview tapes were checked for accuracy of the transcription.

While listening to the tapes, checking against the transcripts, reading and rereading of the data I made notes and annotations onto the transcripts for subsequent coding.

Phase Two: Generating initial codes. As the data familiarisation process proceeded, I systematically developed a series of codes related to the research aims and aligned with the research questions broadly separated into biological science knowledge on the one hand and mātauranga Māori (and Pacific) cultural knowledge on the other. These were gathered into lists and grouped according to emerging themes appropriate to each of the two primary knowledge worlds.

Phase Three: Searching for themes. This deeper search for emergent themes involved the ongoing synthesis of the coded data into conceptual themes and included the sub-conceptual themes which would lead to the development of the conceptual coding frameworks for the subsequent analysis of the data.

Phase Four: Reviewing themes. The coherence and meaningfulness of the emerging themes and concepts meant that in this phase it was important for me to be assured that the codes generated initially and the sub-concepts which emerged were synchronous and matched the appropriate meanings in the data sets. This ongoing refinement process was assisted through regular conversations with my doctoral supervisor which ensured that the emerging concepts were clear and unambiguous

Phase Five: Defining and naming themes. The final defining and naming of the themes and concepts ensured that the conceptual coding frameworks developed from these were aligned with the research aims and questions.

Phase Six: Producing the report. Arising from this stepwise analysis of the data a series of three conceptual coding frameworks were developed which aligned with the research questions and informed by the literature. From this, followed the selection of carefully chosen data extracts which related back to the research questions and literature and on towards the final presentation of the interpreted participant data and discussion.

Arising from the importance of concepts to the representation of student understanding and knowledge, I developed three conceptual coding frameworks for the analysis of participant data (Ritchie et al., 2003, Boeije, 2010; Flick, 2007): Biological science knowledge, mātauranga Māori cultural knowledge and finally, - student agency. Using the frameworks, participant data (summative assessment scripts and interview transcripts) were thematically analysed by using a concept-driven coding process. Chapter 4 presents in detail the three

conceptual analysis frameworks and their theoretical foundations used for the interpretive thematic analysis and critique of the participants' data.

3.8 Trustworthiness

Sound constructivist interpretation according to Lincoln and Guba, (1985, p. 381) is based on purposive (theoretical) sampling and ideographic (contextual) interpretations. Creswell and Miller (2000) offer a useful framework that I adapted to represent the thematically analysed participant data. The three important lenses through which this was achieved to complement the conceptual thematic analysis that was employed were:

1. **The Lens of the Researcher:** Throughout the analysis process, I returned repeatedly to the data see if the constructs, categories, and interpretations made sense. As a form of reflexive accounting, it is "where the researcher, the topic and the sense-making process interact" (Creswell & Miller, 2000, p. 125). The journal contained my reflections throughout the period of field engagement with the two schools.
2. **The Lens of the Participants:** Where the participants' socially constructed reality is what the participants perceived it to be. It involved a checking of how accurately participants' realities had been represented in the final account. This was assisted by allowing the participants to read, check and amend the transcripts of their interviews, which also contained their responses to reflective questions about specified content from their written assessments.
3. **The Lens of People External to the Study:** Where persons external to the study, not affiliated with the project may help validity and includes the audience for whom the account is written. This was assisted by ensuring that I engaged in regular, reflective conversations with my supervisors and at writing retreats with fellow doctoral students where I received regular feedback during the analysis phase and after the submission of sections or chapters submitted towards the end of the writing phase. The opportunity to receive feedback and guidance from university Māori and Pacific cultural advisors as necessary was prioritised throughout the analysis and writing phase.

Trustworthiness within this process consists of four components: credibility, transferability, dependability, and confirmability.

Credibility

Credibility is achieved by ensuring that the research is conducted in ways that are described as 'good practice' (Bryman, 2004; Merriam, 1998). In this research project, I undertook the following three practices to ensure an evidential basis to support its credibility claims:

a. Self-checking. The process of self-reflection and the need to continually monitor my subjective perspectives and biases was achieved by keeping a journal throughout the research process in to which I wrote reflective field notes most often following any visit or engagement with the school and/or research participants or activities undertaken as part of a teaching sequence, field trip or data gathering activity. Into the journal I recorded impressions and reflections on the content and assumptions made that were confirmed or otherwise by the information forthcoming from the instance at hand (see Appendix I).
b. Multiple data sources were accessed to corroborate the project's conclusions. This was supported by the process of 'member checking' of the content by the participants. For example, written data were comprised of the participants unmarked written assessment papers authorised by them to be copied and subsequently analysed to form the basis of the semi-structured interviews which took place thereafter. The verbal digital recordings of the interviews with the participants were independently transcribed and subsequently reviewed by the participants. The reviewing process enabled them to confirm, amend or delete content as they wished.
c. Prolonged involvement in the field is described in detail (see Table 3.1). This enriched the description of the school, the classroom setting as well as deepening the knowledge of the site and participants. This enabled a more in-depth understanding of the context and situation for this project.

Transferability

Transferability refers to the fit or match between the research context and other contexts as judged by the reader, i.e. it is the extent to which the research findings can be generalised (Bryman, 2004; Sarantakos, 2013). It was achieved in this project by the inclusion of rich, thick descriptions that enable readers to gain insight into the participants' experiences so as to be well informed and have an element of vicarious experience by providing relevant, detailed information regarding the context and/or background which also offered an element of shared experience (Sarantakos, 2013).

Dependability

Refers to the capacity of the research to produce consistent results (Sarantakos, 2013), this criterion refers to whether one can track the processes and procedures used to collect and interpret data (Bloomberg & Volpe, 2012). This was achieved by keeping a systematic 'audit trail' – a detailed and thorough set of explanations of how the data were collected and analysed (see Section 3.6). Furthermore, the timeline for this research project (see Section 3.3) as well as the data interpretations and findings which are presented in Chapters 5, 6 and 7.

Confirmability

As qualitative research rests within the parameters of interpretivist epistemology (Bryman, 2004; Sarantakos, 2012), the research must be conducted in a fashion that upholds the values of honesty, impartiality and carried out in ways that are not beholden to personal beliefs and biases which may have an undue influence on the essential elements of the project. This was mitigated by accepting that it was vital for my worldviews and background to be spelt out for the reader as has been done in Chapter 1.

3.9 Ethical considerations

This research project was undertaken under the approval and direction of the University of Auckland Human Participants Ethics Committee (UAHPEC) and its regulations and guidelines for ethical research (Approval Number: 014028, 18 April 2015). These regulations and guidelines were adhered to throughout the engagement period. Establishing safeguards to protect the rights of participants and include informed consent, protecting them from harm, and ensuring confidentiality (Bloomberg & Volpe, 2012). See also Appendices C & D for illustrative examples of a Participant Information Sheet (PIS) and Consent Form (CF).

I remained attentive throughout the study to the 'researcher-participant' relationship, and attuned to the roles, status and cultural norms upon which this relationship was based (Bloomberg & Volpe, 2012). Therefore, the following ethical considerations are described below and include informed consent, attention to Māori and Pacific customary practices, authenticity, voluntary participation, anonymity and confidentiality, power relationships and researcher bias. The ways these considerations were addressed are detailed in the following sections, beginning with informed consent.

Informed consent

Once agreement to proceed was obtained from each school, arrangements were made to leave information with the class teacher for distribution to the students. This comprised of an outline

of the proposed research and copies of the Student PIS and CF's. The Year 13 students who were approached to participate in the research were all aged 17. While this enabled them to give their personal consent to participate in the project, an information sheet for whānau and families was prepared and given out to students to take home.

Informed consent from the participants was in two parts. In Consent Form A (CFa), participants were invited to consent to the collection of their assessment material which consisted of the photocopying and return of their written summative assessment script handed in at the completion of the of the topic (see Appendix C). In Consent Form B (CFb), participants were invited to consent to participating in an individual, one to one interview with me following the completion and analysis of their written summative assessment script (see Appendix D). Participants could choose either or both options (see Table 3.2). The participants were reassured that their decision to take part or not would have no effect on their relationship with the school or their grades.

Māori and Pacific customary practices

The nature of the research project required that the information being discussed with the participants included a combination of Western science and information sourced from mātauranga Māori and Pacific cultural beliefs. In recognition of this, the following practices were given prominence to acknowledge the status and sensitivity of the participants' knowledge which, as taonga (a treasure) was willingly shared and gifted to the research project in both written and verbal form. It was therefore culturally appropriate that practices which respected the origins and content of this information were paramount throughout the engagement period.

The Treaty of Waitangi obligations with respect to partnership and reciprocity concerning the sharing information were acknowledged and embedded in processes. Furthermore, the significance of cultural knowledge as taonga (treasure) determined that I also extend and demonstrate appropriate and equal sensitivity to Pacific participants using culturally appropriate language and protocols when engaging with them. Face-to-face interactions and open conversations were conducted respectfully and in accordance with tikanga (customary protocols) and using either the Māori or Sāmoan languages as and when appropriate. For example, a karakia (incantation) at the start of hui (meetings) with the participants who were familiar and comfortable with this process ensured the cultural safety of the participants and protection of the knowledge they shared in conversation with me.

Māori and Pacific cultural advisors were available for me to consult if required. Finally, I ensured that reciprocity featured in the form of kai (food) at hui. At the end of the data gathering phase, food and refreshments were also available as a culturally appropriate way of acknowledging and thanking the participants and staff for their generous time, goodwill and gifting of their knowledge and expertise to the research.

This research project was based upon a collaborative, relational, culturally responsive methodology adapted from Berryman et al., (2013) and Macfarlane (2004). I remained ever-mindful of the question "How is our research work helping Māori students succeed as Māori?" asked by Bishop and Berryman (2006). This was addressed by adhering to the following over-arching principles and practices as represented by Macfarlane (2004. p. 97) of *Whakawhanaungatanga* (building relationships), *Rangatiratanga* (self-determination), *Manaakitanga* (ethic of caring), *Kotahitanga* (unity, togetherness and bonding) and *Pūmanawatanga* (morale and tone) (see Appendix J).

Complementing this, an equally responsive, collaborative, culturally relational methodology was applied to also accommodate the participants of Pacific ethnicity. This project therefore incorporated the principles and guidelines from the *Pacific Education Research Guidelines – Report* (MOE, 2001) and acknowledged the importance of Pacific worldviews underpinned by Pacific values, belief systems, and ways of sharing knowledge in the following two ways. Firstly, Pacific methodologies were incorporated into data generation, collection processes and the handling and analysis of information. For example, field engagements acknowledged the principles of collective responsibilities and ownership. Second, gifting and reciprocity were embedded in this project in recognition and acknowledgement of the information and time shared by each participant. These aimed to mitigate the likelihood of any cross-cultural issues arising throughout the duration of the research project (see Appendix K).

Because the data had the potential to inform a wide group of people involved in science and indigenous education, participants were assured that their data would be disseminated appropriately, with respect, and with an awareness of the need to incorporate cultural ways of doing so if appropriate to the audience. For example, at the end of the project, the participants and their families would be invited to hui (meetings) where the research findings would be shared with them.

Voluntary participation

Arising from the controversial nature of the socio-scientific issue of pest control both then and now, and the potential for participants to encounter conflicting views, it was therefore important for participants to be fully informed (see PIS Appendix B) and could make their decision free from perceived coercion. To assist this freedom, I undertook the following steps. The Consent Forms (CF) were distributed in person to the students in class which were subsequently returned privately to a labelled, sealed box in their biology classroom. I gave an assurance to the students at the outset that their participation/non-participation, or withdrawal would in no way affect their relationship with the school or their final grades for this assessment. Students were also informed that they were free to withdraw their data up until two weeks after the completion of the data collection phase.

Anonymity and confidentiality

It was anticipated that as the issue of pest control using 1080 is a sensitive issue in the wider community with quite strident views on both sides of the debate, there could be occasions during a class discussion where a participant's views could have been at odds with their peers, their teacher or others who may have not been present such as family members. It was important that participants had the confidence to express their ideas and views openly and that their ideas were kept safe, secure and when used were disguised using pseudonyms. The participants were assured that all data could only be accessed by me and my academic supervisors. Finally, I informed participants that hard copy and digital data would be stored separately and securely for a period of six years after which time all material would be destroyed.

The following procedures were put in place to protect participants' identities. Identities were protected by using pseudonyms for the schools and participants, which were held in a secure place away from the school and are kept separate from the data. The one – to – one interviews were transcribed by an independent transcriber who had signed a confidentiality agreement (see Appendix L). Participants had access to transcriptions of their verbal data and given opportunity to edit their contributions if they wished.

Power relationships

Following advice I received from my supervisors to look beyond my own secondary school for potential participants to avoid any conflict of interest and power imbalances, a successful search eventually resulted in interest from two Auckland secondary school science departments who eventually became the source of the research participants for this project. I

was perceived in a ‘depowered’ sense by the participants through their use of my first name – Brent, something that my students throughout my teaching career had never used. This signified that the participants saw me as a person, a researcher (as opposed to the status of ‘teacher’) and thus not defined by any authority or role designated by the school. This enabled the participants to share information free of any perceived coercion or obligation. The participants were also informed that data collected from the research would be used for a PhD thesis and may be used for academic publications, conference presentations, teaching, and other forms of academic research.

Researcher objectivity

The maintenance of researcher objectivity throughout the project necessitated that I remained vigilant to the possibility that my own biases may exert an undue influence on important aspects of the design and execution of critical data generation collection and interpretation stages of the research process (Saldaña, 2015).

To monitor this, my journal provided a repository for personal reflections, beliefs and thoughts that were most often written immediately following a visit to the school or engagement with the participants (see Appendix I). This helped to establish reflexivity and transparency in the final written analysis (Partasi, 2013). To alleviate the likelihood of undue bias, the semi-structured interview schedule I developed was critiqued by my doctoral supervisor prior to its use.

3.10 Conclusion

The paradigm for this project was comprised of a social constructivist ontology, interpretivist epistemology and qualitative research design as the most appropriate way to conduct this research. Details have been provided of the design for the generation and collection of data followed by a description of the conceptual thematic analysis of this evidence. Critical to the success of this project is its ability to respectfully, honestly and ethically engage with the participants in the generation of evidence that served the primary purpose of the project which was to investigate how a group of senior biology students used biological science knowledge along with mātauranga Māori cultural knowledge concepts to justify their position towards the use of 1080 to control mammalian pests in Aotearoa New Zealand. The procedures and processes outlined in this chapter provide the detail required to be assured that the research was carried out with a high degree of trust and cultural awareness to produce an authentic, unbiased interpretation of the participants’ evidence that they provided freely and truthfully.

Chapter 4 presents the first two of the three conceptual analysis frameworks I created and used for the interpretive analysis of the participants' data.

Chapter 4: Analytical Frameworks

4.1 Introduction

The foundation of this study will involve the identification and use of biological science knowledge and mātauranga Māori knowledge by senior high school biology students. Before exploring how the participants drew upon both knowledge worlds to present their informed and justified position on the use of 1080 in Aotearoa New Zealand, it is necessary to clearly establish the nature and characteristics of existing biological science knowledge and mātauranga Māori knowledge within this context.

The theoretical foundation of this research is underpinned by differing worldviews of knowledge that seek to provide explanations of the natural world and phenomena as a way of understanding the world. In line with the focus of this research, running parallel to a scientific worldview are worldviews of the natural environment from an indigenous origin which, in Aotearoa New Zealand, exists within Te Ao Māori (Indigenous Māori worldview) and whose knowledge base is referred to as mātauranga Māori (Māori indigenous knowledge and understanding).

The purpose of this chapter is to build a conceptual framework for both knowledge worlds as a map of the territory being investigated, and to connect the elements of the study to bring a meta-cognitive congruence to the research (Durham, Sykes, Piper & Stokes, 2015). The importance of such a conceptual map is succinctly described by Miles and Huberman (1994), who state:

> A conceptual framework explains, either graphically or in narrative form, the main … factors, constructs or variables – and the presumed relationships among them (p. 18).

These conceptual frameworks enabled me to focus the analysis on the use of knowledge sourced by the participants from more than one knowledge world – principally Western biological science and mātauranga Māori.

Following this introduction, Section 4.2 introduces the biological knowledge conceptual framework and includes a detailed justification based upon the five tenets of the Nature of Science (NOS) (see Table 4.1) and discussion of each of the chosen biological science *concepts* and *sub-concepts* which comprise the analytical framework (see Table 4.2). Section 4.3 introduces the mātauranga Māori knowledge conceptual framework (see Table 4.3) and

includes a detailed justification based upon indigenous Māori scholarship and discussion of the chosen mātauranga Māori knowledge *concepts* and *sub-concepts* which comprise the analytical framework. In Section 4.4 describes in detail the sequential stages in which the student data are presented and analysed for each of the six biological science concepts and the seven mātauranga Māori environmental concepts which comprise each of the two conceptual analysis frameworks presented in this chapter. Section 4.5 concludes the chapter and includes a brief synopsis of how both frameworks were used in the analysis of participant data.

4.2 Biological science knowledge conceptual framework

France and Compton (2012, p. 2) state that the overriding purpose of science is to explain the natural world through iterative, intellectual and investigative practices that involve observation and controlled manipulations of that world which, for contemporary views of science, they argue as upholding a critical realist' ontological stance. By accepting this proposition, we also accept that the role of scientists as interrogators of the 'real things' or phenomena of the natural world is to construct explanations of them; that is to know the world. Therefore, scientific knowledge is that which has 'real things as its referent'. (2012, p. 3). For, as Moeed and Anderson (2018) point out:

> If the goal is for all students to be able to engage effectively with science as citizens, they also need to understand how scientific knowledge is created and validated, and have the skills to critique scientific claims, as well as apply the knowledge they have in making decisions in their everyday lives (p. 9).

What underlies this process of creating and validating scientific knowledge is widely known as the Nature of Science (or colloquially, NOS), which describes the values and epistemological assumptions underlying the process of science such as the collection and interpretation of data and the derivation of conclusion, observing and hypothesising (Lederman et al. 2002, p. 499). It represents the processes by which scientific knowledge is produced and tested to provide the basis for our confidence in that knowledge (Millar, 2004; Moeed & Anderson, 2018).

Table 4.1
The alignment of the Nature of Scientific knowledge underpinned by literature and interpreted in the New Zealand Curriculum (NZC)

The Five Tenets of the Nature of Science (NOS)	**The Five NOS Tenets as underpinned by the science education literature**	**The big science ideas expressed in the *New Zealand Curriculum* (Ministry of Education, 2007b)**
Empirically based	Scientific knowledge is based on **empirical evidence** (Schwartz & Lederman, 2008, p. 728), Abd-El-Khalick (2004), Bell, (2004), Flick & Lederman, (2004), Osborne, Simon & Collins (2003), Zeidler, Walker, Ackett & Simmons (2002).	Science is **evidence-based** – scientific theories are based on **evidence collected by making observations in the natural, physical world**. These theories are **supported, modified or replaced** as **new evidence** appears.
Inferential, creative and imaginative	Scientific knowledge is the product of human **imagination and creativity** (Schwartz & Lederman, 2008, p. 728) Abd-El-Khalick (2004), Bell, (2004). Flick & Lederman, (2004).	The **search for evidence** in science occurs through an **inquiry process** that **blends human curiosity, imagination, logic and serendipity**.
Subjective and theory-laden	The collection and interpretation of empirical evidence is **influenced by current scientific perspectives** (Theory-laden observations and interpretations) as well as **personal subjectivity** due to scientists' values, knowledge and prior experiences (Schwartz & Lederman, 2008, p. 728) Abd-El-Khalick (2004), Bell, (2004) Cobern & Loving, (2001).	It is strongly **influenced by the ideas people currently hold**. Scientists **use theories and models to describe and explain the natural world** – scientists use simplified theories or models to describe the way the natural, physical world works. They **use** these **models or theories** to **make predictions**, test these predictions through experimentation and observation and use their results to revise and improve the models.
Socially and culturally embedded	The direction and products of scientific investigation are **influenced by the society and culture in which science is conducted** (called socio-cultural embeddedness) and **accepted within the community-based consistency and strength of argument** (Schwartz & Lederman, 2008, p. 728) Abd-El-Khalick (2004), Bell, (2004), Flick & Lederman, (2004)	Science is influenced by society – **science is embedded in the culture of the times**. Scientific views take into account scientific values, ethics, economics and politics. Scientists **work collaboratively** and share their findings and **build on the work of other scientists**.
Tentative (subject to change)	**The knowledge is tentative** but nonetheless **durable** because of these other features (Schwartz & Lederman, 2008, p. 728) Abd-El-Khalick (2004), Bell, (2004), Flick & Lederman, (2004), McComas & Olson, (1998).	Scientific knowledge **is provisional** – although reliable and durable, **scientific knowledge is subject to change** as scientists learn more about phenomena.

As Moeed and Anderson (2018, p. 7) point out, there is common consensus amongst science education researchers that an understanding of the nature of science is essential for scientific literacy for citizenship (Abd-El-Khalick, 2012; Lederman & Lederman, 2014); and most believe in a set of five widely accepted tenets of the Nature of Science (Abd-El-Khalick, 2012, Anderson & Moeed, 2017; Lederman & Lederman, 2014). These tenets represent what is termed by Irzik and Nola (2011) as the "consensus view" which conceptualises NOS in terms of a small number of 'general characteristics' (McCain, 2016), referred to in the literature as the 'five tenets', they form the nature of scientific knowledge (see Table 4.1). Hence, NOS "refers to the characteristics of the [scientific] knowledge as directly derived from how the [scientific] knowledge is produced" (Flick & Lederman, 2004, p. xii).

I accept, for the purposes of this research, that the five tenets reflect a sufficiently broad and deep understanding of how scientific knowledge is produced and tested to have confidence in the concepts chosen as acceptably 'scientific' in origin and meaning. Therefore, from a scientific perspective, at the heart of the central purpose of the Nature of Science (NOS), science students are able to understand how explanations of the natural world and phenomena evolve.

The five tenets listed in Table 4.1 reflect a generalised and widely accepted list of features of scientific knowledge (Moeed & Anderson, 2018, p. 8) and shows how these tenets have been interpreted in the science education literature. From there the third column of the figure shows how the tenets have been interpreted in the *New Zealand Curriculum* (NZC), which is the basis of contemporary science education in New Zealand schools. Overall, Table 4.1 illustrates the coherence between the five tenets, the academic literature and *The New Zealand Curriculum*.

The New Zealand Curriculum specifies that the Living World (or by the more familiar term biology) contextual strand is about living things and how they interact with each other and the environment. As the term contextual strand implies, it provides in this case the biological contexts through which the Nature of Science can be explored especially so since the focus of the nature of science strand is ideas *about* science. Also, as the context of NOS education determines the scope of the epistemic knowledge required (Allchin, 2011, 2013), the concepts used in the biological science conceptual framework that represent the scope of the epistemic knowledge were sourced and confirmed from the following material.

Firstly, initial material was sourced from the biology contextual strand of *The New Zealand Curriculum*, Level 8 within the science learning area, study materials and assessment

exemplars available to high school teachers and students of biology, and the achievement standard AS91602, titled "*Integrate biological knowledge to develop an informed response to a socio-scientific issue"* (see Appendix E). This was supplemented by the specific task set by each of the two school's science departments as part of their syllabus and assessment approaches (see Appendix F & G).

Secondly, two widely-available high school biology resource books were used in both participating schools to support the biology courses in ecology at Year 12. For students, *The Living World* (Relph, Black & Jamieson, 1994) was their textbook and *The Living World: Teacher's help book,* (Relph & Black, 1995) was used by the teachers. Hence, these books became the primary source of the biological terms specific to the natural environment that informed the key concept areas (Boeije, 2010) of the biological science knowledge conceptual framework. Doing so, ensured that these key concepts were sourced closely to the content knowledge covered by the Year 12 course which would be both familiar to and understood by the students and therefore most likely to be included in the body of their justifications for their position on the use of 1080.

Finally, these key concepts were applied to a thematic analysis of the participants' data to confirm their regular occurrence of these fundamental biological science concepts and reveal the main sub-concepts used by the participants as they justified their positions towards 1080 use (Braun & Clarke, 2006). The thematic analysis of the participants' final written assessment papers and interview transcripts revealed that they used <u>six</u> key biological ideas or themes when justifying their support or opposition to 1080 use: environment, population, native, exotic, pest, and pest control.

Table 4.2
Biological Science Knowledge Conceptual Analysis Framework

Biological Science Concepts (Code)	Biological Science Sub-Concepts
Environment (EN): As an ***ecosystem-related ecological concept***, the environment is ***an organism's physical and biological surroundings*** and is defined as, "All the different factors, both ***biotic*** and ***abiotic***, that ***affect an organism in its habitat***" (Relph, Black & Jamieson, 1994, p. 129).	**The environment is:** • a ***non-specific*** entity • ***separate*** from ***living organisms*** • ***comprised of living, named organisms*** • ***comprised of living (biotic)*** and ***non-living (abiotic)*** factors
Population (PN): As an ***ecosystem-related component***, population is defined as, "A ***group of organisms*** from the ***same species*** living in the ***same location***" (Relph, Black & Jamieson, 1994, p. 132).	**A population is:** • a ***group of named organisms living in an area*** • a ***group whose numbers can change***, and where • a ***change in the numbers of pests influences the numbers of the native population***
Native /Indigenous [species] (NI): As a ***population-related ecological concept***, native/indigenous [species] is defined as, "A ***plant or animal*** [species] originally ***only found in a restricted area***" (Relph, Black & Jamieson, 1994, p. 130).	**Native species:** • are ***named*** • ***belong to New Zealand*** • are ***targeted by introduced species***
Exotic/Introduced [species] (EI): As a ***population-related ecological concept***, introduced/exotic [species] is defined as, "A ***plant or animal*** [species] which has been ***brought to a new place***" (Relph, Black & Jamieson, 1994, p. 129).	**Introduced species: (e.g. rats)** • are ***mammalian pests*** • ***negatively affect native populations*** • were ***brought into the habitat by humans*** • and ***other pests can be predators***
Pest (PT): As a ***population-related ecological concept***, pest is defined as, "An ***exotic / introduced plant or animal species*** [that] can ***directly harm organisms*** useful to humans, or ***damage native species*** through ***exploitation or competition***" (Relph, Black & Jamieson, 1994, p. 20).	**A pest is:** • a ***named animal*** • an ***animal identified as a mammal*** • an ***animal introduced from elsewhere by humans*** • ***harmful to a named species*** • an ***animal that can also be human***
Pest Control (PC): As a ***population control process***, pest control is defined as, "Pests can be ***controlled using a variety of methods*** of either ***chemical control using 1080 poison*** or a ***target-specific biological control organism or agent***" (Relph, Black & Jamieson, 1994, p. 20).	**Pest control:** • ***targets specific species*** • ***uses 1080, a poison that can kill*** • ***reduces pest population numbers*** • ***can also use alternative methods***

In summary, within with the context of pest control using 1080, and accepting that the origins of the epistemic knowledge is determined by the application of the five universally accepted tenets of the origin of this knowledge, these six key biological concepts derived from the biological science literature were confirmed from initial analysis of participants' data. For each of the six key biological concepts, a set of sub-concepts were derived from the initial analysis of participants' data.

Beginning with the ecological concept of environment (an organism's physical and biological surroundings), each of the six key concepts and their sub-concepts are combined and appear in Table 4.2 as the biological science knowledge conceptual analysis framework. Within the framework, whenever a link is established between the key concept and a sub-concept, ***bold blue text*** appears as: ***highlighted, italicised*** and ***underlined***. This conceptual framework expresses 'what' biological science knowledge the participants used. In line with the focus of this research and the research questions, the conceptual framework will be used to more deeply analyse 'how' the participants' used these expressions of their epistemic biological knowledge as they justified their position about 1080.

4.3 Mātauranga Māori knowledge conceptual framework

For the purposes of this research project, mātauranga Māori knowledge is another knowledge base used by the participants as they justified their position towards the controversial use of 1080 in Aotearoa New Zealand. In order for this research to investigate how students use mātauranga Māori knowledge when discussing the issue and presenting a justification of their support or opposition to the use of 1080 it is necessary to outline the theoretical foundations of mātauranga Māori knowledge before the focus turns to constructing the second conceptual analysis framework for use in analysing participant data.

This section begins by discussing the definition and origins of mātauranga Māori as an indigenous knowledge base. This is followed by a conceptual framework that is used to present and analyse students' use of culturally-based knowledge. The discussion mirrors that presented for the biological knowledge framework in that it is established from the literature and from the writings of Māori scholars the fundamental nature of mātauranga Māori knowledge within the context of the natural world.

Mātauranga Māori as fundamental body of knowledge

Mead (2003) affirms Whatarangi Winiata's elaborate, cyclical and holistic definition of mātauranga Māori as a body of knowledge handed down through generations, boundless,

timeless and "constantly being enhanced and refined by each passing generation" (p. 320). This encapsulates the fundamental accumulative nature of mātauranga Māori knowledge as it applies to an understanding of Te Ao Māori (the Māori worldview) unique to Aotearoa New Zealand. Winiata's optimism that providing the whakapapa remains unbroken, the body of knowledge referred to as mātauranga Māori will continue to accumulate and grow is central to an understanding of Māori knowledge and Māori ways of knowing which refer to the ways of perceiving and understanding the world as well as the values or systems of thought that underpin those perceptions (Waitangi Tribunal, WAI 262, 2011, p. 22), hereafter referred to as WAI 262. Māori values provide the concepts, principles and lore regarding responsibilities and interactions with the natural and spiritual environments (Dale, Walker & Perrott, 2015).

From the dawn of time in Te Ao Māori, every species, every place, every type of rock and stone, every person (living or dead), every god, and every other element of creation is united through a web of common descent, which has its origins in the primordial parents Ranginui – the sky father and Papa-tu-a-nuku – the earth mother (WAI 262, 2011, p. 23). Thus, in Te Ao Māori, there is a strong and enduring connection among the living and non-living elements of the natural world, whereupon all the earthly and spiritual elements of our world are related through the concept of whakapapa. They are referred to in the present tense as if alive and related to in personal terms. For example, this is seen whenever people describe their relationship to a geographical feature such as a mountain or river through the recitation of whakapapa. For example, "Ko Maungakiekie tōku maunga." (Maungakiekie is my mountain) signifies the relationship of the speaker to a prominent landmark from the area of their birth.

Scholars of mātauranga Māori knowledge who include Cleve Barlow (1991), Rev. Māori Marsden (Marsden & Royal, 2003), Mason Durie (2005) and Hirini Moko Mead (2013) offer a cogent and comprehensive discourse on mātauranga Māori. Their writings expand and elaborate on the two core principles at the heart of the understanding of mātauranga Māori knowledge – whanaungatanga (kinship) and kaitiakitanga (guardianship).

For example, the critical importance of whakapapa (the practical manifestation of kinship) to an understanding of the Te Ao Māori can be illustrated with reference to these two core principles. Firstly, the principle of whanaungatanga which describes both the relationship between people as well as the relationship between people and natural resources. All relationships of importance in mātauranga Māori knowledge are explained through kinship/whanaungatanga. Māori relationships with taonga (anything that is treasured) in the environment are articulated using kinship concepts (WAI 262, 2011, p. 105).

The second core principle is kaitiakitanga (guardianship). Marsden (Marsden & Royal, 2003) explains that the term tiaki, whose basic meaning is 'to guard' may in other contexts also mean, to keep, preserve, to conserve, to foster, to protect, to shelter, to keep watch over. The prefix kai- with a verb denotes an agent of the act. Whereas a kaitiaki is a guardian, keeper, preserver, conservator, foster-parent, protector; the addition of the suffix -tanga, when added to a noun, transforms the term to mean guardianship, preservation, conservation, fostering, protecting, and sheltering (Marsden & Royal, 2003, p. 67).

Thus, kaitiakitanga is the obligation, arising from the kin relationship, to nurture or care for a person or thing. It has a spiritual aspect, encompassing an obligation to care for and nurture physical and spiritual wellbeing (WAI 262, 2011, p. 23). Kaitiaki can also be spiritual guardians existing in non-human form. For example, every forest and swamp, every bay and reef, every tribe and village– indeed anything, everything of any importance at all in Te Ao Māori – has these spiritual kaitiaki. They can include particular species that are said to care for a place or a community (such as the kiore or Polynesian rat), warn of impending dangers and so on. (WAI 262, 2011, p. 23).

The ancient ones (tawhito), the spiritual sons and daughters of Ranginui (the sky father) and Papa-tu-a-nuku (the earth mother) were the kaitiaki or guardians. For example, Tāne-Mahuta was the kaitiaki of the forest, Tangaroa of the sea, Rongo of herbs and root crops. Different tawhito (spiritual offspring) had oversight of the different departments of nature. At harvest time, mankind was duty bound to thank and propitiate the guardians of those resources. Thus, Māori made ritual acts of propitiation before doing so (Marsden & Royal, 2003, p. 67).

In addition to spiritual kaitiaki, people who have mana (power) are also kaitiaki and carry out their role in accordance with the values of kaitiakitanga – to act unselfishly, with right mind and heart, and with proper procedure. Often, kaitiaki have responsibilities over treasured tangible things such as land, water, plants and wildlife; and intangible things such as language, identity and culture (WAI 262, 2011, p. 23). These items are referred to as taonga (treasures).

Mātauranga Māori values and the environment

Derived from the traditional belief system based on mātauranga Māori knowledge, values can be defined as instruments through which Māori make sense of, experience and interpret their environment, the basis for the Māori worldview (Te Ao Māori). This worldview can govern responsibilities and the relationships Māori have with the environment and the way they make decisions. Adapted from Harmsworth and Awatere (2013), seven mātauranga Māori

environmental values directly linked to the context of this research project were identified and are defined as:

- Whakapapa – ancestral lineage, connections, and relationships to ecosystems
- Mauri – the binding force linking the physical and spiritual
- Wairuatanga – a spiritual dimension
- Mana whenua – authority over land and resources
- Tikanga – customary practice, values, protocols
- Manaakitanga – acts of giving and caring for whenua (land)
- Kaitiakitanga – environmental guardianship

Harmsworth and Awatere (2013, pp. 275-276) argue that these values underlie important Māori environmental concepts and form the basis for Te Ao Māori perspectives (the Māori Worldview) when determining what is valued and their quest to understand ecosystems.

Te Ao Māori acknowledges the natural order to the universe and a balance or equilibrium. The diversity of life is embellished through the interrelationship of all living things as dependent on each other. "Māori see and seek to understand the total system and not just parts of it" (Harmsworth & Awatere, 2013, p. 274). Māori view the environmental elements as embodying distinct spiritual as well as physical qualities (WAI 262, 2011, p. 106).

Māori of Aotearoa New Zealand developed an intimate relationship with our unique flora and fauna over many generations. Māori as kaitiaki (guardians) of our indigenous species exercised their kaitiakitanga (guardianship) with respect to these plants and animals whom they respected as taonga (treasured) species (WAI 262, 2011, p. 63).

Māori saw the world through the lens of kinship (whanaungatanga). Everything was related – people (living and non-living), land, sea, flora and fauna and the spiritual world all connected. Land, sea, wind and other environmental elements were ancestor-gods; linked to the living through whakapapa with the wellbeing of a person linked to the wellbeing of all others to whom they were related (WAI 262, 2011, p. 64). This wellbeing was maintained through the binding of all in a web of mutual responsibility (WAI 262, 2011, p. 65), with the most important of these responsibilities is kaitiakitanga – the obligation of kinsfolk to nurture and care for their relations.

Using several fundamental mātauranga Māori concepts as a starting point, the following sub-sections develop and present the theoretical basis for the seven core principles of mātauranga

Māori environmental concepts as they relate to the context of this research. But before doing so, and in line with the process used to establish the relationship between the knowledge worlds and the New Zealand Curriculum, the mātauranga Māori environmental concepts and their origins share a unique relationship with an equally important and parallel New Zealand Curriculum document called *Te Marautanga o Aotearoa* (TMoA) (MoE, 2007a) which coincidentally contains a science strand based around science knowledge from a Te Ao Māori worldview.

Science in Te Marautanga o Aotearoa (TMoA)

The *Te Marautanga o Aotearoa* (TMoA) curriculum is a partner to the mainstream English-medium New Zealand Curriculum (NZC) and is designed for use in Māori-medium schools. Of special interest to this researcher are the science aspects, the equivalent of the biology strand and how the TMoA curriculum is imbued with a Te Ao Māori perspective. For example, the TMoA curriculum states:

- A student's critical faculty is enhanced by the inclusion of a Māori worldview: their own 'baskets' or perspectives become a foundation for studying those that have originated in other cultures.
- By learning about science from a Māori perspective, students deepen their own inquiry into the nature of science. Connecting traditional knowledge to modern knowledge gives them opportunities to question assumptions and test theories
- Students learn to be vigilant concerning the impacts of science in the world and to engage with the big issues that confront scientists – issues that affect the health and well-being of individuals, society and ecosystems.

From the TMoA curriculum, one of the four strands of Pūtaiao (Science) relevant to this research context is the Te Ao Tūroa (The World of Nature), that includes all living things in the human, plant, animal and other kingdoms. From a Te Ao Māori perspective, Te Ao Tūroa is metaphorically associated with most of the traditional familial deities, which collectively represent a Māori system of organising and understanding the natural world and the relationships between all living things. It reminds us to respect the mauri of everything we find or use. One of the four sub-strands of Te Ao Tūroa (The World of Nature) is Te Taiao (the biological environment) relates most closely to the context of this research project.

Mātauranga Māori environmental concepts

A review of Te Ao Māori (Māori worldview) and mātauranga Māori (Māori knowledge) perspectives discussed in the literature revealed close and mutually reinforcing connections related to both the environmental context of this investigation and the research question addressed in this chapter.

Finally, these key concepts were applied to a thematic analysis of the participants' data to confirm the regular occurrence of these fundamental mātauranga Māori concepts and reveal the sub-concepts used by the participants as they justified their positions towards 1080 use (Braun & Clarke, 2006). The thematic analysis of participants' final written assessment papers and interview transcripts confirmed that they used seven key mātauranga Māori ideas or themes when justifying their support or opposition to 1080 use: whakapapa, mauri, wairuatanga, mana whenua, tikanga, manaakitanga and kaitiakitanga. Beginning with whakapapa, each of these concepts is discussed separately in detail below. Within the discussion, whenever a link is established between the key concept and a sub-concept, ***bold green text*** appears as: ***highlighted, italicised*** and ***underlined***. These concepts and sub-concepts are combined and in Table 4.3 as the mātauranga Māori knowledge conceptual framework.

Whakapapa (WP)

The mātauranga Māori concept of whakapapa is recognised in Te Ao Māori as ***the genealogical descent of all living things from the gods to the present time***. Everything (including humans) has a whakapapa: birds, fish, animals, trees and every other living thing; as do soil, rocks and mountains – the whenua (land). It is on this basis, that ***humans have a kinship relationship with the rest of nature through a genealogical connection*** – that is a part of nature not superior to it (Patterson, 1992, p. 23). It is through whakapapa that ***humans are an integral part of ecosystems and linked to all aspects living, non-living and spiritual*** (Harmsworth & Awatere, 2013).

At the core of the whakapapa concept are relationships (Winiata, 2006, p. 208) and the interrelatedness and unity of all things through kinship. The natural environment and all its components are imbued with a life-force (mauri), spirituality (tapu) and a wairua (spirit) which comes from the gods through whakapapa (Durie, 2005, p. 138). Whakapapa is ***the source of knowledge in respect of the creation and development of all things*** (Barlow, 1991, p. 173).

Mauri (MR)

As a universal concept in Māori thinking, mauri is described by Harmsworth and Awatere, (2013, p. 276) as an internal energy or life force derived from whakapapa, ***an essential essence or element sustaining all forms of life***. Mauri ***provides life and energy to all living things and is the binding force that links the physical to the spiritual worlds*** (e.g. wairua). It denotes a health and spirit, which permeates through all living and non-living things. All plants, animals, water and soil possess mauri.

Uniting the spiritual with the physical at birth (Barlow, 1991, p. 83), mauri is a special power … which ***makes it possible for everything to move and live in accordance with the conditions and limits of its existence***. Everything has a mauri, including people, fish, animals, birds, forests, lands, seas, and rivers; the mauri is that power which permits these living things to exist within their own realm and sphere.

According to Patterson (1992), ***the possession of mauri by all living things, especially trees, forests and rivers, requires that they are deserving of respect*** (Patterson, 1992 p. 42). Mauri, possessed by all living and non-living things, ***is preserved through respectful treatment which ensures their continuing health and vitality***. Disrespecting their mauri would mean that the forest or river would not flourish and consequently lose its vitality and fruitfulness (Patterson, 1992, p. 23). Damage or contamination to the environment is therefore damage to or loss of mauri (Harmsworth & Awatere, 2013, p. 276). Consequently, anything that negatively impacts mauri, and in accordance with Māori reasoning, could potentially separate the physical from the spiritual and could result in the death of the individual or severely compromise its ability to thrive (Hikuroa, Slade & Gravley, 2011).

Wairuatanga (WR)

Incorporating the concept of wairua which from a mātauranga Māori perspective, states that all things have a spirit as well as a physical body; even the earth has a spirit, and so do the animals, birds and fish; mankind also has a spirit (Barlow 1991, p. 152). Patterson (1992) notes that from a Te Ao Māori perspective, the spiritual world [as opposed to the material world] is what matters most to Māori ***for the material [world] is subordinate to the spiritual [world]*** (1992, p.91). Consequently, an exploration of Māori values would be inadequate without paying due attention to Māori spirituality such as wairua (Patterson, 1992), and wairuatanga.

Warren, Webster and Kiriona (2007) refer to wairua as surrounded by what they refer to as ***the unseen and unspoken energies which are attended to by the recitation of karakia***

(incantations to the spirit world) which often precede and conclude ceremonies ***in accordance with Māori tikanga*** (customs and rituals). This process ***ensures the spiritual safety of those present***.

Mana (MW)

Incorporating the concept of mana, which is an important component of Māori spirituality and described by Barlow (1991) as ***the enduring, indestructible power of the gods***. Barlow interprets mana in a contemporary context by describing ***mana*** as encompassing various meanings, ***including the power of the gods, the power of ancestors, the power of the land and the power of the individual*** (Barlow, 1991, p. 61).

In the context of this research project, mana whenua more specifically relates to the concept of mana in the context of the environment. Barlow elaborates that ***mana whenua refers to the power associated with the possession of lands***; it is also the power associated with the ability of the land to produce the bounties of nature….A person who possess land has the power to produce a livelihood for family and tribe, and every effort is made to protect these rights" (Barlow, 1991, pp. 61 – 62). The possession of mana whenua status therefore bestows what Harmsworth and Awatere (2013, p. 275) describe as ***having authority or control over the management of natural resources***.

Tikanga (TK)

According to Mead, while mātauranga Māori might be carried in the mind, tikanga Māori puts that knowledge in to practice and adds the aspects of correctness and ritual support as the practical face of Māori knowledge (Mead, 2013, p. 19). It may be looked at several ways.

Tikanga is based on the concept of 'tika' (a state of naturalness) and that the way that something is 'tika' is through tikanga; with the tikanga of a thing being its nature or function (Patterson, 1992, p. 102). Therefore, the way in which something is tika is through tikanga i.e. the correct way of doing something (Mead, 2013, p. 17). In broad terms, Patterson describes ***the 'tikanga of humans' as both 'how we behave' (our appearance, conduct, habits) and something innate that makes us behave the way we do in accordance with what is expected of us*** i.e. 'to be fully human' (1992, p. 103). Mead (2013) refers to tikanga generally as ***a normative system since it deals with moral behaviour which requires an individual to act in ways that respect the general guidelines of acceptable behaviour as encapsulated in tikanga Māori***.

Relevant to the context of this research project, Mead (2013), outlines several ways that we can view tikanga Māori. Of these, two perspectives are directly relevant to the discussion of a sociocultural issue such as the use of 1080 poison to control pests in Aotearoa New Zealand. Firstly, ***tikanga Māori can be looked at from the point of view of ethics – described as the Māori ethic and directly concerned with the conduct and principles practised by a person or group*** (2013, p. 17) and that cultural values determined the standards of behaviour and what was valued most. Secondly, tikanga Māori could be considered as ***a means of social control whereby everything encompassing aspects of interpersonal relationships***, such as meetings and interactions, are structured through ***social rules which provide ways for people to behave and interact in accordance with tikanga Māori expectations*.**

Mead (2013) makes another relevant distinction within tikanga Māori between mātauranga Māori (the knowledge base and ideas associated with tikanga) on the one hand and the protocols associated with the correct practice of tikanga on the other. While broadly speaking, tikanga Māori includes both aspects, some practices or protocols may be called kawa. Simply put, the knowledge base is the tikanga Māori aspect and the practice of it is the kawa e.g. the kawa of the marae is all about protocols, though tribal variations do exist (Mead, 2013, p.20).

With respect to human behaviour towards the physical environment, tikanga ***encompasses a series of rituals, protocols and natural laws that regulate actions and behaviour of people*** (Harmsworth & Awatere, 2013), referred to as ritenga, which details ***a series of practical rules to sustain the wellbeing of people, communities and natural resources***. In an environmental context for example, Harmsworth & Awatere (2013, p. 276), state that this behaviour was effectively managed through rules associated with the application of tapu, rahui, and noa depending on circumstance and events. The key outcome of these actions was to maintain a balance between regulated and de-regulated states, where tapu was sacred, rahui was restricted, and noa was relaxed or unrestricted access.

In addition, the management of natural resources was reliant on rituals such as karakia (incantations). For example, incantations to the kaitiaki (spirit guardians) were recited to maintain the tika (balanced state) (Patterson, 1992, p. 22). With respect to harvest for example, providing that behaviours were in accordance with the expectations of the tribe, and that only what was needed was taken, the balance would be maintained, and ***all would be in equilibrium and in a natural state - in a state of 'tika'***.

Manaakitanga (MK)

Closely akin to the concept of arohatanga, manaakitanga is ***the exercise of showing, through acts of kindness, a duty of care through acts of giving and caring***. Specifically, care for land is known to Māori as manaaki whenua; and the care for people is known as manaaki tangata (Harmsworth & Awatere, 2013).

According to Patterson (1992), manaakitanga is also the expression of friendship, respect, kindness and help to others – ***to display aroha (love) for each other through giving and helping one's kinship group maintains its solidarity and creates a sense of community***. For example, the sharing of food demonstrates the holistic nature of manaakitanga ***with elements such as reciprocation, the nurturing of relationships, looking after people, acknowledging their worth and ensuring their safety*** (Warren, Webster & Kiriona, 2007). These activities ***enhance the mana (status) of all those involved*** (Winiata, 2006, p. 203). Of relevance to this research is manaaki whenua which refers specifically to acts of caring for the land and all that it supports in accordance with custom. This care ensures that the resources of the natural world continue to nourish the people who rely on its bounty.

Kaitiakitanga (KT)

In the context of this research investigation, kaitiakitanga, the second of the two core principles in mātauranga Māori knowledge (the first being whanaungatanga), is described by Māori scholars as ***the active guardianship of the environment*** (Marsden & Henare, 1992; Roberts, Norman, Minhinnick, Wihongi & Kirkwood, 1995; Harmsworth & Awatere, 2013).

Kaitiakitanga is ***deeply embedded in tikanga*** (Muru-Lanning, 2016, p. 144), as Māori were ***obliged to protect ancestral lands*** (Patterson, 1992) ***and taonga*** (treasures) (Winiata, 2006). Those responsible for carrying out this obligation of kaitiakitanga were called ***kaitiaki and could be human, non-human or spiritual***. According to Patterson, everything has its protective patupaiarehe (guardian spirits). The natural environment, under the protection of the super-natural beings is tapu (restricted) (Patterson, 1992). Through whanaungatanga obligations, Māori exercised a duty of care passed down from ancestors to descendants, to nurture and protect places, natural resources and taonga (treasures of the natural world) (Muru-Lanning, 2016, p. 144).

It is acknowledged that there are multiple interpretations of these mātauranga Māori concepts. Bearing this in mind, the final conceptual analysis framework developed combined the values and concepts of Te Ao Māori and mātauranga Māori to produce an instrument through which

the participants' written, and transcribed evidence is analysed and presented. Table 4.3 presents the mātauranga Māori knowledge conceptual analysis framework.

Table 4.3
Mātauranga Māori Knowledge Conceptual Analysis Framework

Mātauranga Māori knowledge Concepts (Code)	**Mātauranga Māori knowledge Sub-Concepts**
Whakapapa (WP): As an environmental concept, whakapapa extends ***to link humans and all flora and fauna to ecosystems*** and provides a holistic, integrated perspective ***connecting the total environment*** (Harmsworth & Awatere, 2013).	• ***Kinship of all living things descended from the gods*** • ***Unity among humans, living and non-living elements*** of the natural world • The ***source of knowledge inherited from ancestors***
Mauri (MR): As an environmental concept, ***mauri is derived from whakapapa*** and ***possessed by all plants, animals, water and soil***. It is ***an internal energy or life force that sustains all life*** and ***the binding force that links the physical to the spiritual world*** (Harmsworth & Awatere, 2013).	• ***Force that links the physical to the spiritual world*** • Source of ***respect towards all living things*** • ***Vitality/fruitfulness of the natural environment*** • Enabler for ***everything to live within conditions and limits of its existence***
Wairua (WR): As an environmental concept, wairua refers to the ***spiritual energy possessed by living things*** and is ***related to their wellbeing*** (Harmsworth & Awatere, 2013).	• ***Material world is subordinate*** to ***the spiritual world*** • A ***spiritual connection to land*** • ***Karakia/incantations*** to ***ensure spiritual safety***
Mana whenua (MW): As an environmental concept, ***mana whenua is the authority possessed*** most often by ***a group who exercise their control and management*** of ***land and natural resources*** (Harmsworth & Awatere, 2013).	• Mana – the ***power of the gods, ancestors, land and the individual*** • Mana Whenua – ***authority over the management of natural resources***
Tikanga (TK): As an environmental concept, the area of ***tikanga***, known as ***ritenga specifically refers to, protocols and laws that regulate actions and behaviour related to the physical environment and people***. Ritenga includes concepts such as ***tapu*** (sacred), ***rahui*** (restricted), and ***noa*** (unrestricted), which were ***practical rules to sustain the wellbeing of people, communities and natural resources*** through the ***regulation of actions and behaviour related to the physical environment and people*** (Harmsworth & Awatere, 2013).	• An ***expression of values*** • Customary ***practices, beliefs rituals and protocols***
Manaakitanga (MK): As an environmental concept, manaakitanga is ***expressed through reciprocal acts of giving and care*****.** If this is directed at the land it is referred to as manaaki whenua (Harmsworth & Awatere, 2013).	• ***Acts of caring*** by ***showing respect and kindness*** • ***Holistic nurturing of relationships*** through ***reciprocation***, by ***acknowledging worth and ensuring safety*** • Demonstrating ***mana-enhancing behaviours***
Kaitiakitanga (KT): As an environmental concept, kaitiakitanga is ***the exercise of guardianship over the environment and its living and non-living elements*** (Harmsworth & Awatere, 2013).	• ***Active guardianship of the environment*** according to ***tikanga*** • ***Protection*** of ***the natural environment and its taonga*** • There are ***human, non-human or spiritual kaitiaki***

4.4 Applying the frameworks for analysis

Identification of the concept

Following the identification of the major environmental concepts and their sub-concepts revealed from the literature, multiple response data from the participants' unmarked written assessments and transcriptions of individual interviews with them were analysed thematically (Braun & Clarke, 2006). Evidence was coded according to where key words were identified to align with the environmental concepts and sub-concepts from the conceptual frameworks described earlier in this chapter.

From this analysis, the spreadsheet in Appendix N displays the six key biological science concepts (environment, population, native, exotic, pest, and pest control) and the seven key mātauranga Māori environmental concepts (whakapapa, mauri, wairuatanga, mana (including mana whenua), tikanga, manaakitanga, and kaitiakitanga). Colour indicates the participant's position and the numerals identify how many statements were made, as shown in this key.

1	Represents a single statement supporting 1080 use
2	Represents a single statement opposing 1080 use
1	Represents one statement in support and one statement opposed
1 + 1	Represents two statements supporting 1080 use
2	Represents two statements opposing 1080 use

Participants express their knowledge of the concept

Having established the central themes emerging from the analysis of their final written assessment papers and interview transcripts, each of the concepts is presented and discussed. In Chapter 5, the analysis of the six biological science concepts appear in the Sections 5.2 – 5.7. In Chapter 6, the analysis of the seven mātauranga Māori environmental concepts appear in the Sections 6.2 – 6.8.

As the sub-concepts were identified and used by participants to justify their support or opposition to the use of 1080, a tally was kept and tabulated. Participant responses were analysed and tallied for (+) and against (-) for their use of the sub-concept. This aligns with the information presented in Appendix N.

Quotations exemplifying participants' justifications are presented and interpreted along with the evidential statements to illustrate their use of the concept and sub-concepts.

- If the quotations are by participants whose overall justified position was in support of 1080, the text will appear as **bold green** with significant words or phrases **underlined.**
- Conversely, if the quotes and phrases are by participants whose overall justified position is opposed to 1080, the text will appear as **bold red** with significant words or phrases **underlined.**
- Quotations exploring participants' justifications are presented and a brief discussion concludes the section.

4.5 Conclusion

This chapter has presented, described and justified the two conceptual frameworks I developed for the analysis of participants' data. The frameworks were comprised of concepts and definitions sourced from the science education literature and indigenous scholarship and confirmed by a thematic analysis of the participants' data.

It is proposed that each framework will be used separately to analyse the data and evidence from unmarked student-participant summative assessments and the transcriptions of their individual interviews. The frameworks will guide the constant interpretation of the data fragments in search of evidence for how the participants used these concepts to discuss and justify their position towards the use of 1080. Armed with these main conceptual categories, and with codes attached for each, the reassembling of the data will reveal how the participants used the concept to support their position as interpreted. Emerging from this analysis are a series of sub-concepts which come under the main topic and closely resemble the ways the participants have used the idea.

The prevalence of the sub-concept is indicated by recording the number of times each was used, by whom and whether the sub-concept was used in support of a position in favour of 1080 use or opposed to 1080 use by the participants. Together, this analysis builds up a comprehensive picture showing the concepts used by students and, of central importance to the second phase of analysis, identifies those students who drew information from both knowledge worlds that signified those operating at the cultural interface.

The next three chapters present the results from the analysed data beginning in Chapter 5 with participants' use of biological science knowledge concepts. Chapter 6 presents the data analysis of student use of mātauranga Māori knowledge concepts. The final data analysis

appears in Chapter 7 which details how participants used concepts from both knowledge worlds.

Chapter 5: Participants' Use of Biological Science Knowledge

5.1 Introduction

This chapter presents and analyses evidential data as participants justified their position in support of, or opposition to, the use of 1080 to control pest animal species in Aotearoa New Zealand. They used biological knowledge to support their justified position. The chapter presents data from 39 participants whose completed unmarked assessment scripts were copied and analysed. From this group, 34 participants were interviewed individually about their assessment scripts.

Participants' ecological knowledge base and assessment background

Before presenting the analysis of the participant biological knowledge, it is necessary to background the participant ecological knowledge base that they would have acquired through the completion of the previous year's specialist course in Level 2 NCEA Biology. Participants completing the prerequisite Level 2 course had the opportunity to cover topics in introductory ecology. Of the two internally assessed Achievement Standards in ecology at Level 2, participants at Secondary School completed both while at High School the participants completed one (See Table 5.1).

Table 5.1
Level 2 NCEA Achievement Standards in Biology

Number	Achievement Standard	Credits	Internal/ External	Secondary School	High School
91155	Demonstrate understanding of adaptation of plants or animals to their way of life	3	Internal	Yes	No
91158	Investigate a pattern in an ecological community, with supervision	4	Internal	Yes	Yes

These topics and their assessments for NCEA Level 2 Biology would give participants entering Year 13 and Level 3 Biology, knowledge of the key biological concepts and processes relating to ecology.

These courses and their Achievement Standards gave participants an opportunity to explore ecological concepts and apply these to local examples. This would allow participants to study the three critical elements of ecology of relevance to this research project: Firstly, participants

in this course would study how organisms interact with their environment (a classic definition of ecology); secondly, study biological communities and the physical factors of the environment in a given area and how they relate to each other (a classic definition of ecosystem); and last of all, study all the biotic (living) and abiotic (physical factors) in an area that affect the lives of the organisms present – the classic definition of the environment (Bayley, 2005, p 61).

An understanding and application of these concepts and processes covered in Year 12 biology the previous year would provide a framework for these biology participants studying biology at Level 3 to apply their biological knowledge to develop a justified position on the use of 1080 to control exotic animal pests in Aotearoa New Zealand; specifically, possums and rats. They would be aware that management practices used in ecology are necessary in order to protect an ecosystem. For example, pest management; where it is necessary to introduce artificial controls following the introduction from elsewhere of plants or animals who have overtime become pests in the absence of natural controls that were in place in their native habitats (Bayley, 2005, p. 75).

This chapter reports participants' views on the use of 1080 to control possums, rodents and mustelids. They were asked to provide a biological justification for their position. With the AS91602 (See Appendix E), as an understood context for this coursework, a research question was developed to explore what biological knowledge participants used when justifying their position on this issue. It asked:

> Where do participants position themselves towards the socio-scientific issue based upon their biological knowledge?

The tasks set by each school appear in Appendix F & G. At Secondary School, the research task was focused on the proposed dropping of 1080 near Auckland's south-eastern water catchments in the Hunua Ranges. The context was topical in 2015 and it at aroused interest from participants on either side of the 1080 debate (See Appendix F). At High School, the task required participants to research, write and present a speech of a more generalised nature about the use of 1080 to control possums in New Zealand (See Appendix G).

Consequently, all participants in both schools were required by the Achievement Standard AS91602 to present in the body of their final, summative, written assessment paper their personal, justified position towards 1080 use. This chapter reports on the biological knowledge

the participants of Secondary School and High School used when they presented their justified position on the use of 1080.

Following this introduction, the participants' written and transcribed evidence is analysed and presented using the format described in Section 4.4. Each of the next six sections presents an analysis of each of the six biological science concepts which comprise the conceptual analysis framework which was detailed in Chapter 4. The participants' evidence is presented in the following order: environment (Section 5.2), followed by population (Section 5.3), native (Section 5.4), introduced/exotic (Section 5.5), pest (Section 5.6) and pest control (Section 5.7). To complete the chapter, Section 5.8 presents a conclusion from the analysis.

5.2 The biological concept of environment

Participants express their knowledge of environment

Four distinct sub-concepts were identified that linked to the literature background explaining the concept of environment. These are:

a. The environment as a non-specific entity
b. The environment is separate from living organisms
c. The environment is comprised of living, named organisms
d. The environment comprises living (biotic) and non-living (abiotic) factors

An analysis of the data revealed the extent to which participants referenced these sub-concepts whenever they justified their position towards 1080 use whether supportive or opposed. This is shown in Table 5.2 and their use of these specific sub-concepts to support their position is discussed in turn.

Table 5.2
The Biological Concept of Environment

Participant understanding of the biological concept of environment	**Supporting 1080**	**Opposing 1080**	**Total**
The environment as a non-specific entity	13	0	13
The environment is separate from living organisms	7	0	7
The environment is comprised of living, named organisms	4	1	5
The environment comprises living (biotic) and non-living (abiotic) factors	3	1	4
Total	27	2	29

The participants' understanding of the biological concept of the environment in their written justifications for their position included four distinct sub-concepts: Firstly, there was an awareness of the non-specific nature of the environment; secondly, that the environment is separate from the living organisms; thirdly, that the environment is comprised of living, named organisms; lastly, that the environment is comprised of living (biotic) and non-living (abiotic) elements. Their use of these specific concepts to support their position will be discussed in turn.

The environment as a non-specific entity

When discussing their position towards the use of 1080 to control the pest population, all 13 responses supporting the use of 1080 had a view of the environment as a non-specific entity. For example, Nadia linked the ecosystem with the environment:

> *New Zealand's native birds (including the kōkako) have been a target to pests such as rats, negatively affecting New Zealand's* ***natural environment and ecosystem****; therefore, the use of 1080 is a must.* Nadia

Nadia's understanding of the environment is the surroundings of the organisms she named; that is, native birds on the one hand and pest organisms on the other. Nadia linked the natural environment to the ecosystem without any distinction.

The environment is separate from living organisms

At a more complex level of understanding, all seven respondents in favour of 1080 identified living species as a component of the environment, though they did not name a species other than to use the group reference. For example, Kay's supporting statement prioritised the protection of our environment, which she viewed as abiotic and separate from living organisms.

> *In my opinion, we should prioritise in* ***protecting our environment and our native species*** *and if 1080 helps protect our native species then I am both for and against the use of 1080.* Kay

The environment is comprised of living, named organisms

Five participant responses named a species occupying the environment when expressing their reasoning. For example, Rose identified rats, kākāpo and kōkako:

> *The huge risk* ***rats*** *have on our* ***environment…it is beneficial for our environment*** *in the long run because, you know, special birds like the* ***kākāpo … kōkako.*** Rose

The environment comprises living (biotic) and non-living (abiotic) factors

In expressing her opposition to 1080, Kit Kat identified the abiotic factor of agricultural chemicals in the environment on the one hand and the biotic factors of humans, trees and possums on the other:

> ***Humans****...pollute oceans, destroy nesting grounds, releasing vast amounts of* ***agricultural chemicals into the environment****, but we also cut down thousands of hectors (sic) of* ***trees*** *daily. We really (sic) on* ***trees*** *a lot and so do* ***possums****.* Kit Kat

Discussion

Essential to a biological understanding of the environment as a collective term for the surroundings of an organism requires the inclusion of both living and non-living factors. There were only four statements that referred to the living and non-living factors as an essential element of the environment.

13 participant responses considered the environment as a block rather than in terms of the interactions between the living and non-living factors. Seven responses distinguished the environment from its living elements.

It appears that a fuller understanding of the environment as a biological concept was expressed by four participants. While most responses relied on a partial understanding of the environment as they considered its composition only in terms of the living elements, four statements demonstrated an understanding of both the living and non-living factors. This was illustrated by Kit Kat in her reference to chemical contamination of the environment.

While participants could illustrate the ecological elements which comprise the environment such as the living and non-living components and demonstrate a sense that the environment surrounds the organisms within it, there appeared no mention of the dynamic self-regulating nature of the environment that would occur in the absence of exploiting/competing populations. Their desire to remove the pest was directly related to the opportunities doing so would give the native populations a chance to thrive and the environment to flourish.

5.3 The biological concept of population

Participants express their knowledge of population

Three distinct sub-concepts were identified that linked to the literature background explaining the concept of population. These are:

a. A group of named organisms living in an area
b. Population numbers can change
c. A change in the numbers of pests influences the numbers of the native population

An analysis of the data revealed the extent to which participants referenced these sub-concepts whenever they justified their position towards 1080 use whether supportive or opposed. This is shown in Table 5.3 and their use of these specific sub-concepts to support their position is discussed in turn.

Table 5.3
The Biological Concept of Population

Participant understanding of the biological concept of population	Supporting 1080	Opposing 1080	Total
A group of named organisms living in an area	16	2	18
Population numbers can change	23	4	27
A change in the numbers of pests influences the numbers of the native population	6	0	6
Total	45	6	51

For participants, the biological concept of population was cited regularly throughout their written justifications. Participants expressed their understanding across three distinctive, yet interrelated sub-concepts: firstly, that a population is comprised of a group of named organisms in an area; secondly, that the numbers of these individuals can change; and finally that by changing the numbers of the pest population, changes will follow in the numbers of the native population. Their use of these specific concepts to support their position will be discussed in turn.

A group of named organisms in an area

Rats in the Hunua Ranges were specifically mentioned by Secondary School participants as their assessment task was constructed around the proposed aerial 1080 poison drop in the Hunua Ranges. For example, Nora's support of the proposed drop expressed thus:

> *Since there are results showing the benefit on the use of 1080 and successful outcomes, my decision of the Auckland council to use 1080* ***to control rat population in the Hunua range*** *is FOR.* Nora

Population numbers can change

Participants who supported the use of 1080, often described the impact of an aerial drop of 1080 directly affecting the pest population to a specified degree. Spec put it like this:

> *Well-managed aerial 1080 operations* ***achieve a 90% reduction in possum populations*** *over large areas of rugged inaccessible land.* Spec

Ofa was clear that it was possible for a population to be completely removed as a result of an aerial 1080 drop:

> *It is ok to support the Department of Conservation on their idea of using aerial 1080 as a method of trying to kill and* **wipe out the pest population,** *rats in particular, over the Hunua Ranges.* Ofa

An opponent of the use of 1080, Tee, acknowledged that possum population numbers were increasing and in need of control:

> *I…oppose the use of 1080. I would have rather used other methods of controlling* ***possum population increase****.* Tee

A change in the numbers of pests influences the numbers of the native population

Participants were able to connect the effects of reducing the pest population with a consequential effect on the population that had been negatively affected by the activities of the pests. For example, Manu connected a decrease in the possum population to a subsequent revitalisation of the native flora and fauna of New Zealand:

> *I propose that 1080 drops still continue,* ***to maintain and decrease the overall population of possums, to a sustainable amount****…. I personally believe 1080 is the best course of action in* ***revitalizing New Zealand's native forests birds and tuatara.*** Manu

Sam referred to the regeneration of native endangered populations of New Zealand as a consequence of controlling the population of pests in the Hunua ranges:

> *My personal opinion on the issue of continuing the use of 1080 is that it is an effective and crucial component to the* ***regeneration of the native endangered populations of New Zealand****. I strongly support the use of 1080* ***to control pests*** *in the Hunua Ranges.* Sam

By removing rats by up to 90%, Anders understood that population stability came about from the increased rate of reproduction as a consequence of the efforts to reduce the rat population by up to 90%:

> ***Rats, I think 90% or something, and by doing that it gives time for those birds to regenerate and reproduce more off spring and so [the population of birds]…are becoming more stable.*** Anders

Discussion

Participants' understanding of the concept of population was expressed in terms of a named group of organisms occupying a particular area. This was evident by the participants of Secondary School whose task was set around the proposed drop of 1080 in the Hunua Ranges. Participant responses showed that they could name a population and a location.

Participants also understood the dynamic nature of a population in terms of changing numbers. This was shown in two ways. Firstly, how the number of pests can be reduced by the 1080 poison and secondly, how a change in the population of one organism (in this case the rat) can affect the numbers of other organisms (in this case the native organisms). Therefore, from both a conceptual and process point of view, participants understood the causal effects arising from the interactions of one population (pest) with another (native).

5.4 The biological concept of native

Participants express their knowledge of native

Three distinct sub-concepts were identified that linked to the literature background explaining the concept of native. These are:

a. Native species belong to New Zealand
b. Native species are named
c. Native species are targeted by introduced species

An analysis of the data revealed the extent to which participants referenced these sub-concepts whenever they justified their position towards 1080 use whether supportive or opposed. This is shown in Table 5.4 and their use of these specific sub-concepts to support their position is discussed in turn.

Table 5.4
The Biological Concept of Native

Participant understanding of the biological concept of native/indigenous	Supporting 1080	Opposing 1080	Total
Native species belong to New Zealand	19	0	19
Native species are named	8	1	9
Native species are targeted by introduced species	18	0	18
Total	45	1	46

The participants' understanding of the biological concept of native/indigenous in their written justifications for their position included three concepts: Firstly, that native species belong to New Zealand; secondly, participants were able to name these native; and lastly that native species are targeted by exotic/introduced species. Their use of these specific concepts to support their position will be discussed in turn.

Native species belong to New Zealand

That these species belong to New Zealand was a recurrent sentiment expressed in the 19 responses from participants who supported 1080 use. They mentioned in general terms 'native species' but without naming them. For example, Mia identified with this group 'our' and labelled them 'native and claimed New Zealand ownership:

> *We should be really looking after **our New Zealand native species**.* Mia

Unique to New Zealand was how Chloe described native flora and fauna and used the possessive term 'our' three times when discussing native birds and plants.

> *So methods like aerially dropping 1080 have to be put into action in order to save **our native birds and plants**. New Zealand lacks native mammals with the exception of the bat, so protecting **our unique species** needs to become our responsibility and I believe 1080 is the most effective way to maintain and prioritise the survival of **our native birds and plants**.* Chloe

Chloe appeared able to express her understanding of native as birds and plants belonging uniquely to New Zealand.

Native species are named

Nine participant responses named a New Zealand native species. Examples included kōkako, kākāpo, huia, moa and kiwi. For example, Charlee and Raizada named the kōkako bird:

> *It isn't a permanent fix either, but it is a starting point in the protection of* ***our native animals, and in this case the kōkako****.* Charlee

Raizada, the only respondent to use the term, demonstrated a deeper level of understanding with her use of 'endemic' when referring to plants and birds in the Hunua ranges:

> *I feel this is the most effective method of maintaining the pest (rat) population, moreover, significantly improving the survival of* ***endemic plants/birds in the Hunua Ranges such as the kōkako****.* Raizada

Manu, who opposed the use of 1080, referred to the impact of human intervention on two native bird species:

> *The extinction of many* ***native birds*** *for instance the* ***moa*** and ***huia*** *are a result of human intervention.* Manu

Native species are targeted by introduced species

Another way that participants' responses expressed their understanding of native was best illustrated by Katie who advocated for 1080 in order to protect a native species which would otherwise have been wiped out by the introduced mammalian pest. She understood a native as a potential target of an introduced species:

> *I believe that the usage of 1080 is something that should be advocated as* ***it protects our native plant and animal species from extinction*** *that would not have occurred if the introduction of mammalian pests were non-existent, especially for the three species of rats.* Katie

Katie demonstrates an awareness of the protective value of 1080 use to stave off what would otherwise be the wiping out of New Zealand's native plants and animals.

Discussion

Participants talk about native as an over-riding concept broadly occupying three distinct areas as they expressed native together with ideas of New Zealand ownership. Firstly, their responses indicated their use of the term native could refer to an unidentified group of organisms, specifically animals and /or plants living in Aotearoa / New Zealand. Secondly, participant use of the term native was further developed as they referred to named native extant and extinct species of Aotearoa New Zealand. Finally, participants understood native from the perspective of a New Zealand species under threat from an alien invader species from across the sea. Native organisms were described as targets of introduced organisms and needing some form of protection from these invaders or saved from extinction. The biologically correct but singular reference to endemic species in the Hunua ranges by one respondent stood alone.

5.5 The biological concept of introduced/exotic

Participants express their knowledge of introduced/exotic

Four distinct sub-concepts were identified that linked to the literature background explaining the concept of introduced/exotic. These are:

a. Introduced rats are mammalian pests
b. Introduced rats adversely the affect native population
c. Humans brought the pest into the habitat
d. Introduced pests can be predators

An analysis of the data revealed the extent to which participants referenced these sub-concepts whenever they justified their position towards 1080 use whether supportive or opposed. This is shown in Table 5.5 and their use of these specific sub-concepts to support their position is discussed in turn.

Table 5.5
The Biological Concept of Introduced/Exotic

Participant understanding of the biological concept of introduced/exotic	Supporting 1080	Opposing 1080	Total
Introduced rats are mammalian pests	3	0	3
Introduced rats adversely the affect native population	1	0	1
Humans brought the pest into the habitat	2	2	4
Introduced pests can be predators	3	0	3
Total	9	2	11

The participants' understanding of the biological concept of exotic/introduced in their written justifications for their position included four sub-concepts: Firstly, there was an awareness that introduced rats are mammalian pests; secondly, that the introduced rats adversely affect the native population; thirdly, that humans brought the pest into the habitat; and lastly that introduced pests can be predators. Their use of these specific concepts to support their position will be discussed in turn.

Introduced rats are mammalian pests

Three responses specified exotic or introduced pests as mammals. For example, Chloe when she suggested she had first-hand experience:

> ***I have also witnessed*** *the fast-growing problem of* ***introduced mammalian pests such as rats*** *pose on out environment.* Chloe

Introduced rats adversely affect the native species population

Ava, a supporter of 1080 use, understood an introduced species to be one characterised by their adverse effect on native species populations:

> *The biological knowledge I have gathered has allowed me to present a personal opinion. Because 1080 is effective in killing the* ***introduced rat species*** *which continue to* ***devastate the native animals and plant species of the native forests****....* Ava

For Ava, the ongoing devastation wrought on the native populations by the rats introduced into New Zealand justified her support of 1080 which she regarded as effective in killing the rat invader.

Humans brought the pest into the habitat

The role humans played in the introduction of the pest organism featured in Moana's overall position opposing 1080 use when she referred to introduced groups/populations as not going very well:

> *Overall my perspective on the use of 1080 is that it's just like everything else humans do* ***they introduce something, and it doesn't go very well so they try to destroy/get rid of whatever they have made, created or introduced to such groups/populations****.* Moana

For Moana, the use of 1080 was at the heart of a failed attempt by people to introduce an organism from elsewhere which eventually turned out to have negative consequences and hence the need to remove it using 1080 poison. What was created to solve the original problem of pests has become a problem of its own.

Introduced pests can be predators

Blue took the position in favour of 1080 with a comment about introduced predators whose absence she saw as beneficial to the native species populations of Tiritiri Matangi Island:

> *Tiritiri island* ***is more suitable for wildlife*** *with* ***more ground plants and no predators,*** *as there were* ***many native species present****.* Blue

A realisation by Raizada that Stoats preyed upon kiwi:

> *A huge advantage that I find of using 1080 is that it can also kill off* ***stoats [the] main predators*** *of kiwi.* Raizada

Discussion

As in the previous discussion of the biological understanding of the term native, the use by participants of the term introduced was mostly attached to the word species. As for native this meant that participants saw 'introduced' as a universal term for a group of organisms which they referred to as a species as coming from afar, from beyond our shores and that humans were responsible for bringing them here to Aotearoa New Zealand. Further, they used their understanding of the role of the introduced species organism to describe the introduced species as mammalian, foreign, and predatory on the indigenous native populations of Aotearoa New Zealand. Overall, the number of responses making reference to introduced were sparse indicating that participants may not be fully aware of the problem of exotic organisms and their pest status.

5.6 The biological concept of pest

Participants express their knowledge of pest

Five distinct sub-concepts were identified that linked to the literature background explaining the concept of pest. These are:

a. The pest is named as an animal
b. The pest animal is identified as a mammal
c. The pest is an animal introduced from elsewhere; by humans
d. Pests are harmful to a named species
e. Humans are also pests

An analysis of the data revealed the extent to which participants referenced these sub-concepts whenever they justified their position towards 1080 use whether supportive or opposed. This is shown in Table 5.6 and their use of these specific sub-concepts to support their position is discussed in turn.

Table 5.6
The Biological Concept of Pest

Participant understanding of the biological concept of pest	Supporting 1080	Opposing 1080	Total
The pest is named as an animal	14	4	18
The pest animal is identified as a mammal	4	0	4
The pest is an animal introduced from elsewhere; by humans	6	2	8
Pests are harmful to a named species	10	2	12
Humans are also pests	1	2	3
Total	35	10	45

The participants' understanding of the biological concept of pest in their written justifications for their position included five sub-concepts: Firstly, participants could name a pest animal; secondly, that the pest animal is a mammal; thirdly, that the pest animal was introduced from elsewhere by humans; fourthly, that pests are harmful to target species; and lastly, humans by their actions are pests too. Their use of these specific concepts to support their position will be discussed in turn.

The pest is named as an animal

The tasks set by each school determined that the pest organism was an animal rather than a plant. Participants were able to recognise a named pest when referring to animals that were problematic to Aotearoa New Zealand. When discussing a named animal pest, the rat was mentioned in 14 statements, the possum was mentioned in 13 and stoat in two. For example, Blue and Dawn identified rats and possums as the pest animals causing the concern:

> *Murphy's Bush is sparse due* ***to pests such as possums*** *and as a result there was a lack of native birds present.* Blue

> *1080 is an effective solution of eradicating* ***pests such as the rat*** *in large areas of land such as the Hunua Ranges.* Dawn

Dee, an opponent of 1080 called for the possum to be respected, while acknowledging the status of the possum as New Zealand's foremost vertebrate pest:

> ***Possums*** *deserve respect as much as any other animal, even though it is New Zealand's* ***foremost vertebrate pest****.* Dee

The pest animal is identified as a mammal

Four responses identified their pest organism as a mammal. Katie put it this way as she advocated for the short-term use of 1080:

> *The usage of 1080 should not be a long-term dependent commitment, rather a short term, temporary or additional method of eradicating and controlling introduced* ***mammalian pests****.* Katie

Also, for Chloe, these mammalian pests were problematic for our environment and were an ever-growing problem:

> *I have also witnessed the fast-growing problem of introduced* ***mammalian pests*** *such as rats pose on out environment.* Chloe

A pest is an animal introduced from elsewhere; by humans

The role of humans in the introduction of the pest animals was mentioned in eight responses. Both Dawn and Kris were unequivocal as to where the blame lay:

> *They lived on New Zealand for millions of* ***years before humans introduced pests into their habitat.*** Dawn

> *I agree that we as* ***people need to take responsibility for the crisis we have caused by introducing pests*** *into this isolated and predator free environment.* Kris

An opponent of 1080, Dee called for the possum to be respected as a living organism, in the same way as we respect humans as living organisms:

> *I am AGAINST* ***as animals should be treated equally because they have a life just the same as humans.*** Dee

Pests are harmful to a named species

Twelve responses promoted the argument that participants understood the harm pest organisms cause through their interactions with native organisms. For example, Raizada, 1080's ability to also kill off stoats which meant survival of the kiwi and the increased survival chances of native kōkako and kākā birds. Raizada discussed the advantages of using 1080 poison and expressed her belief that pests caused harm to the kiwi:

> *A huge advantage that I find of using 1080 is that it can also kill off* ***stoats (main predators of kiwi) and possums through eating poisoned rats*** *(secondary killing thus controlling population of pests overall) and* ***an increased number of survival(sic) for not just the kōkako but also other birds such as kākā.*** Raizada

Humans are also pests

Three respondents believed that humans were not immune from aiding and abetting the pest in the negative impact on the environment; even going as far as to openly state that humans were also to be regarded as pests with their impact on a far greater scale that that wrought by possums. Kit Kat, an opponent of 1080, was unequivocal:

> ***Humans are the world's biggest pest****… We really (sic) on trees a lot and so do possums.* Kit Kat

With quite specific reference to the role of humans in the eventual extinction of the moa and huia bird species, 1080 opponent Manu outlined the ways humans have behaved in a pest-like fashion:

The extinction of many native birds for instance the moa and huia ***are a result of human intervention. Humans have been involved in mass deforestation and animal extinction across the history of man.*** Manu

Discussion

The five sub-concepts of the biological concept of pest identified in participant justifications, covered a wide range of understanding. From being able to name pest organisms (exclusively mammalian), through to demonstrating that by the actions humans undertake, that they too can be categorised as pests, participants have shown a breadth of understanding of the concept of pest in their justifications.

According to a number of responses, to be a mammal brought in from overseas which then goes about establishing itself in the ecosystem who by their interactions often harming native organisms, fairly well guarantees that before long the status of pest will be bestowed upon these individuals. It will most certainly guarantee that these pests will become the target of efforts to eradicate or at least control their numbers using a range of methods.

5.7 The biological concept of pest control

Participants express their knowledge of pest control

Four distinct sub-concepts were identified that linked to the literature background explaining the concept of pest control. These are:

a. A species can be targeted
b. 1080 is a poison that can kill
c. 1080 can control pest population numbers
d. Alternative methods of pest control

An analysis of the data revealed the extent to which participants referenced these sub-concepts whenever they justified their position towards 1080 use whether supportive or opposed. This is shown in Table 5.7 and their use of these specific sub-concepts to support their position is discussed in turn.

Table 5.7
The Biological Concept of Pest Control

Participant identification of the biological concept of pest control	Supporting 1080	Opposing 1080	Total
A species can be targeted	17	1	18
1080 is a poison that can kill	13	6	19
1080 can control pest population numbers	5	2	7
Alternative methods of pest control	15	3	18
Total	50	12	62

The participants' understanding of the biological concept of pest control in their written justifications for their position included four distinct concepts: Firstly, participants stated that a species could be targeted; secondly, that 1080 is a poison and can kill; thirdly, 1080 can control pest population numbers; and lastly, that alternative methods of pest control can be used alongside or instead of 1080 and could include the biological use of an alternative method of control. Their use of these specific concepts to support their position will be discussed in turn:

A species can be targeted

Eighteen participant responses discussed the specific targeted nature of 1080. For instance, Freya was aware of the specific nature of 1080 as a poison that worked on a target species e.g. rats:

> *I am wary of the chance of* ***the targeted animals (e.g. rats)*** *developing resistance to the poison, rendering 1080 useless.* Freya

For Anders, the target species is harmed by 1080:

> *They are putting in all these safety measures to make sure the use of 1080 won't be harmful* ***to anyone other than the target species****.* Anders

1080 is a poison that can kill

Nineteen responses recognised that 1080 can kill. For example, Blue and Kit Kat showed their understanding of 1080 as a lethal poison:

> *As we know that* ***1080 is very effective over large areas, therefore the more we kill possums the faster*** *we can stop using 1080 poison.* Blue

> *[Do] we have the right* ***to kill possums using a poison*** *which not only harms possum[s] but also other animals too?* Kit Kat

1080 can control pest population numbers

The effectiveness of 1080 as a control of pest populations as indicated by Kit Kat was also demonstrated by Nadia who stated:

> *1080 would be the ideal method of pest control as not only is it **98% effective on rats,** but also **90% effective on possums.*** Nadia

Alternative methods of pest control

Eighteen responses indicated that participants understood the role of 1080 working alongside other methods of pest control. Lana used her insight knowledge gained from her visit to the pest-free off-shore island of Tiritiri Matangi in the Hauraki Gulf where she saw how 1080 poison could work in tandem with more traditional non-chemical methods of pest control used by people working to keep the island pest free. For example:

> *As I have visited the island of Tiritiri it shows the wonderful preserved wildlife still growing by the numbers. This shows that **poison can still be used alongside the conservationists and rangers** who try to continue the growth of wildlife for future generations to see.* Lana

Ten participant responses named some alternative, non-chemical methods of pest control such as hunting, trapping and shooting. For example, Dotti who opposed 1080 use, acknowledged the effectiveness of 1080 but advocated for traditional methods which she was able to name:

> ***I believe that there are other ways to control the population of pests (possums)** without harming any other creature. **For example shooting and trapping.*** Dotti

Ashe saw traditional methods as safer than 1080:

> *When the pest numbers are low, **I would recommend trapping as the repercussions are safer.*** Ashe

Yet Spec acknowledged the limitations of these alternatives when compared to 1080:

> *Yes hunting and trapping are alternatives to 1080, **but only in a limited number of circumstances and they are labour intensive.*** Spec

For Tibs, the lure of employment and economic benefits associated with the traditional method of trapping were appealing:

> *Wherever possible continue to use the **traditional method of trapping** as it will create more jobs and keep the fur trade going thus helping the economy.* Tibs

Freya and Omar demonstrated their understanding of specific alternative biological control methods, some of which were still under development. For example Omar, a supporter of 1080 use, advocated two alternative biologically-based control methods:

> *Scientists have started **making viruses** and also **started to control their breeding rate,** the key alternative if we don't want to use traps and poisons would be **the use of fertility control,** which would slowly reduce numbers over time.* Omar

Omar continued:

> *We should start researching other ways to control the possum population **like spreading a virus that just affects possums and other pests** or by **controlling their breeding patterns.*** Omar

Freya offered another alternative biological control method:

> *I guess my main one that I put here there is like **immune sterilisation like stopping pests' ability to reproduce.*** Freya

Discussion

Once targeted as a pest, control methods can be developed to kill and effectively control pest population numbers. For participants on either side of the issue of pest control, the use of 1080 or conventional alternatives such as trapping or shooting featured strongly in their justifications. Participants agreed that 1080 was an effective poison that could be used either on its own or in association with conventional methods of control such as trapping or shooting. Participants deemed these conventional methods as safer than 1080 but that their use and effectiveness was limited.

Participants demonstrated their knowledge of the proposed use of biological methods such as control agents or immunosterilisation methods. This combined with their knowledge of conventional methods combined to show their high level of understanding of the current pest control regime and the possibilities for future alternatives to 1080 use.

5.8 Conclusion

This chapter presented the findings related to the first research question: Where do participants position themselves towards the socio-scientific issue based upon their biological knowledge? The depth and breadth of participant understanding of the six biological concepts presented was evident when participants justified their support of or opposition to the use of 1080 and the biological knowledge they used when doing so.

The biological concept of the environment was the first area of consideration. It is apparent that participants have an incomplete view of the environment. For them, the environment was seen as a whole, non-specific entity rather than in its more scientific and complete form of comprising the interactions between the living (biotic) factors and the non-living (abiotic) factors. Instead, participants referred to the environment more like a static rather than fluid dynamic self-regulating entity.

The biological concept of population, as the second area of consideration indicated that participants understood the dynamic nature of populations and used examples of named populations to show effects of the interactions between them. In the context of the task, these predator-prey interactions demonstrated participants had a good understanding of the influence of these interactions on the numbers of organisms whether predator or prey/ pest or target organism.

The biological concept of native as the third of the seven concepts uncovered in participant justifications was seen by participants as a generic term much like the environment to describe a species of organisms belonging to or resident here in Aotearoa New Zealand. Only some participants could name a native species which required protecting from the exotic invader organism.

The biological concept of introduced or exotic emerged as participants described the interactions between the pest organisms and those native organisms targeted or preyed upon by the pest invader. Participants exclusively discussed ‘introduced species’ as if referring to group of organisms brought here by humans and who have adversely affected the native residents. Overall, participant references to introduced organisms was sparse.

The biological concept of pest was more broadly understood by participants. Their responses indicated a set of criteria through which an organism can be compared and classified as a pest. Specifically, these criteria included: animal, mammal, brought in/arrived from offshore (with the assistance of humans) and once here established themselves and wrought devastation on the native inhabitants. Three statements clearly regarded humans as fitting these criteria and were also categorised as pests.

Pest control was the final biological concept to emerge from the data. Akin to the title and context of the participant research task, the control of pests using 1080 gave ample opportunity for the participants to focus the justification for their position on this biological concept. Whether they supported or opposed to the use of 1080, participants showed an awareness of

conventional methods of pest control and the level of effectiveness of such methods. Likewise, participants on either side of the issue agreed that 1080 was an effective pest control method. Where they disagreed was on its viability as a long-term solution to the pest problem. Some participants were aware of biological control methods currently under development and that this offered a possible replacement for 1080 in the future. Participants' use of mātauranga Māori knowledge will be analysed and presented in the next chapter.

Chapter 6: Participants' Use of Mātauranga Māori

6.1 Introduction

This chapter presents and analyses how students used mātauranga Māori cultural knowledge when justifying their support of (or opposition to) the use of 1080 to control pest animal species in Aotearoa New Zealand. The conceptual analysis framework presented in Chapter 4, developed using indigenous perspectives of Te Ao Māori (the Māori worldview), and was used for the presentation and analysis of the participants' data.

Following this introduction, the student written, and transcribed evidence is analysed and presented in the following order: whakapapa (Section 6.2), mauri (Section 6.3), wairuatanga (Section 6.4), mana/mana whenua (Section 6.5), tikanga (Section 6.6), manaakitanga (Section 6.7), and kaitiakitanga (Section 6.8). To complete the chapter, Section 6.9 presents a conclusion from the analysis.

6.2 The mātauranga Māori concept of whakapapa

Students express their knowledge of whakapapa

Three distinct sub-concepts were identified that linked to the literature background explaining the concept of whakapapa. These are:

a. Kinship of all living things – descended from the gods
b. Unity among humans, living and non-living elements of the natural world (e.g. land)
c. The source of knowledge inherited from ancestors

An analysis of the data revealed the extent to which students referenced these sub-concepts whenever they justified their position towards 1080 use whether supportive or opposed. This is shown in Table 6.1 and their use of these specific sub-concepts to support their position is discussed in turn.

Table 6.1
The Mātauranga Māori Concept of Whakapapa

Sub-concepts of whakapapa	Supporting 1080	Opposing 1080	Total
Kinship of all living things – descended from the gods	13	10	23
Unity among humans, living and non-living elements of the natural world (e.g. land)	3	4	7
The source of knowledge inherited from ancestors	2	1	3
Total	18	15	33

Whakapapa as kinship of all living things, descended from the gods

A central aspect of the mātauranga Māori concept of whakapapa, which featured in 23 responses, is that all living things are descended from the gods and are therefore closely related kin through a genealogical connection. An example of a reference to God as the creator was mentioned by 1080 opponent Dee.

> ***God created us all as equals not differently****…on the earth and we should all be treating* ***possums as equals as animals****, not killing them*. Dee

Dee used this as the basis for her belief that humans and possums as living things are created equally and, on this basis, neither group superior to the other which she referred to by the term 'not differently'. Hence, Dee opposed the use of 1080 to eradicate an organism whom she regarded as an equal to humans.

Whakapapa as unity among humans and living and non-living elements of the natural world (e.g. land)

Seven responses described the oneness and unity of humans with the living and non-living elements of the natural world. For the students, the unity of humans with the natural world meant on an equal footing-specifically, equality of treatment, hence why this theme featured often in those responses from students who opposed the use of 1080.

For example, 1080 supporter Nadia understood that, to Māori, the living and non-living world is perceived as one, from which she concluded conferred an equality of status of all living things.

> *To the Māori,* ***humans and land are seen as one*** *in which* ***all living things are considered as equal.*** Nadia

1080 opponent Rose recalled a point of view from her research that resonated with her about how humans (representing the physical world) were connected and unified with nature (representing the non-physical and spiritual world).

> *The part that really stuck out for me was when it says* ***that the humans and nature are seen as one*** *with* ***neither being more superior [to] the other.*** Rose

Rose based her concerns for the use of 1080 to eradicate the rat on the close connections of the natural world to humans, hence removing the notion of human superiority over the creatures of the natural world. From this understanding she saw equity in the relationship with no advantage of one creature over another in this context.

Another recurrent aspect of the whakapapa concept expressed by students was the connections humans have with whenua (land). Lavinia acknowledged that Māori have a connection with the land and that this connection was a spiritual one.

> *This is an issue of the **land and this [was] originally Māori** and I think this – they have like **spiritual connections to their land**.* Lavinia

From these responses, both supporters and opponents of 1080 saw strong connective relationships between humans, the living and non-living worlds and the land. For these students, the closeness of this relationship meant, that all living things were to be respected and treated equally. For example, this was a central concern for Rose, Dee and those students who opposed 1080 use. However, for Lavinia, Nadia and those students who supported the use of 1080, the importance of whakapapa relationships to Māori were at the core of their concerns for the use of 1080. Despite these concerns and acknowledgement of the importance of relationships based upon whakapapa concepts of unity and oneness of humans with the natural world, these students maintained their overall support for the proposal to use 1080 to control the possum population.

Whakapapa as the source of knowledge inherited from ancestors

Three responses referenced whakapapa as a source of knowledge inherited from ancestors. For example, Lavinia used the concept of an inheritance of taonga (important gifts/treasures) being passed down from the ancestors (tupuna) through a whakapapa lineage to future generations.

> *If we don't use 1080 **the taonga that was left to us [from] tupuna** would be lost **for future generations.*** Lavinia

Nadia, who also supported the proposed use of 1080 in the Hunua area, expressed her understanding of the whakapapa concept of ancestral links by way of an example which referred to an iwi (tribe) in the central North Island region of Aotearoa-New Zealand. This particular iwi regarded the kiore (Polynesian rat) as sacred through its connection to their early human ancestors (tupuna).

> *Because like for the kiore rat like there is a tribe that holds it significant because **it has roots to their early ancestors.** So, it's kind of like a cultural thing for them. So, it's sacred and really important that it's not harmed and stuff.* Nadia

From a mātauranga Māori perspective, this animal is to be treated respectfully and protected from harm. It is therefore conceivable that Nadia maintained her support for the eradication of a rat population in the Hunua Ranges regarded as pests whilst at the same time acknowledging that in a different geographic region many hundreds of kilometres away from Hunua, a related

rat population would be afforded protection and survive because of the cultural regard in which it is held as a tribal guardian. From a knowledge perspective, its status as a kaitiaki for the tribe required that knowledge of its existence and the code of conduct to be followed for its protection, and its representation in tribal art and cultural iconography held for this tribe a knowledge reservoir of cultural and tribal significance.

For Nadia and Rose, the natural world is a source of knowledge and understanding which could be communicated to Māori and passed down to them through whakapapa.

> *Māori believe that* ***the natural world is able to "speak" to them and give them knowledge and understanding.*** Nadia
>
> ***…as the natural world 'speaks' and gives knowledge and understanding to humans***. Rose

While aware that the gods were the source of human knowledge, students did not specify the content of knowledge passed down or how the natural world communicates with humans. What was clear from their comments was that students understood the concept of whakapapa as a channel through which the spiritual world communicated with the physical world.

Discussion

Whakapapa was understood by students in general terms as the descent of all living creatures from the gods and featured through references they made to god as the creator. This conferred a kinship relationship amongst all things. Students who referred to a unity/oneness among humans and the living and non-living elements of the natural world typically used references to the connection humans have with land through whakapapa. Students described how humans gained understanding and knowledge from the natural world passed down from ancestors with whom they were connected through whakapapa.

6.3 The mātauranga Māori concept of mauri

Students express their knowledge of mauri

Four distinct sub-concepts were identified that linked to the literature background explaining the concept of mauri.

a. A force that links the physical to the spiritual world
b. A source of respect towards all things
c. The vitality /fruitfulness of the natural environment

d. An enabler for everything to live in accordance with the conditions and limits of its existence

An analysis of the data revealed the extent to which students referenced these sub-concepts whenever they justified their position towards 1080 use whether supportive or opposed. This is shown in Table 6.2 and their use of these specific sub-concepts to support their position will be discussed in turn.

Table 6.2
The Mātauranga Māori Concept of Mauri

Sub concepts of mauri	Supporting 1080	Opposing 1080	Total
Force that links the physical to the spiritual world	1	2	3
Source of respect towards all things	2	1	3
Vitality /fruitfulness of the natural environment	2	2	4
Enabler for everything to live in accordance with the conditions and limits of its existence	2	1	3
Total	7	6	13

Mauri as a force that links the physical to the spiritual world

Three expressions used by students to reinforce their argument when either opposing or supporting the use of 1080 referred to the existence of a binding force connecting humans and nature. For example, Rose spoke of how this link between humans and nature was forceful in terms of how it allowed both humans and nature to each derive power from the other. In doing so, this bound humans and nature together in a mutually beneficial relationship.

> *You would think there was no relationship but really it means so much* ***because it was a source of power to humans and humans were our source of power to nature itself.*** Rose

Therefore, without referencing mauri directly, Rose focused on the existence of what she termed a 'relationship' between humans and nature. For her it was this relationship that bound humans to nature-and that something was 'mauri'.

Dee expressed her understanding of the concept of mauri by discussing the interdependence of Māori with the natural world of which they feel a part of. Again, like Rose, Dee displayed in her comment an awareness of a strong 'sense of cultural connection' which in this instance alludes to the existence of an invisible, connective bond – that of 'mauri'.

> *Māori have a* ***strong sense of cultural connection to the natural world*** *and feel part of it.* Dee

The theme of a binding or unifying force was also evident in the comment made by Lavinia.

> *I had to think about Māori people, and I thought this is an issue of the land and this originally* ***Māori and I think this they have like spiritual connections to their land.*** Lavinia

Lavinia's understanding of the importance to Māori of land was expressed through her reference to the connection Māori have to their land. The binding force in this instance was a spiritual one.

Mauri as the source of respect that humans show all things

For Manu, there exists a connective relationship between humans and the natural world to the extent that proximity was so close and so tight there is no apparent distinction between humans and the natural world. This manifests in a mutually respectful relationship between them.

> *With the kaitiakitanga with* ***the mutual respect between [humans] and [the natural world]*** *there is no distinction between them.* Manu

Manu saw how the obligations of the kaitiakitanga role required that humans respect the natural environment and by doing so acknowledge its mauri and preserve the natural environment from harm. Dee also referenced respecting mauri in her statement regarding the duty of care Māori have towards nurturing mauri.

> *...a* ***sense of duty to nurture the mauri****....* Dee

This example, provided by Lavinia, followed on from her understanding of the spiritual connection Māori have with the land, when she also understood that, for Māori, the use of 1080 would be seen as a disrespectful act which would disturb the cultural connection which by inference would also disturb the mauri.

> ***If we are disturbing that connection and what [Māori] value we are disturbing [Māori] culture.*** Lavinia

This view expressed by Lavinia alludes to the second mauri sub-concept which is that the respect accorded living things comes out of an acknowledgement of a life force possessed by the individual plant or animal – its mauri. Lavinia alluded indirectly to the existence of a binding force and that 1080 would disturb this and be disruptive. Nevertheless, despite these concerns, Lavinia remained firmly in support of the 1080 proposal.

Chloe reiterated the importance to Māori of respecting the natural environment, especially the treatment of land.

> ***What I was talking about Māori and how they respect the land, how they hold so much respect for the land***…. Chloe

She continued:

> *I know that, you know, the whole Treaty of Waitangi* ***how in touch they were with nature and how they lived off the land and did really treated it like a god.*** Chloe

For Chloe, Māori treatment of the land with a god-like reverence was important because the land was a source of sustenance for Māori both physically and spiritually. Chloe was able to express an understanding from a Te Ao Māori perspective that respect for land (the Earth mother) was necessary in order for the fruits of the land to sustain the people. This meant that 1080 was able to remove any threat to the physical and spiritual strength of the land, hence Chloe's support for the use of 1080.

Mauri as the vitality / fruitfulness of the natural environment

Of the four statements which referred to the vitality and fruitfulness of the environment, Chloe balanced her justified position in favour of 1080 by also demonstrating she understood that the removal of the possum pests was an environmentally respectful and responsible act.

> *1080 is the most effective way to eradicate pests within places similar to the Hunua Ranges,* ***to give our environment the chance to flourish once again.*** Chloe

As a consequence of the removal of the possum population, the natural environment would have the chance to flourish. Its vitality restored once again; its mauri intact.

This statement from Chloe ranks in importance the mauri of the environment ahead of the mauri of the possum. This shows that, in her view, the mauri possessed by all living things comes with a caveat. Chloe maintained her support for the 1080 drop to eradicate the possum (whose mauri did not appear to rank high enough for it to be considered critical to counter her position), which she maintained in favour of eradication. Chloe understood that the damage to the mauri of the forest outweighed the mauri of the possum in this instance.

Mauri enables everything to live in accordance with the conditions and limits of its existence

The consequence of restoring balance to the natural order of things, thus revitalising the mauri of the natural environment, was mentioned in several statements. For example, Dee's support for 1080 came from seeing first-hand the natural beauty of a pest-free forest environment that had its mauri restored by the removal of pest animals on Tiritiri Matangi Island.

> *When I went to Tiritiri Matanga (sic) island and Murphy's Bush, I realised that the* ***environment of the trees and forests were beautiful and cleansed of any pests****, and* ***the birds were safe*** *because of the use of 1080 being used to control the possums.* Dee

In this quote, Dee illustrates her understanding that the beauty of the forest area relied on the removal of the pest animals which she referred to as 'cleansed' and that once removed, the birds could live in relative safety and from this live freely and in accordance with their role in the natural setting. The implication from this quote is that the removal of the pest organism, the restoration of the mauri of the environment, also restores the mauri of the bird population.

Discussion

For mauri, students who referred to a force linking the physical and spiritual worlds used references to terms such as an equality or unity derived from whakapapa. The life-force possessed by living things was expressed from the perspective that 1080 would be disruptive to this force and hence disrupt the mauri of the organism. This was regardless of whether or not students were referring to pest organisms or native creatures, which deserved respectful treatment as an acknowledgement of their mauri. Also, when referring to the vitality of the environment students used terms such as 'flourishing' – a reference to the vitality that is evident when mauri is strong.

6.4 The mātauranga Māori concept of wairuatanga

Students express their knowledge of wairuatanga

Three distinct sub-concepts were identified that linked to the literature background explaining the concept of wairuatanga.

a. Material world is subordinate to the spiritual world
b. The connection humans have to land is spiritual
c. Karakia/incantations ensure spiritual safety

An analysis of the data revealed the extent to which students referenced these sub-concepts whenever they justified their position towards 1080 use whether supportive or opposed. This is shown in Table 6.3 and their use of these specific sub-concepts to support their position is discussed in turn.

Table 6.3
The Mātauranga Māori Concept of Wairuatanga

Sub-concepts of wairuatanga	Supporting 1080	Opposing 1080	Total
Material world is subordinate to spiritual world	0	1	1
A spiritual connection to land	1	0	1
Karakia (incantations) to ensure spiritual safety	1	0	1
Total	2	1	3

Material world is subordinate to spiritual world

The existence of wairua in the form of a superior spiritual dimension was illustrated by Rose who believed that the focus on people ahead of money placed the spiritual dimension ahead of and superior to a people-focused economic one.

> ***Māori thought of which one is more spiritual to an individual. They focus on people and not money***. Rose

This featured strongly as Rose argued her final view opposing the use of 1080 as it came down to a straightforward choice between the two.

Wairua expressed as a spiritual connection to the land

For Lavinia the spiritual connection with land, valued by Māori, was a significant aspect of her concern. For her, valuing Māori culture means that she values the spiritual connection Māori have to the land.

> *I thought this is an issue of the land...originally Māori ...**they have like spiritual connections to their land** and if we are **disturbing that connection and what they value we are disturbing their culture.*** Lavinia

Lavinia showed an awareness of the importance to Māori of their spiritual connection with the physical world and understood that from this, 1080 would likely disturb that connection. However, despite these concerns, Lavinia maintained her support for the ongoing use of 1080.

Wairua as spiritual safety through karakia / incantations

One participant, Chloe provided first-hand experience of karakia being used in an authentic setting to ensure spiritual safety. She illustrated how her grandmother would recite karakia (incantations) while in the forest to gather plant material for use in traditional healing. This was a direct acknowledgement of the spiritual dimension and demonstrated its importance in order to ensure their spiritual safety/wellbeing.

> *She makes this sort of medicine and when I used to go out and get the [plant] ... but every time* ***that she would take it she would always say a karakia just to ask basically the land god for permission.*** Chloe

Chloe, in the presence of her grandmother, could learn about the customary processes and the importance of incantations (karakia) to the spiritual guardians to ensure their spiritual safety and respect the unseen energies of the plant material which, through karakia would preserve its internal energy, life force and power (mauri) for use in the treatment of ailments. Chloe's knowledge and awareness of the spirituality of the physical environment appeared not to have influenced her position supporting the use of 1080 in this instance.

Discussion

For wairuatanga, students made reference to the importance of a spiritual element when considering the effects of 1080 on the living and non-living environment. Specifically, this included an understanding of the subordination of the material world to the spiritual world and that the connections humans have to the land is of a spiritual nature. At a deeper level, one student demonstrated of the importance of ritual karakia (incantation) by recounting a real-life example when she took part in a culturally appropriate process that was used prior to the harvesting of nature's bounty by a relative who was a traditional healer which ensured a spiritual oneness with the spirit guardians.

6.5 The mātauranga Māori concept of mana/mana whenua

Students express their knowledge of mana

Two distinct sub-concepts were identified that linked to the literature background explaining the concept of mana.

a. Mana – the power of the gods, ancestors, land and the individual
b. Mana whenua – authority/control over the management of land and its natural resources

An analysis of the data revealed the extent to which students referenced these sub-concepts whenever they justified their position towards 1080 use whether supportive or opposed. This is shown in Table 6.4 and their use of these specific sub-concepts to support their position will be discussed in turn.

Table 6.4
The Mātauranga Māori Concept of Mana/Mana Whenua

Sub-concepts of mana whenua	Supporting 1080	Opposing 1080	Total
Mana – the power of the gods, ancestors, land and the individual	1	1	2
Mana whenua – authority/control over the management of land and its natural resources	6	0	6
Total	7	1	8

Mana – the power of the gods, ancestors, land and the individual

The mātauranga Māori concept of mana refers to the notion of power. This can be possessed by the gods, ancestors, land or the individual and exercised and understood in accordance with customary Te Ao Māori beliefs (Māori worldviews) as a force binding the physical and non-physical worlds.

Rose expressed her understanding of mana-as-power when she discussed the binding force notion of the mauri concept. She agreed with the mātauranga Māori perspective where humans and nature were seen as one. Rose interpreted this as a balanced power relationship with neither being more superior to the other. For example.

> *It is all about equity and there is not one person being more advantaged than the other even though we are talking about humans, you know. You would think there was no relationship but really it means so much because it was a* ***source of power to humans and humans were our source of power to nature itself.*** Rose

The reciprocal balanced equitable power-sharing relationship between humans and nature that Rose refers to lies at the heart of the mana of individuals. This is derived from the relationship they have with the power of nature; effectively, she recognised the mana-enhancing power of the natural world.

Mana whenua – authority/control over the management of natural resources

Taking the concept of mana still further, were seven student responses that referred to the authority and control aspects of the closely related application of the mana concept –that of mana whenua. This was especially so when students discussed the management of natural resources. All seven responses were from students supportive of the use of 1080.

For 1080 supporter Lavinia, she understood the concept of mana whenua from the perspective of the attachment of Māori to their land, which would require the Auckland Council to obtain

permission from the local iwi and involve the tribal representatives in the project from the outset.

> *Māori…do value their land a lot. They belong somewhere. They…are almost attached to their land,* ***so if you're doing something that is going to harm the land of course they will be involved, and they always have to get permission from [Māori]****.* Lavinia

She gave the example of a 'quite biased' but 'smart' strategy used by the Auckland Council to engage more effectively with local Māori by utilising a person from the Department of Conservation who was of Māori descent.

> *They had to get permission from this group of community, and* ***they used a person from the Department of Conservation of Māori descent*** *to I think go and convince the community that dropping 1080 is beneficial to the environment and…I think that was quite biased but smart.* Lavinia

Anders, a 1080 supporter, also typified the views of this group who, like Lavinia, had concerns regarding the processes being followed by local authorities to engage with local communities in the lead up to the dropping of 1080 in the Hunua ranges.

> ***The iwi was not consulted until the decision to drop 1080 was made*** *and due to the misinformation and uncertainty in the process,* ***the iwi cannot fully support the programme.*** Anders

The process of consultation would normally see all stakeholders actively involved in discussions at all stages of a proposal of this significance. Anders expressed a concern at what she saw as a lack of consultation with, and involvement of, local iwi in the early stages of the planning for the 1080 drop. Anders was aware of the misinformation this could spread and that this had the potential to build uncertainty for local Māori which could very likely compromise the support of the local iwi for the proposed 1080 drop.

Anders believed that with the right education campaign and by keeping the local iwi routinely informed of the proposed 1080 treatment programme, they would be more inclined to support the proposal. This inclusive approach would acknowledge the mana whenua status of the iwi and their authority over tribal lands and resources.

These statements by Lavinia and Anders illustrate their practical understanding of the concept of mana whenua as it pertains to the exercise of authority and control over tribal land use and the management of the resources within tribal boundaries. All three students were acutely aware of the importance of including all stakeholders of the area-land owners and the tribal group who held mana whenua obligations over tribal lands and resources.

Finally, for Sam, who supported 1080 use, the preservation of mutually respectful relationships was mana-enhancing and at the heart of the issue. Sam saw the landowners and the local iwi being treated differently from each other with one group of (non-Māori) landowners included in the consultation process while at the same time local iwi (mana whenua) were not. Sam was concerned that the net effect of this differential approach would be twofold. The loss of tribal mana through loss of control and participatory rights could ultimately damage the relationship between the Auckland Council and local iwi.

> *The decision to use 1080 also affects Māori communities culturally…**the landowners around the area were informed, however the iwi owning the land weren't. This damaged their relationship** with the Auckland Council in particular **and meant that they had no control.*** Sam

For Sam it was important to acknowledge the mana whenua status of the local iwi through consultation where they would be able to exercise their cultural authority over the natural resources and the way they are managed. In doing so, the Auckland Council would be seen in a positive light, empowering the local iwi by inviting their representatives to the table to discuss and receive the views of the local iwi as partners under the Resource Management Act 1991 (RMA) and the Treaty of Waitangi, 1840. This is mana enhancing for both the Auckland Council and the local iwi, which is directly related to the mātauranga Māori concept of manaakitanga which is covered in Section 6.7.

Discussion

For mana whenua, students who referred to mana, typically used terms such as power or illustrated an example showing the authority or control a tribal group have over an area and its resources. This authority was recognised whenever students called for an inclusive consultation with the local Māori inhabitants who were in most cases the people who had mana whenua over the area where the proposed 1080 drop was planned to take place.

6.6 The mātauranga Māori concept of tikanga

Students express their knowledge of tikanga

Two distinct sub-concepts were identified that linked to the literature background explaining the concept of tikanga.

a. An expression of values
b. Customary practices, beliefs, rituals and protocols

An analysis of the data revealed the extent to which students referenced these sub-concepts whenever they justified their position towards 1080 use whether supportive or opposed. This is shown in Table 6.5 and their use of these specific sub-concepts to support their position will be discussed in turn.

Table 6.5
The Mātauranga Māori concept of Tikanga

Sub-concepts of tikanga	Supporting 1080	Opposing 1080	Total
An expression of values	8	1	9
Customary practices, beliefs, rituals and protocols	14	2	16
Total	22	3	25

Tikanga as an expression of values

The first common unifying concept was that tikanga is an expression of values – specifically cultural values that determine standards of behaviour. Nine responses expressed an understanding of tikanga Māori from a values-based perspective. These are generally principles or standards of behaviour that reflect a judgement about what is important in life and valued most. The eight statements from students supporting the use of 1080 acknowledged that the use of 1080 would be disruptive to Māori cultural values. For example, Chloe expressed it thus.

> ***The use of 1080 would disrupt [Māori] beliefs and cultural values.*** Chloe

Chloe, a fervent supporter of 1080, understood how 1080 could be seen as a disruptive and possibly destructive agent counter to the Te Ao Māori worldview. This disruptive narrative was also echoed by another 1080 supporter Nadia who saw the proposal to eradicate rats in the Hunua ranges using 1080, as an interference with values, which could ultimately lead to conflict with local Māori. She drew the distinction between a western worldview and a traditional mātauranga Māori view of nature where the animal is valued as a living entity, deserving of respect as a member of the natural world.

> *The use of 1080 to eradicate the rats in the Hunua ranges* ***may cause conflict with Māori...as their perspective on nature is different to the western world*** *in which they find sacredness in all living things.* Nadia

Nadia continued.

> *Just the fact that* ***there are [Māori] people who value the animal differently****, so that affects their reason for using 1080, whether they support it or not because* ***they just [have a] different perspective on land and just the environment***. Nadia

Nadia explained that her views were culturally based, and she saw the issue from an ethical perspective which reflects her values. From Nadia's cultural perspective, she saw the use of 1080 as inhumane.

> *Culture is something that I can relate to because it's like strong and my life and so it's natural for me to write about...**I talked about how 1080 can be seen as an inhumane way of pest control.*** Nadia

Another aspect of the students' expression of values is in their reference to the attachment of Māori to land. This was seen by Lavinia as closely related to identity through a sense of belonging when she provided this reasoning for her support of 1080. For example.

> ***Māori do value their land a lot. They belong somewhere, they are almost attached to their land.*** Lavinia

The value of all living creatures featured in Dee's assertion that possums were not the pests that they had been labelled as but deserved to be valued as living creatures in their own right and treated respectfully.

> ***Possums deserve respect as much as any other animal****...This is the reason I am AGAINST as **animals should be treated equally because they have a life just the same as humans.*** Dee

For Manu, his values showed in his strong belief in the unfairness of targeting the possum for eradication because of their damage of the environment, yet the same could not be said of humans, a dominant species, who have been responsible for deforestation and extinction of living things on a scale far greater than the damage caused by the possum.

> *Humans have been involved in mass deforestation and animal extinction across the history of man. **So, why kill possums when we don't kill humans for the same reason.*** Manu

Manu states that the killing of possums through programmes such as 1080 drops is a response disproportionate to what he sees as more severe harm and destruction on a far greater scale caused by humans, who seemingly go unpunished. From Manu's values perspective, this is very unfair to the possum regardless of the destruction it causes to the natural environment.

Finally, reputational value was an important consideration for Spec whose support for the use of 1080 was founded upon the need to restore the reputation of Aotearoa New Zealand as an environmentally friendly country.

> *I believe that the use of 1080* ***will enable Aotearoa to re-establish itself as the environmentally friendly country*** *that it is known to be.* Spec

The values discussed above lead on to the second major sub-concept of tikanga which is, a manifestation of these values positions and seen in customary practices, beliefs, rituals and protocols.

Tikanga as customary practices, beliefs, rituals and protocols

Fourteen student responses referred to customary Māori tikanga practices to either support or oppose their view of 1080 use. Four student responses referred to customary practices to support their view. Despite her overall support for the use of 1080, Nadia recognised that Māori have a traditional belief system that 1080 could in some way run counter to.

> *Culturally, the use of 1080 may* ***contradict traditional Māori beliefs.*** Nadia

Sam, who was in overall support of the use of 1080, took this idea still further by referring to an article she had located in her research.

> *…the landowners around the area were informed, however the iwi owning the land weren't….****and that it may have negative impacts on tikanga (traditions) and mātauranga Māori (Māori understanding and knowledge)****.* Sam

Sam showed how the use of 1080 would negatively affect two aspects of tikanga Māori; firstly, traditions and secondly as Māori understanding and knowledge within mātauranga Māori.

Several responses referred to the rituals and protocols associated with tikanga Māori and how through these, human behaviour towards the physical environment is regulated. For example, the following analysis provides a strong illustration of the importance of these behaviours. Chloe supported her position on 1080 through her understanding of the importance of respecting the sanctity of the natural environment and showing this respect through appropriate respectful, culturally determined, behaviour.

> *It is believed that* ***Māori own some parts of the land and those parts are sacred*** *and* ***should be treated with a certain demeanour.*** Chloe

She exemplified this demeanour by also stating how, as a matter of pride under Māori tikanga, the land was to be treated respectfully.

> ***Māori really take pride in their land*** *and …****treat it with respect.*** Chloe

Discussion

For tikanga, the terms used by the students were non-specific for example referring to 'customs' was common amongst those who referred to Māori customary practices and protocols. Student understanding of the concept of tikanga centred upon the traditional Māori belief structure and how the use of 1080 would defile/negatively impact/contradict these cultural beliefs. This was regardless of the overall position of the student toward 1080 use. Whether supporting or opposing 1080, student responses acknowledged the negative impact the use of 1080 would have on Māori customary beliefs.

Students recognised that an aspect of tikanga – specifically ritenga (which encompasses the regulatory rituals and expected behaviours towards the natural environment) was described generally as ways of behaving with a firm belief that within customary practices were embedded particular demeanours or ways of treating the environment respectfully – without any specific actions mentioned.

Students also saw that there was a values position under tikanga which needed to be considered in an environmental context. This aspect was a common unifying concept as students understood how values influenced behaviour. For some, they clearly understood that the use of 1080 would run counter to these values – more often in a disruptive sense – that could ultimately lead to conflict with local Māori.

The value placed on the pest animal lay at the heart of this. Students recognised and gave priority to their belief that the possum as a living creature was to be valued ahead of its status as a pest organism. It was valued as having life itself and it along with all other living creatures deserved valuing. This ethical/values laden perspective was further broadened by those students who saw the effects of 1080 on the animal and regarded the use of 1080 as an inhumane method which caused the unnecessary suffering of the organism. A strong degree of empathy was expressed by students who argued from this perspective.

6.7 The mātauranga Māori concept of manaakitanga

Students express their knowledge of manaakitanga

Three distinct sub-concepts were identified that linked to the literature background explaining the concept of manaakitanga.

a. Acts of caring by showing respect and kindness
b. Holistic nurturing of relationships through reciprocation, by acknowledging worth and ensuring safety
c. Demonstrating mana-enhancing behaviours

An analysis of the data revealed the extent to which students referenced these sub-concepts whenever they justified their position towards 1080 use whether supportive or opposed. This is shown in Table 6.6 and their use of these specific sub-concepts to support their position will be discussed in turn.

Table 6.6
The Mātauranga Māori Concept of Manaakitanga

Sub-concepts of manaakitanga	**Supporting 1080**	**Opposing 1080**	**Total**
Acts of caring by showing respect and kindness	2	2	4
Holistic nurturing of relationships through reciprocation, by acknowledging worth and ensuring safety	4	0	4
Demonstrating mana-enhancing behaviours	1	1	2
Total	7	3	10

Manaakitanga as acts of caring by showing respect and kindness

Acts of caring by showing respect and kindness were mentioned in four responses. Central to Dee's opposition to the use of 1080 was, in terms of the mātauranga Māori concept of manaakitanga, out of a duty of care she believed should be accorded all animals including the possum. She went further

> *Possums **deserve respect** as much as any other animal, even though it is New Zealand's foremost vertebrate pest. This is the reason I am **AGAINST as animals should be treated equally** because **they have a life just the same as humans.*** Dee

Despite Dee's acknowledgement that the possum is Aotearoa New Zealand's foremost vertebrate pest, which for most would be sufficient grounds for supporting the use of 1080, she maintained her opposition to the use of 1080 by stating her belief that all animals (including humans) should be respected on the basis that all have a life to live which reflects one of the central tenets of the mātauranga Māori concept of manaakitanga.

Manaakitanga as the holistic nurturing of relationships through reciprocation, by acknowledging worth and ensuring safety

The importance of nurturing relationships and preventing harm was further illustrated by four statements which referred to specific examples where the actions described by the students

demonstrated an acknowledgement of the worthiness of the recipient or described behaviours that ensured the safety of those involved.

Manu, who was a supporter of 1080, perceived a double standard at work when he compared humans with possums when he asked rhetorically why we (as humans) who kill possums in response to their environmentally destructive behaviour, escape a similar sanction for the environmental destruction we as a species cause on a much larger and more obvious scale.

> *Humans have been involved in mass deforestation and animal extinction across the history of man. So,* ***why kill possums when we don't kill humans for the same reason?*** Manu

From a holistic manaakitanga perspective, Manu's concern at this apparent double standard showed the extent of his belief in the worth of the possum. His call for the fair treatment of humans and possums alike demonstrated an act of care for all involved. The tension in his expressed position demonstrated his ability to empathise with the possum on the grounds that while it may have been responsible for damage to the environment for which it was paying a high price for, humans, who were equally as destructive in his view, were able to escape similarly fatal consequences.

The sub-concept of protection and safety was reflected in Nadia's concern for the kiore (Polynesian rat). On the one hand she acknowledged that for Māori the kiore is sacred and requires caring for and protecting, on the other she understood that as a rodent, most non-Māori would regard the kiore as a pest.

> *Because like for the Kiore rat like there is a tribe that holds it significant because it has roots to their early ancestors. So,* ***it's kind of like a cultural thing for them.*** *So,* ***it's sacred and really important that it's not harmed and stuff.*** *But for other cultures it might not be a big deal for them because it's a pest to them. So, they want to get rid of it while the Māori don't want to get rid of it.* Nadia

This illustrates that in this context, the values held by those people who protect the possum could potentially clash with the values of those who see the possum as a pest and call for its eradication.

Demonstrating mana-enhancing behaviours

The mana-enhancing element of manaakitanga was illustrated in two statements, one each from opposing positions towards 1080 use. For example, Dee who presented arguments both in support of and opposed to the use of 1080, illustrated how mana-enhancing behaviours

could feature in both contrasting positions. Firstly, Dee called for the fair and equal treatment of all animals including the possum.

> ***Possums deserve respect as much as any other animal****…as animals should* ***be treated equally*** *because they have a life just the same as humans.* Dee

This statement describes behaviours which respect and acknowledge the worthiness of all life reflects the manaakitanga concept in action. Secondly, Dee expressed support for the use of 1080 following her visit to the pest-free island of Tiritiri Matangi in the Hauraki Gulf.

> *Also, when I went to Tiritiri Matanga (sic) island and Murphy's Bush I realised that the environment of the trees and forests were beautiful and* ***cleansed of any pests,*** *and the birds were safe.* Dee

In this statement Dee expressed her support for the use of 1080 by describing the beauty of the trees and forests and connected the safety of the birdlife there to the absence of pest animals. Her reference to cleansing activities to remove pests described what could be termed mana-enhancing behaviours to acknowledge worth and ensure the safety of the avian residents of the island.

Discussion

For manaakitanga, student expression of this concept centred on the two main aspects of respect and kindness. The important relational element of manaakitanga was demonstrated by the acknowledgement of worthiness through acts of kindness. Students recognised that these acts were also mana-enhancing to the individuals involved and to the plants and animals who benefitted from these actions.

6.8 The mātauranga Māori concept of kaitiakitanga

Students express their knowledge of kaitiakitanga

Three distinct sub-concepts were identified that linked to the literature background explaining the concept of kaitiakitanga.

a. Active guardianship of the environment in accordance with tikanga
b. Protection of the natural environment and its taonga (treasures)
c. There are human, non-human or spiritual kaitiaki

An analysis of the data revealed the extent to which students referenced these sub-concepts whenever they justified their position towards 1080 use whether supportive or opposed. This

is shown in Table 6.7 and their use of these specific sub-concepts to support their position will be discussed in turn.

Table 6.7
The Mātauranga Māori Concept of Kaitiakitanga

Sub-concepts of kaitiakitanga	Supporting 1080	Opposing 1080	Total
Active guardianship of the environment in accordance with tikanga	**6**	**3**	**9**
Protection of the natural environment and its taonga	**5**	**0**	**5**
There are human, non-human or spiritual kaitiaki	**2**	**2**	**4**
Total	**13**	**5**	**18**

Kaitiakitanga as active guardianship of the environment in accordance with tikanga

Two responses demonstrated student understanding of the concept of kaitiakitanga as the active guardianship of the environment in accordance with tikanga practices. For example, Dee recognised the contrasting environments of Murphy's Bush (a regenerating stand of native flora within urban South Auckland) and the pest-free environment of Tiritiri Matangi in the Hauraki Gulf when she described the latter as 'cleansed of pests'. This indicated Dee's awareness of the effects of the active removal of pests by those responsible acting as kaitiaki (guardians) of the island, and how different the two contrasting environments were as a consequence of the dedicated efforts by the kaitiaki of the island to eliminate pest organisms, replenish the islands native flora and fauna and to maintain these robust regenerating populations free from the threats of pest organisms.

> *Also, when I went to Tiritiri Matanga (sic) island and Murphy's Bush I realised that the environment of the trees and forests were beautiful and* ***cleansed of any pests,*** *because of the use of 1080 being used to control the possums.* Dee

This statement appeared in Dee's justification for her support of 1080 despite also giving reasons for her opposition to its use in pest control. Just as she had seen contrasts in the environments of Murphy's Bush and Tiritiri Matangi Island, so too were her contrasting positions towards 1080 use. It appears that following her visit to Tiritiri Matangi, Dee formed a favourable position towards the use of 1080 after seeing the positive effects of the regeneration of the flora and fauna on the island. This was sufficient evidence for Dee to favour the eradication of pests using 1080.

In contrast, Dee's opposition to 1080 was based on her understanding of how the use of 1080 would be 'significant' as it related to her understanding and acceptance of Māori opposition to the use of 1080. For Dee, she understood Māori connection to the natural world and the

active nature of the kaitiaki role which she showed by referring to the dutiful nurturing of the mauri (life force) of all living things.

> *Māori have a strong sense of cultural connection to the natural world and feel part of it. This is mainly due to generating a sense of duty* ***to nurture the mauri (essential life force)*** *of all things in the natural world and the human communities that depend on it.* Dee

From this, Dee understood how the use of 1080 would run contrary to the kaitiaki role and negatively impact the mauri of life in the natural world. This was the basis of her opposition to 1080.

While for Sina, her support for the use of 1080 in the Hunua Ranges relied on whether or not the Auckland Council followed the appropriate customary practice (tikanga) when following the kaitiakitanga process. Sina needed assurance that the Auckland Council would follow customary practice and consult the local guardians (kaitiaki) prior to the 1080 operation. Her main concern was that the Auckland Council appeared not to have consulted the Ngai Tai ki Tāmaki Trust who, as kaitiaki of the area, had customary rights under tikanga to be consulted and consent to the proposal to drop 1080 upon their customary land.

> *Yet when choosing my position on the 1080 decision, the only concern I personally had was the council decision to only consult the Ngai Tai ki Tāmaki Trust after the decision to be made thus* ***not allowing the Māori to exercise their rights of being kaitiakitanga of the Hunua Ranges.*** Sina

Sina maintained her support of the proposal after she learned that the Auckland Council was actively consulting the Trust representatives (who are the local kaitiaki) in accordance with their obligations under mātauranga Māori tikanga.

> *However,* ***as the council is currently consulting the local iwis of the region****, my opinion was shifted towards agreement of the use of 1080 as the Māori were a part of the planning phases of the 1080 operation.* Sina

Both of Sina's comments illustrate her understanding of tikanga, the active nature of the kaitiaki role and how necessary it is for local authorities to seek out and purposefully engage with the kaitiaki of the area in order for culturally appropriate protocols to be adhered to as part of the process. For her, the critical factor in her final decision to support the proposed use of 1080 in the Hunua catchment area was that a process of engagement and consultation with kaitiaki was underway.

Kaitiakitanga as the active protection of the natural environment and its taonga

Kaitiakitanga as the active protection of the natural environment and its treasured living and non-living contents (taonga) was recognised by six responses from students who saw the tangata whenua as the protectors of the forests of Aotearoa-New Zealand. For example, 1080 supporter Manu acknowledged that the tangata whenua (local Māori) carried out a protective role with respect to the forests.

> *New Zealand forests were **protected** by **tangata whenua.*** Manu

Manu further illustrated that he saw kaitiakitanga in the broad context of protecting our native wildlife as well as introduced species such as the possum, which he believed should be treasured along with our native species.

> ***The cultural aspect of kaitiakitanga supports this as the possum should be treasured as part of our protected wildlife*** *but maintaining small pockets of possums instead of eradication.* Manu

This view appears to contradict Manu's support for the use of 1080 to eradicate the possum past. However, from a cultural perspective it demonstrates that Manu sees kaitiakitanga as non-selective when it comes to a focus on all living things which should be treated with the same level of respect. This relates back to the core mātauranga Māori value of whanaungatanga (kinship), the ultimate source of Māori collective responsibility, from which there is an obligation to exercise a duty of care passed down from ancestors to descendants to nurture and protect places, natural resources and taonga (treasures from the natural world), as described by Muru-Lanning (2016). The role of kaitiaki emerges from these kinship obligations.

Chloe's support of 1080 firstly acknowledged the pest problem and then saw 1080 as important for the saving of our native birds and protecting our unique [native] species – a role to be shared.

> *I am allured to condoning the use of 1080. The problem of these pests is only going to grow and grow and is only getting worse. So, methods like aerially dropping 1080 have to be put into action in order **to save our native birds and plants.** New Zealand lacks native mammals with the exception of the bat, **so protecting our unique species** needs to become our responsibility.* Chloe

Finally, Spec took Chloe's rationale still further. For him to support the 1080 drop, it was a matter of protecting the land from the possum pest, and that 1080 was an aid to the kaitiaki in their fight against the possum invader.

> *So **when we look at kaitiakitanga and the people having to protect the land from possums.** This made me realise that 1080 was actually assisting these people and fighting back against the possums.* Spec

Therefore, both Chloe and Spec saw 1080 supporting the drive to eradicate Aotearoa New Zealand of the possum pest either directly or as an agent in the fight to save our native birds and plants.

There are human, non-human or spiritual kaitiaki

Since kaitiakitanga is the active protection of the natural environment and its treasured living and non-living contents (taonga), who or what performs the role are known to Māori as the kaitiaki (guardians). According to mātauranga Māori scholars, the role of kaitiaki is not exclusively human (Patterson, 1992). Kaitiaki can also be non-human (in the case of the Polynesian rat known to Māori as kiore) or spiritual protectors known to Māori as patupaiarehe (guardian spirits).

1080 opponent Rose demonstrated that kaitiaki could also be non-human. She used the example of the kiore (Polynesian rat) which is regarded by a particular iwi (Māori tribe) from the central North Island as a guardian of the people living in that locality.

> ***Māori believe that the kiore and other species, they regard them as their guardians.*** Rose

Rose understood that as Māori had a duty of care towards their kaitiaki as part of their obligations under whanaungatanga, the death of the kiore from 1080 poisoning is for her unacceptable. The kiore, as a tribal guardian, has an exalted place in the eyes of the tribe and is afforded customary protection under this concept. It is therefore understandable that Rose would oppose the use of 1080 on the grounds that to kill the kiore would violate their sanctity of their position as kaitiaki.

> *So, you know that **their kiore or their guardians** to die like literally, [Māori] wouldn't like it because they would have to fight for their guardians.* Rose

Local Māori opposition to 1080 would therefore be predicated on their opposition to what they would see as the killing of their kaitiaki – unacceptable from a Māori worldview.

Discussion

Finally, for kaitiakitanga, students used numerous examples of where people were the active guardians of the environment and they discussed the outcomes of these actions. The protective aspect of kaitiakitanga came through when students expressed their views on the importance

of considering the possum pest as an environmental taonga (treasure). Further exemplified by the students was their understanding that kaitiakitanga is a role carried out by kaitiaki and that they can be either human, non-human or spiritual.

6.9 Conclusion

This chapter presented the results of the analysis of student use of mātauranga Māori knowledge for each of the seven core concepts relevant to the research question: How do students use mātauranga Māori when justifying their position towards the use of 1080 to control animal pests in Aotearoa New Zealand? From the evidence presented and discussed, it may be concluded that the participants drew concepts which reflected their depth of understanding of the cultural significance of these concepts, used appropriately in the 1080 context by some such as Sam, Nadia, Lavinia and Chloe to support their position in favour of 1080 use and by Rose and Dee to support their opposition to 1080 use. Participants' integration of biological science knowledge and mātauranga Māori knowledge will be analysed and presented in the next chapter.

Chapter 7: Integrating Biological Knowledge and Mātauranga Māori

7.1 Introduction

This chapter presents an interpretive situated analysis of student-participant data using indigenous scholar Martin Nakata's theoretical concepts of the 'cultural interface' (Nakata, 2007 p. 9) and the 'locale of the learner' (Nakata, 2007 p. 10). This analysis responds to research question 3, which asks:

> How do participants integrate mātauranga Māori concepts <u>and</u> biological science concepts as they develop and present a justified response to the socio-scientific issue?

Following this introduction, Section 7.2 provides a description of Martin Nakata's theoretical concept of the cultural interface and a critique of his interpretation of the 'locale of the learner'. In Section 7.3, the theoretical concept of student agency (Tang & Yang, 2017) is discussed and where the essential features of this concept are incorporated into the 'locale of the learner' to create an expanded description for use as an analysis framework. Section 7.4 proposes and describes three knowledge-world interfaces of the framework that will be used to interpret and analyse student-participant data. In Section 7.5, the 10 participants designated as occupying the cultural interface are identified ahead of a description of how the findings will be presented and discussed for each of them in the subsequent Sections 7.6 – 7.15. The chapter concludes in Section 7.16 with a summary of the major findings from the interpretive analysis and description of the participant students' data.

Using knowledge concepts from both knowledge worlds

Table 7.1 presents the data for the 10 participants and shows their ethnicity and the total number of concepts from both knowledge worlds each participant used to either support or oppose 1080 use. Total numbers of concept statements ranged from 5 used by Sina and up to 36 used by Chloe. The participants' data from Table 7.1 is displayed as well in Figure 7.1 and establishes that for these 10 participants a shared knowledge space exists.

Table 7.1
Participants who used knowledge concepts from both knowledge worlds

Name	Ethnicity	Biological Science Concepts		Total	Mātauranga Māori Concepts		Total
Manu	Māori	6	3	9	12	-	12
Spec	Sāmoan	6	-	6	2	-	2
Rose	Khmer	10	-	10	0	12	12
Dee	Māori	-	3	3	3	20	20
Sam	Māori	10	-	10	4	-	4
Nadia	Sāmoan	20	-	20	15	-	15
Anders	Māori	8	-	8	2	-	2
Sina	Māori/Sāmoan	4	-	4	1	-	1
Lavinia	Tongan	2	-	2	18	-	18
Chloe	Māori	16	-	16	20	-	20

KEY: Green numerals are statements in support of 1080
Red numerals are statements opposed to 1080

As displayed in Figure 7.1, participants drew concepts from both knowledge worlds.

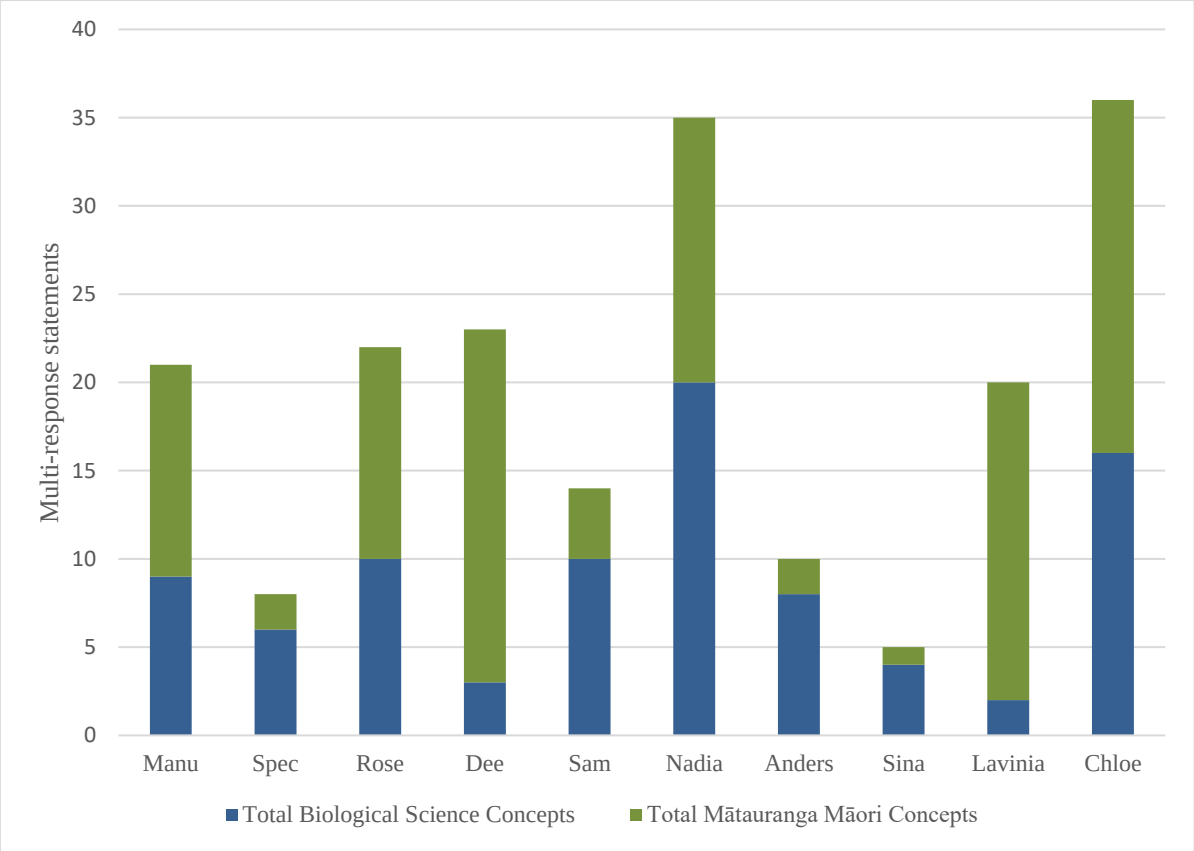


Figure 7.1. The use of biological science concepts by the 10 participants who occupied the knowledge-world interface.

7.2 The cultural interface and the 'locale of the learner'

This section describes the theoretical concepts of the 'cultural interface' (Nakata, 2007, p. 9) and the 'locale of the learner' (Nakata, 2007, p. 10). According to Tang and Yang (2017), the multi-dimensional space of the cultural interface brings into analytical focus actively resourceful students who draw information from both knowledge worlds. For this research, this space would occur at the confluence of mātauranga Māori and biological science knowledge.

Aikenhead and Ogawa (2007) view these two knowledge worlds as epistemologically and ontologically disparate and argue that a dichotomous relationship exists between indigenous and Western ways of knowing on a continuum described as the "colloquial dyad" (p. 539). Sillitoe (2017) would counter this view by stating that "we do not have two tenuously connected knowledge traditions separated by a cultural-epistemological gulf" (Sillitoe, 2017, p. 4); but rather, we have both cultural and scientific knowledge in a constant process of change, each with a 'pervasive variability' within their respective knowledge worlds (Sillitoe, 2017, p. 4).

If applying this stance to the Aotearoa New Zealand context of this research, Sillitoe (2017) would likely see the two knowledge worlds of biological science and mātauranga Māori as a form of a many-sided hybrid with the space in between these worlds described by him as a dynamic 'networked spectrum of relations' (2017, p. 4). Whereas Mercier (2007, p.22) describes the experiential, interstitial third space of the cultural interface as "a neutral space of free-flowing interaction between science and indigenous knowledge worlds." Such a dynamic relational network as this at the cultural interface affords the opportunity, according to Durie (2005), for individuals to combine both worlds with the likelihood that the insights of one could enhance the other and where the energy of the two systems could combine to create new knowledge and innovation.

In this multi-layered, multi-dimensional space of dynamic relations, where different systems of thought and different knowledge systems converge, the cultural interface is described as a positive metaphor by Kahu and Nelson (2018) as at this convergence zone, the emphasis of this spatial metaphor is upon the importance of actively drawing on both ways of being rather than focusing, from a deficit view, on any lack of alignment between cultures or positioning the student as in deficit. These descriptions open an opportunity to use Martin Nakata's theoretical concept of the cultural interface (2007), to analyse the integration of knowledge from these two worlds.

To develop this metaphor, in schools and classrooms, students, teachers and communities are brought together in these conceptual spaces where they can draw on a range of diverse understandings and experiences at several cultural interfaces. According to Kearney et al. (2014, p. 340), schools are where new understandings and experiences are conditioned both at and by the interface, and where lived experiences become an opening for inquiry.

Therefore, Nakata's cultural interface theory provides a useful theoretical framework for thinking about how we might engage and relate these potentially conflicting, combining or co-existing knowledge worlds, at the interface where these understandings, experiences and knowledge domains intersect (Nakata, 2007; Kearney et al., 2014). Acknowledging these descriptive accounts from the literature, this researcher proposes that the cultural interface provides a framework that can be adapted and used for a situated analysis of positions, contexts and experiences (Kearney et al., 2014, p. 341) to examine and interpret how a group of senior high school students integrate biological science and mātauranga Māori knowledge in the context of their research assignment.

Central to the focus that drives this research, Nakata (2007) introduces a second theoretical concept of a space within the cultural interface he calls the 'locale of the learner', which he describes as:

- Where and how individuals <u>position</u> themselves and are positioned by others, and, of relevance to this research,
- How they <u>experience</u> and <u>navigate</u> different knowledge systems (Nakata, 2007).

Critically, Nakata's premise that the 'locale of the learner' is comprised of three elements he refers to as 'position', experience' and 'navigation', invites a closer inspection from which a more detailed and functional description could be derived. Before attempting to do this, we must take in to consideration in more detail how Martin Nakata theorised the formal learning space of the cultural interface.

According to Nakata (2002), the cultural interface is "the place where we live and learn, and relationships develop, the place that conditions our lives and shapes our futures, where we are <u>active agents</u> in our own lives and where we make decisions – our life world" (p. 285). The reference to students as 'active agents' at the cultural interface opens the possibility to foreground the concept of student agency to firstly, deepen our understanding of the 'locale of the learner' and secondly, to interpret student-participant data.

7.3 Agency as a theoretical analysis framework

The reference to individuals at the interface described by Nakata as 'active agents' provides an opportunity for this research to incorporate the concept of student agency into the analysis framework. This is possible because within the 'locale of the learner' – in the space between these two knowledge worlds – active, agentic processes of discovering, negotiating, decision-making and experiencing occur (Kahu & Nelson, 2018). Inside the relational spaces that learners occupy at the cultural interface, students can act and respond to situations with agency by drawing on several modes of understanding and experiences (Kearney et al., 2014, p. 341).

It is proposed in this research that the cultural interface describes where the 10 identified students demonstrated their agency as they actively drew on 'both ways of being' and, in response to the information they were gathering, made decisions as they negotiated with the information across the space in between the knowledge worlds of biological science and mātauranga Māori. It is further proposed that the concepts of the cultural interface and the 'locale of the learner' (Nakata, 2007) give the opportunity for this researcher to, 1) create a functional theoretical framework when describing their agentic processes that, 2) can be used to analyse student-participant data.

Therefore, the triadic epistemic agency framework shown in Figure 7.2 represents how students respond to and deal with the knowledge available to them. Epistemic agency is the way in which students locate themselves by using a combination of one or more of the following three processes: positioning, navigating and experiencing the knowledge worlds.

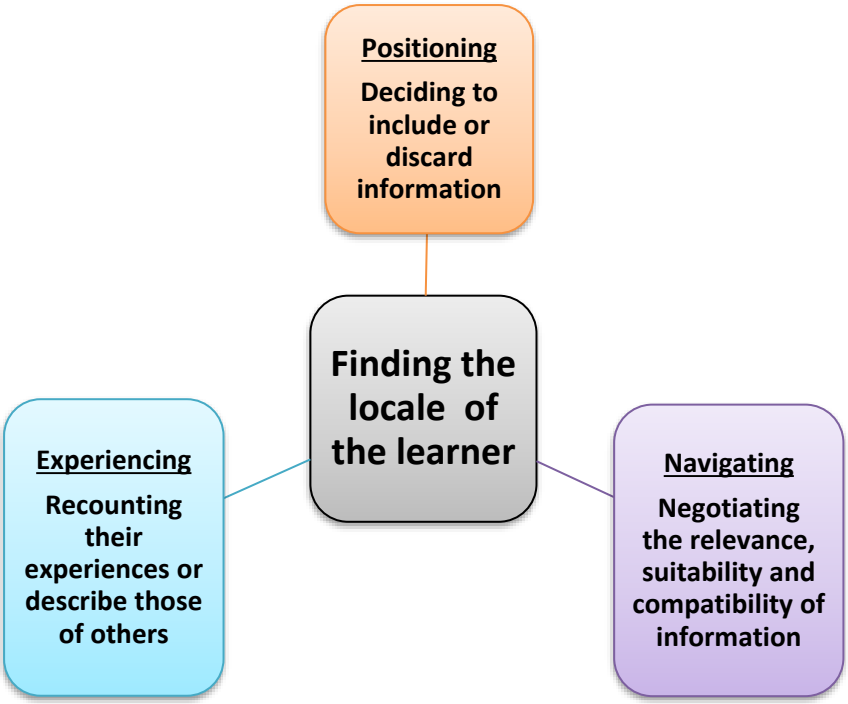


Figure 7.2. The Triadic Epistemic Agency Framework. An interpretation of Nakata's (2007) concept of the 'locale of the learner', incorporating the three processes of epistemic student agency.

These expanded descriptions, presented in Figure 7.2, have been interpreted and defined as agentic processes with respect to knowledge use in the following ways. For example:

- **Positioning.** This process occurs when students decide to either include or discard information as they build support for their view towards 1080 use.
- **Navigating.** This process occurs whenever students negotiate and critique the relevance, suitability and compatibility of the information they drew from the knowledge worlds as they build support for their view towards 1080 use.
- **Experiencing.** This process occurs when students recount their experiences or describe the experiences of others to support their view towards 1080 use.

These definitions will enable an analysis of data to better understand how students at the cultural interface integrate this knowledge as they justify their view towards the use of 1080. Consequently, it represents the mechanism in which the students can locate their locale at the cultural interface. Figure 7.3 displays the three theoretical knowledge-world interfaces which are explained in detail in Section 7.4. The presentation of the data is described in Section 7.5 and the 10 interface inhabitants are identified and displayed in Table 7.2.

7.4 Representing the knowledge-world interfaces

The proposed framework also consists of three distinctive interfaces where the two knowledge worlds converge. These are characterised and elaborated on in Figure 7.3. The features common to all three illustrations are:

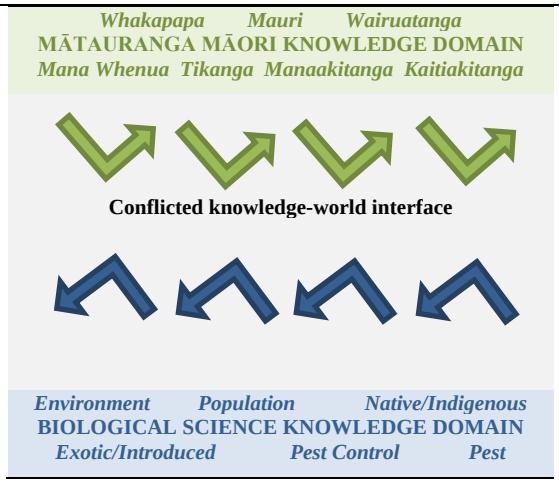
- The **biological knowledge domain** and the **six named biological concepts** that were analysed and discussed in Chapter 5, appear in **blue**.
- The **mātauranga Māori knowledge domain** and the **seven named cultural concepts** that were analysed and discussed in Chapter 6, appear in **green**.
- The arrows representing the knowledge drawn from each of the domains are orientated in such a way as to illustrate the outcome of the distinctive epistemic agency demonstrated by the participants at each of the three knowledge-world interfaces. Unique to each interface is the orientation, shape and proximity to each other of the coloured arrows at the convergence zone (see Figure 7.3). Shown as:

a. 

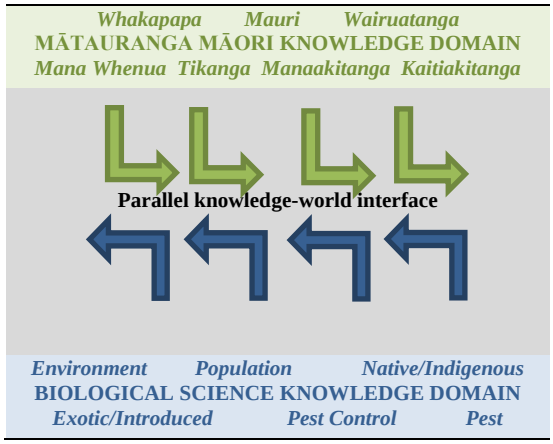
b. 

c. 

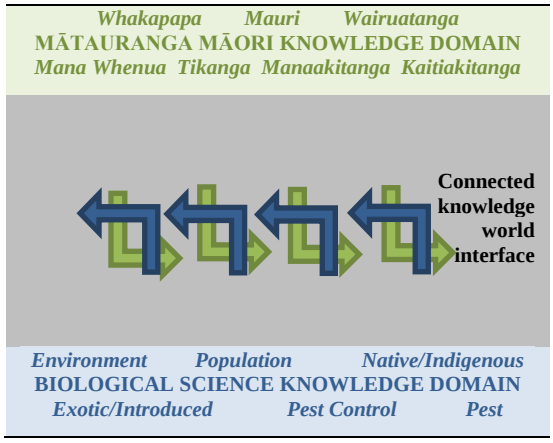
- The ‘space in between’ the two knowledge domains where the blue and green arrows appear is shaded grey.



(a) Conflicted knowledge-world interface. At the conflicted knowledge-world interface, the coloured arrows, which represent the conceptual knowledge being drawn from both knowledge worlds are orientated **back towards their origins**.



(b) Parallel knowledge-world interface. At the co-existent, parallel knowledge-world interface, the coloured arrows which represent the conceptual knowledge being drawn from both knowledge worlds, are orientated in **parallel.**



(c) Connected knowledge-world interface. At the connected knowledge-world interface, the coloured arrows which represent the conceptual knowledge being drawn from both knowledge worlds, are orientated to **connect** and **interweave.**

Figure 7.3. Three knowledge-world interfaces where the two knowledge worlds converge.

7.5 Data presentation from the cultural interface

First, this section identifies the 10 students who drew information from both knowledge domains, thus qualifying them as inhabitants of the cultural interface. The 10 interface inhabitants are: Manu, Spec, Rose, and Dee from 'High School' and Sam, Nadia, Anders, Sina, Lavinia and Chloe from 'Secondary School'. Table 7.2 presents the multi-response data extracted from Appendix N for these participants.

Secondly, this section describes how the findings will be presented and discussed in subsequent sections. Each student will have their written and transcribed evidence presented and analysed. Quotes and phrases from the mātauranga Māori and biological science knowledge worlds used in the analysis to exemplify students' justifications, are highlighted using the same colour scheme as earlier described for Figure 7.3, which is.

- Information from the mātauranga Māori knowledge domain will appear as ***bold green*** with significant words or phrases ***underlined.***
- Likewise, information from the biological science knowledge domain will appear as ***bold blue*** with significant words or phrases ***underlined.***

Each student will also have their individual interface diagram presented and discussed using the format described previously in Section 7.4 and illustrated in Figure 7.3.

In addition, selected quotes from the text will be added to their individual interface diagrams to indicate how a particular concept was used by the student. For example.

- A biological concept will appear inside the interface diagram as ***bold blue*** and connect to a selected quote and page reference inside a speech bubble e.g. ***Population***

  *"Maintain … the overall **population** of possums, to a sustainable amount." **p. 11***

- A cultural concept will appear inside the interface diagram as ***bold green*** and connect to a selected quote and page reference inside a speech bubble e.g. ***Kaitiakitanga***

  *"New Zealand forests were **protected by tangata whenua**." **p.15***

Table 7.2
Analysis grid for the 10 student inhabitants of the cultural interface.

	BIOLOGICAL SCIENCE CONCEPTS	HS 04	HS 12	HS 19	HS 20	SS 27	SS 28	SS 32	SS 34	SS 37	SS 39
	Pseudonym	Manu	Spec	Rose	Dee	Sam	Nadia	Anders	Sina	Lavinia	Chloe
1	**ENVIRONMENT**										
a	The environment as a non-specific entity		1			1	2				2
b	The environment is separate from living organisms			1						1	1
c	The environment is comprised of living, named organisms			1			1				1
d	The environment comprises living (biotic) and non-living (abiotic) factors										
2	**POPULATION**										
a	A group of named organisms living in an area	1		1		1	1	1			
b	Population numbers can change	2	3			2	2	2			
c	A change in the numbers of pests influences the numbers of the native population	1		1		1	1	1			
3	**NATIVE/INDIGENOUS**										
a	Native species are named	1 + 1		1			2				
b	Native species belong to New Zealand	1		1		1	3	1			3
c	Native species are targeted by introduced species			1		1	3	1			1
4	**EXOTIC/INTRODUCED**										
a	Introduced rats are mammalian pests										1
b	Introduced rats negatively affect native populations										
c	Humans brought the pest in to the habitat	1									
d	Introduced pests can be predators										
5	**PEST**										
a	The pest is named as an animal				1		3		1		1
b	The pest animal is identified as a mammal					1					1
c	The pest is an animal introduced from elsewhere; by humans										1
d	Pests are harmful to a named species				1		1				
e	Humans are also pests	1									
6	**PEST CONTROL**										
a	A target species can be targeted					1	1	1	1	1	1
b	1080 is a poison that can kill			2	1			1			1
c	1080 can control pest population numbers		1						1		
d	Alternative methods of pest control		1	1		1			1		
	MĀTAURANGA MĀORI CONCEPTS	**HS 04**	**HS 12**	**HS 19**	**HS 20**	**SS 27**	**SS 28**	**SS 32**	**SS 34**	**SS 37**	**SS 39**
		Manu	Spec	Rose	Dee	Sam	Nadia	Anders	Sina	Lavinia	Chloe
1	**WHAKAPAPA**										
a	Kinship of all living things descended from the gods	2		5	5		5			4	2
b	Unity among humans, living and non-living elements of the natural world (eg. land)			1	3		1			2	
c	The source of knowledge inherited from ancestors			1			1			1	
2	**MAURI**										
a	Force that links the physical to the spiritual world			1	1					1	
b	Source of respect towards all things				1						2
c	Vitality/fruitfulness of the natural environment				2					1	1
d	Enabler for everything to live in accordance with the conditions and limits of its existence				1						2
3	**WAIRUATANGA**										
a	Material world is subordinate to spiritual world			1							
b	A spiritual connection to land								1	1	
c	Karakia/incantations to ensure spiritual safety										1
4	**MANA WHENUA**										
a	Mana – the power of the gods, ancestors, land and the individual			1						1	
b	Mana whenua - authority/control over the management of natural resources					1		2		2	1
5	**TIKANGA**										
a	An expression of values	1			1		4		1	2	1
b	Customary practices, beliefs, rituals and protocols	2		1	1	3	2			1	6
6	**MANAAKITANGA**										
a	Acts of caring by showing respect and kindness	1			2					1	
b	Holistic nurturing of relationships through reciprocation, by acknowledging worth and ensuring safety	1			1		1			1	
c	Demonstrating mana-enhancing behaviours				1 + 1						
7	**KAITIAKITANGA**										
a	Active guardianship of the environment in accordance with tikanga	2	1	1	2		1		1		1
b	Protection of the natural environment and its taonga	2	1								2
c	There are human, non-human or spiritual kaitiaki	1		1	1						1
	BIOLOGICAL SCIENCE CONCEPTS TOTAL	9	6	10	3	10	20	8	4	2	16
	MĀTAURANGA MĀORI CONCEPTS TOTAL	12	2	12	23	4	15	2	3	18	20
	KEY										

1	Represents a single statement supporting 1080 use
1	Represents a single statement opposing 1080 use
2	Represents two statements supporting 1080 use
2	Represents two statements opposing 1080 use
1 + 1	Represents two statements (1 in support & 1 opposed) to 1080 use

The analysis will also comprise an interpretive discussion of the ways each student demonstrated their agency by using the one or more of the three processes presented in Figure 7.2. Quotes from each student will appear highlighted in a colour to indicate which agentic process they used as they actively engaged with the information as follows.

- **Positioning.** This took place when students made **decisions** as they **chose** to **include** or **discard** the information.
    - Quotes are ***dark orange*** with significant words or phrases ***underlined***.
- **Navigating.** This took place when students **negotiated** and **critiqued** the **relevance, suitability** and **compatibility** of the information.
    - Quotes are ***dark purple*** with significant words or phrases ***underlined***.
- **Experiencing.** This took place when students **recounted their experiences** or **described those of others.**
    - Quotes are ***teal blue*** with significant words or phrases ***underlined***.

Using this format, the next three sections (7.6 – 7.8) present participant data and an interpretive analysis of evidence supporting the existence of a specific knowledge-world interface. These sections will provide a detailed examination of a strong example of each interface type. Section 7.6 illustrates the conflicted interface using evidence from Manu. Next, Section 7.7 illustrates the parallel interface using evidence from Rose and Dee. The connected interface will be discussed and illustrated in Section 7.8 using evidence from Nadia, and Chloe. The discussion will highlight the agentic processes used by these participants and where appropriate other examples will be used to show some further extrapolation using evidence from the participants Spec, Sam, Anders and Sina. The evidence presented will be interpreted to show how they experienced the different knowledge systems that characterise their knowledge interfaces.

7.6 The conflicted knowledge-world interface

It is proposed that the conflicted knowledge interface is where the participants' two knowledge-worlds appear to conflict and remain separate (see Figure 7.3a). It is proposed, from the epistemic learner agency displayed by Manu towards the information he gathered and responded to, that he is the sole occupant of a conflicted knowledge-world interface when justifying his view towards 1080.

At this interface, Manu drew upon information from both knowledge worlds but did not connect, combine, overlap or interweave the knowledge. Instead, and despite being aware of concepts from both knowledge worlds, Manu maintained a distance between the two

knowledge systems as he discussed his decision to openly favour the use of concepts from one knowledge world at the expense of the other.

Manu's cultural interface

Analysis of Manu's written assessment and subsequent interview transcript revealed that he drew information from both knowledge domains and supported the use of 1080. Manu made nine statements that covered **four biological concepts.** He also made twelve statements that covered **four mātauranga Māori concepts** (see Table 7.2).

To illustrate, Manu demonstrated his understanding of population biology with his use of 'sustainable' when he proposed in his opening statement a continuation of the 1080 aerial drops to 'revitalise' some of New Zealand's native flora and fauna.

> *I propose that 1080 drops still continue, to **maintain and decrease the overall population of possums, to a sustainable amount,** whereby **TB exposure and defoliation is limited to small pockets** and regions within the country. I personally believe 1080 is the best course of action in **revitalising New Zealand's native forests, birds and tuatara.***

For Manu, it was important to decrease the possum population to a sustainable level which, thereafter could be managed and maintained most likely by other forms of control that he did not specify. In his view, this would limit the widespread devastation caused by the unmanageably large numbers of possums and consequentially give the opportunity for native flora and fauna to revitalise.

The biological knowledge exhibited by Manu was characterised by reference to population dynamics and that there are ways for pest populations to be managed rather than eradicated. An acceptance by Manu that this option was viable reflected his understanding of population biology.

As he navigated along the space between the two knowledge worlds, Manu justified his use of scientific knowledge by expressing an ethical viewpoint as he called for a continuation of the 1080 aerial drop. Consequently, he critiqued his use of biological knowledge with an ethical argument which was compatible with his stance against the complete eradication of the possum population.

> ***Extinction is unethical as the possum was introduced by humans in the 1860s to begin a fur trade.*** *The possum did not relocate or do any more damage than humans had already done, so,* ***what right do we have to exterminate them?***

To justify his view, Manu drew upon these knowledge domains and remained unconvinced of the efficacy of 1080 as he actively critiqued the information available to him. Manu was able to hold a view in favour of 1080 while at the same time holding a view against the complete eradication of the possum population. For him this was possible because to do otherwise would be unethical. Manu believed that humans had no moral right to drive the possum to extinction any more so than for any other creature.

Here, Manu's strong values-based, ethical viewpoint reflected his understanding and use of four cultural concepts to support his stance – whakapapa, tikanga, manaakitanga and kaitiakitanga (see Table 7.2). Manu recognised the significance of a Te Ao Māori perspective when viewing the relationship between humans and the natural world when he referred to the mutual respect shown between both of them. For example.

> ***The mutual respect between [humans] and [the natural world] there is no distinction between them.***

Manu's ability to see them both as 'one and the same' and indistinguishable speaks to his understanding of the human – natural world connection through whakapapa links and the kinship obligations of kaitiaki to care and protect the natural world and its living and non-living elements. This was further reinforced by Manu with the following comment.

> ***The cultural aspect of kaitiakitanga supports this*** *as the possum should be* ***treasured as part of our protected wildlife*** *[by] maintaining small pockets of possums instead of eradication.*

Here, Manu appealed to his understanding of the mātauranga Māori concepts of kaitiakitanga and manaakitanga, which were at the heart of his ethical stance. Manu referred to the possum as 'treasured' which, from a Te Ao Māori cultural perspective, meant that the creature would be regarded as a 'taonga'. This would then require it to be managed and cared for as an integral part of the living ecosystem. Manu also demonstrated the importance of the care and protection of all living creatures as an embodiment of the manaakitanga concept when he called for the possum to be treasured; that is – to be cared for and protected as taonga species.

From Manu's perspective, the environmental damage and degradation caused by human activity, specifically the extinctions of wildlife, placed humankind on par with the environmental damage the possum was responsible for. Therefore, humans could also be referred to as environmental pests. For example.

> ***The extinction of many native birds*** *for instance the* ***moa*** *and* ***huia*** *are a result of* ***human intervention****.* ***Humans have been involved in mass deforestation and animal extinction*** *across the history of [humankind].*

Manu then asked rhetorically.

> *So,* ***why kill possums*** *when* ***we don't kill humans for the same reason****?*

This question reflected his values-based view which, when interpreted from a mātauranga Māori perspective, comes under the concept of 'tikanga as an expression of values.'

This stance, as well as Manu's questioning of the necessity to eradicate the possum, demonstrated that his interface world is a conflicted one. As Manu used the cultural concept of manaakitanga to critique the biological outcome of the complete eradication of the possum, he showed that the issue and approach to the control of the possum population can be viewed simultaneously from two opposing perspectives. For example, his call to regard the possum as taonga, that the animal be treasured by the exercise of mana-enhancing behaviours under the requirements of manaakitanga could invariably result in conflict with those who regard the possum as a pest and who call for its eradication. In making this call, Manu demonstrated his understanding of the potential conflict between two opposing worldviews.

While Manu initially appeared to accept the information he was gathering from both knowledge domains to support his view, it soon became apparent that he saw the resources as quite distinct and potentially conflicting. This came from Manu's navigation through his critiquing of the relevance and suitability of the information he was accessing. The agentic process of navigating was revealed through his explanation as to how he dealt with information which appeared to be at odds with his knowledge world. This also led to him demonstrating the second agentic process – positioning.

Beginning from an ethical stance, Manu's agentic positioning developed from his increasing awareness of a growing disparity between the two knowledge worlds. Evidence for this appeared as Manu drew a clear distinction between factual evidence and cultural evidence. From his perspective, these two evidence domains were increasingly incompatible and was revealed as he developed his argument into two distinct, conflicting perspectives. The first evidence domain was a factually-based, academic/biological one he termed 'clinical'.

> *When I was writing* ***I sort of took it from an academic point*** *where it is sort of* ***clinical and just stating facts.***

Manu then contrasted these factual, clinical references with those he termed 'cultural.' In this example, he returned to the mātauranga Māori concept of manaakitanga with reference to 'protection' of forests. For example.

> *Because even here where it is under cultural* ***even though I am Māori,*** *I put culture in* ***New Zealand forests were protected by tangata whenua****.*

After acknowledging his Māori identity, it emerged that through a process of critiquing the relevance of the information Manu was finding, he made a deliberate decision to discard information that was increasingly at odds with his personal culturally-based beliefs. Here, Manu demonstrated the agentic process of positioning as he stepped back and detailed how he dealt with these two competing and apparently contradictory knowledge domains by describing the information he included and that which he discarded.

> *I didn't mention that I was part of the [Māori] people.* ***I sort of distanced myself*** *to put it onto the paper.* ***I sort of put a distance between my own [cultural] beliefs and the [scientific] facts.***

From an acknowledgement of his Māori identity in the previous quote to him no longer mentioning his Māori whakapapa links, Manu rationalised his decision to do so by regarding his Māori cultural beliefs as non-factual and incompatible with the scientific information he found. For Manu, dealing with this incompatibility by a process of putting a distance between 'the facts' and his own 'cultural beliefs' was a necessary strategy important to his agentic positioning. He saw a clear distinction between his 'beliefs' – based on his cultural thinking – and the academic 'facts' sourced from the scientific literature that he found. His knowledge-world interface was now becoming increasingly conflicted as his stance and decision making clarified.

Another illustration of the agentic process of positioning occurred when Manu made a direct reference to his ethnicity as he described how he decided to separate himself from his Māori worldview whenever he discussed the issue from a 'factual-clinical' perspective.

> ***I am no longer a part of being Māori*** *when I was doing this* ***I sort of separated myself and stated what it was.***

The agency displayed here by Manu was his way of dealing with what he described as the 'clinical' nature of the arguments. His overt strategy was to distance himself from his Māori cultural heritage prior to putting his justifications on paper. Not only does this indicate an agentic positioning process taking place, but it also reinforces that a process of navigating was

also occurring as Manu perceived the incompatibility of his cultural world with the biological science knowledge world – each stood in stark contrast with each other.

As an active agent at the cultural interface, Manu's decision to separate the knowledge into two distinct and exclusive categories, which he called 'factual' on one hand, from his own 'cultural' beliefs on the other, illustrated his awareness of the conflicted nature of the two knowledge worlds. Manu's decision to draw support from one knowledge world, while at the same time distancing himself from the other illustrated the degree to which he saw the two knowledge worlds as incompatible and potentially conflicting as he made the conscious decision to leave aside the cultural domain in favour of the scientific one. For him, the importance of managing the possum population to limit the damage they cause to the natural environment was paramount.

The evidence from Manu has thus far indicated that he inhabited a conflicted knowledge-world interface. This is reinforced by the reason Manu gave for the dominance of one worldview 'Western culture' over the other 'Māori culture' which was reflected in the assessment. It was on this basis that Manu saw two distinctive, potentially conflicting perspectives, which also revealed how Manu viewed the influence of the two knowledge-worlds as he navigated them.

> *Again, there was just the assessment standard, but I feel like I guess in a way* ***it sort of reflects New Zealand I guess****, you know,* ***we are watched over by western culture*** *I guess, and* ***just a dab*** *of* ***Māori culture****.*

Therefore, Manu acknowledged that, from his perspective, there was a dominance of Western thinking and culture over his Māori cultural view. This view characterised his agentic approach throughout as he grappled with two knowledge worlds which appeared increasingly at odds and conflicted. Manu's conflicted knowledge-world interface is displayed in Figure 7.4.

Manu's Cultural Interface

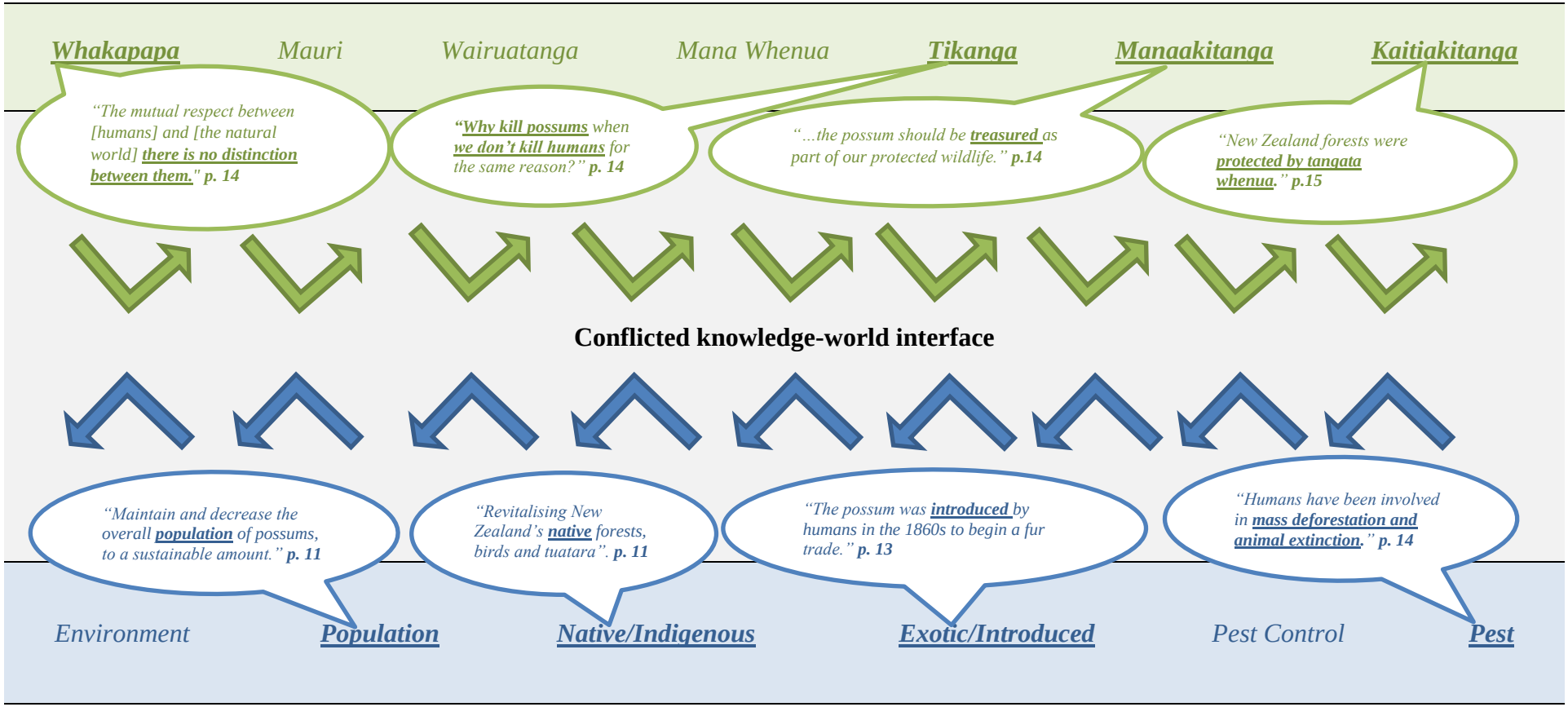


Figure 7.4. Manu's conflicted knowledge-world interface.

7.7 The parallel knowledge-world interface

It is proposed that the parallel interface is where the participants' two knowledge-worlds appear to co-exist and are parallel (see Figure 7.3b). From the evidence presented, Spec, Rose, Dee, Anders and Sina occupied a parallel knowledge-world interface. At this interface, these participants drew upon information from both knowledge worlds but did not keep them apart and conflicted or connect, combine, overlap, and interweave them. Instead, they maintained both knowledge systems in an unconnected but parallel form as they actively used separate information from both systems to support their views towards the use of 1080. It is proposed, from the analysis of the epistemic learner agency displayed by Rose and Dee about the information she gathered and responded to, that they occupied a parallel knowledge-world when justifying their views towards 1080. A detailed examination of evidence from Rose and Dee is presented next that will illustrate their parallel knowledge world interfaces.

Rose's cultural interface

Analysis of Rose's written assessment and subsequent interview transcript revealed that she drew information from both knowledge domains and did not completely support the use of 1080. Rose made 10 statements that covered **four biological concepts**. She also made twelve statements that covered **five mātauranga Māori concepts** (see Table 7.2).

Rose justified her support for 1080 by using biological knowledge while at the same time drawing upon mātauranga Māori knowledge to justify her opposition to 1080 use. In her written assessment, indicative of her developing knowledge-world interface, Rose appeared indecisive as she initially expressed the view of being not fully supportive of 1080 but instead needed to explore other options for the control of the possum pest as she navigated her way forward in to the knowledge worlds.

> *The position of where I stand is not completely decided … my preferred option is not to fully support 1080* ***but to explore into another alternative solution.***

At interview, as Rose recalled her earlier view in support of 1080, she began to detail her agentic positioning as she revealed moving away from her initial thinking which was influenced by her perception of the way 1080 ended the life of the animal.

> *So, the first position when I first got this [assignment] I was thinking that* ***1080 is the right thing to use because it is easier…. I thought it is safer for the animals*** *as well. It's a nice peaceful way to die.*

Rose drew upon her environmental biological knowledge (see Table 7.2), when she acknowledged that rats posed a real threat to two named native/indigenous bird species (kākāpo and kōkako).

> *The huge **risk rats** have on our **environment… [1080] is beneficial for our environment** in the long run because, you know, special birds like the **kākāpo [and] kōkako.***

Rose also demonstrated her understanding of the biological concept of population when she referred to the effectiveness of 1080 on possum numbers.

> *I think the use of 1080 is a very effective way to handle the **population of possums.***

Rose went on to demonstrate that to 'handle the population' effectively (in her words) meant that it was about using a method of pest control that had several advantages over the traditional methods of pest control in terms of cost, speed and efficiency.

> ***[1080] is very cost-efficient**, and it is a **great way to get the job done faster**. Setting traps and other toxins are **not as efficient as the aerial distribution of 1080.***

Rose relied on biological knowledge to support her stance in favour of the use of 1080, which she saw as an efficient, effective method of pest control in contrast to the more traditional methods of controlling possums, such as trapping.

Table 7.2 also shows that Rose used evidence from the mātauranga Māori knowledge domain which she used to support her opposition to 1080 use. Rose made use of the concepts of whakapapa, mauri, wairuatanga and elements of the concept of kaitiakitanga in her developing opposition to 1080. Thus, Rose's paralleling of concepts from the two knowledge domains became increasingly evident.

As Rose navigated along the mātauranga Māori knowledge pathway, it became clear that she regarded the mātauranga Māori concepts she was using as both relevant and suitable as a support for her views of 1080 use. With the concept of whakapapa, for example, the view that there is kinship and unity between all living things resonated with Rose. This was shown when Rose cemented her understanding of the importance of the relationship the natural world has with the non-living (spiritual) world through whakapapa when she expressed a clear navigational reference to one specific advantage to humans of this close relationship. This referred to the natural world as a form of navigational aid by giving knowledge and understanding to humans.

…as the natural world 'speaks' and gives knowledge and understanding to humans.

Rose understood that through a whakapapa connection, humans derive and receive their knowledge about, and understanding of, the natural world through a channel of communication where whakapapa is the conduit. Rose delved deeper in to the relationship between humans and the natural world by referring to the force that binds them together. She expressed in her own words the mātauranga Māori concept of mauri as a source of human power, which she referred to as 'nature'.

> ***You would think there was no relationship but really it means so much because it was a source of power to humans and humans were our source of power to nature itself.***

Rose used the agentic process of positioning as she included information from other viewpoints. Rose was quick to demonstrate her awareness of mātauranga Māori as she discussed some of the cultural information she had found that appears to have had both relevance and compatibility with her views.

> ***Thinking of the people of the land obviously and how they connect this topic to their cultural beliefs but also spiritual beliefs…kaitiakitanga.***

For example, Rose demonstrated her understanding of the mātauranga Māori concept of kaitiakitanga when she referred to the guardianship role of the kiore (Pacific rat) and other non-specified species.

> *Māori believe that the **kiore and other species**, they regard them as **their guardians.***

To reinforce how Rose's navigation of the cultural information she was using influenced her view, she was able to indicate how, by researching and drawing more information from the two knowledge worlds, her initial view which was in favour of 1080 use, began to be tempered. Her initial support for 1080 was expressed in Rose's earlier quote from the biological science domain, in which she referred to the threat rats posed to *"special birds like the **kākāpo [and] kōkako."***

As Rose continued to gather more information from both knowledge domains throughout the assessment process, she began to realise the negative effects the 1080 poison had on the animal.

> *Along the way **when I was able to do more research I just thought it is really unfair.***

The information that she found challenged her initial belief that the poison was safe and worked quickly on the animal. Navigating both the cultural and scientific knowledge worlds,

Rose continued to demonstrate her agency by showing how she negotiated with the information she drew from these two knowledge domains which helped her settle on her final view which she called her 'new perspective'.

> *So, [looking into another culture] that and* ***learning tangata whenua just people of the land.*** ***It made me think that was my new perspective, learning other people's view.*** ***That is how it helped me come up with this perspective****.*

As she gained an awareness of other points of view, Rose saw how this related to a difference in the priorities inherent within these two different worldviews. Rose accepted the difference between the two worldviews, and that information sourced from these worlds helped support her view towards 1080. Rose's agentic approach towards these different worldviews was not to discard or deny one in favour of the other, but to accept and embrace the difference as if each had its own legitimacy based on the cultural domain from which it originated. Rose was unequivocal in the way she saw the two contrasting worldviews and clearly distinguished one from the other. For example.

> ***Māori thought of which one is more spiritual to an individual****. They focus on people and not money…*

Having drawn a contrast between the two distinctive worldviews, wherein the priorities of one world which prioritised 'people' contrasted with the other world that prioritised 'money', Rose continued to demonstrate how she positioned herself by the way she described, in a navigational sense, how these two co-existent and parallel worldviews assisted her towards her final view on the issue. She continued

> *…and* ***that is what I found out about those two groups and it helped me come down.*** ***Those two perspectives actually helped me*** ***conclude my overall thinking.***

The twin agentic processes of navigating and positioning, exemplified in this quote, characterised how Rose approached the two parallel knowledge worlds. The agency she displayed in doing so was summed up best by her changing views. At the beginning, Rose was supportive of 1080 use as she applied her understanding of the environment, population and the importance of native flora and fauna (see Table 7.2) to justify her support for the use of 1080. However, towards the end she was opposed to 1080. This was due largely to her researching the topic extensively which led to exposure to a cultural worldview that featured in the twelve statements she used in as part of her justified opposition to the use of 1080 (see Table 7.2). She summed it up thus.

> ***Because thinking about it, if I was to do it in the beginning it would have been for 1080. Looking at it back now it is actually against because in the beginning I actually agreed on [the use of] 1080.***

This analysis has shown that while gathering information early on in her research phase, Rose relied on knowledge from the science knowledge world to support her view in favour of 1080. With references already quoted as to the benefit of 1080 to the environment, its effectiveness to control possum populations and its efficiency and speed as a control method, Rose appeared early on to favour 1080 use. Continuing to gather information which widened her scope, she delved into knowledge from the mātauranga Māori domain. As Rose settled on her final stance, it was noticeable that as her exposure to mātauranga Māori increased Rose's early support for 1080 diminished and her opposition to 1080 use grew

Rose's reasoning indicates her acknowledgement of the co-existent nature of two parallel knowledge worlds at the cultural interface. Rose's use of knowledge from both knowledge worlds, despite each world supporting opposing positions, is characteristic of her parallel knowledge-world interface. At the cultural interface, Rose's view changed as she accessed knowledge from the two domains. This resulted in her initial view supporting 1080 being replaced by a view firmly opposed to its use. Rose's parallel knowledge-world interface is displayed in Figure 7.5.

Rose's Cultural Interface

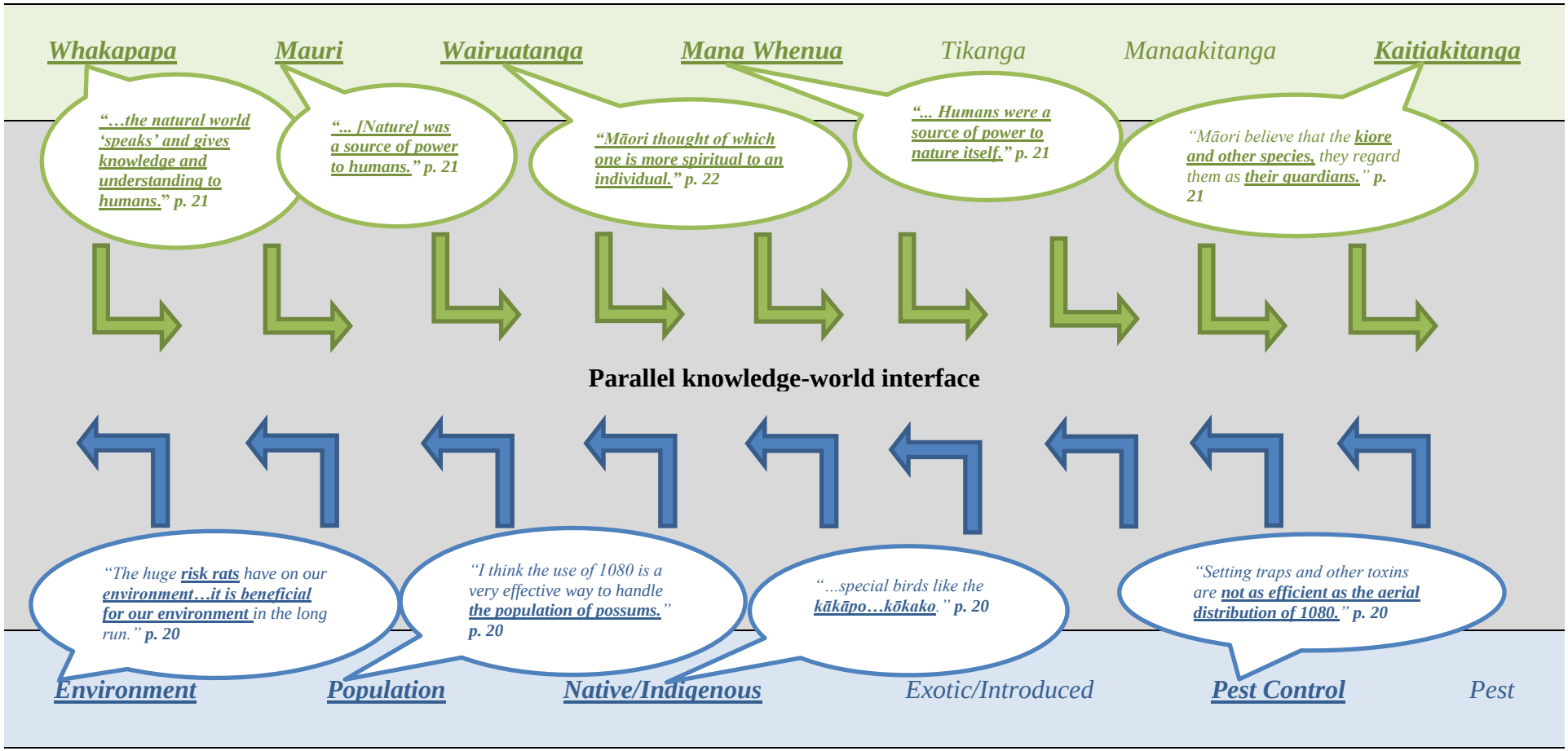


Figure 7.5. Rose's parallel knowledge-world interface.

Dee's cultural interface

Dee's justified view, as written in her assessment paper, opposed the use of 1080. Analysis of her written assessment and subsequent interview transcript revealed that Dee drew information from both knowledge domains. Dee made three statements that covered **two biological concepts**. She also made 23 statements that covered **five mātauranga Māori concepts** (see Table 7.2).

The weight of evidence presented in Table 7.2 suggests that Dee opposed the use of 1080, with most of her opposition justified by drawing upon information from the mātauranga Māori knowledge domain. However, a deeper analysis suggests that Dee simultaneously held a dual point of view towards 1080 – on the one hand arguing for the use of 1080 while on the other arguing against.

Despite drawing on the available information across both knowledge worlds throughout the assessment period (see Table 7.1) and becoming aware that 1080 can successfully control possum numbers, Dee admitted to still being unsure of her stance, which she expressed as both "FOR" and "AGAINST" the use of 1080. Consequently, Dee expressed her dual view both in favour of and opposed to the use of 1080 from the outset.

> ***In my opinion, I feel that I am unsure of my decision…. I am both FOR*** *and* ***AGAINST*** *the* ***control [of possums using] 1080****.*

Dee presented evidence that validated both sides of the 1080 debate which gave a justification for her dual stance. She elaborated by referring to two quite contrasting sets of information with both views appealing to her. Her view opposing 1080 was founded upon an article she had read that expressed a view based on the mātauranga Māori concept of manaakitanga with its statement concerning the importance of respecting all animals including the possum pest.

> **AGAINST:** ***Firstly, the reason I am against 1080*** *suggests from* ***He Kōrero Paihana research news,*** ***'Possums deserve respect as much as any other animal,*** *even though it is* ***New Zealand's foremost vertebrate pest.'*** ***This is the reason I am AGAINST*** *as* ***animals should be treated equally because they have a life just the same as humans.***

By accepting these dual, but intuitively contradictory viewpoints, Dee demonstrated the agentic process of experiencing through her reliance on a first-hand mātauranga Māori worldview from 'He Kōrero Paihana'. This also indicates a process of positioning with respect to the information she was accessing. For example, on the one hand, from a biological science perspective, Dee acknowledged the possum as New Zealand's foremost vertebrate pest. On the other, from a mātauranga Māori perspective, Dee called for the animal to be respected as

a living creature of the natural world. Dee's reliance on these contradictory references illustrated that the two knowledge-worlds were able to co-exist and run in parallel in support of her view opposing 1080 use.

The agentic process of experiencing was again apparent when Dee referred to the comments made by an experienced hunting guide, Peter Dunway who had looked in to the issues in search of 'the truth about 1080'. Dee decided to rely on the author's experiences as a hunting guide and accept the biological evidence Peter Dunway located as compatible with her view supporting the use of 1080. This is an example of Dee exercising her agency by using the experiences of another person, in this case an experienced hunting guide, to support her view and bolster her argument in support of 1080. Peter Dunway's desire to restore balance to the debate also resonated with Dee who took statements from the hunting lobby who opposed 1080, alongside statements from the environmental lobby who supported 1080 use.

> **FOR:** ***Peter Dunway, Rotorua, a hunting guide decided to find out the truth about 1080.*** *Anti-1080 hunting magazine decided to find out the truth about the toxin. He strongly suggests 'I could see the debate had become unbalanced. You have the hunting lobby on one side, saying 1080 kills birds and the environmental [lobby] on the other saying 1080 saves them.'* ***He shows that he really is interested in the fact of wanting to find the truth behind it all. He also states, 'I'm definitely a supporter of 1080, it's a simple tool that does the job.'*** ***This statement shows a strong point on my decision as well for being FOR the use of 1080.***

These quotes confirm that Dee held a dual point of view towards 1080 and was comfortable with the evidence that 'strongly influenced' both her support for and opposition to 1080 use. Dee used the experiences of hunting guide Peter Dunway to justify her support for 1080, while at the same time justifying her opposition to 1080 by using the mātauranga Māori concept of manaakitanga to call for the equal treatment of all animals as expressed by person writing from their first-hand experience in *He Kōrero Paihana*.

In doing so, Dee demonstrated that her cultural interface consisted of two parallel knowledge-worlds from which she drew her information. She navigated both worlds using an agentic process of positioning by holding unequivocally to her belief in the veracity of the information she had drawn upon and utilised. It was through this process that she was able to assert and maintain her dual point of view to both support and oppose 1080 use, as supported by both quoted statements.

> ***Personally, these statements influence my decision for being both FOR and AGAINST*** *as 1080* ***can be either useful or harmful.***

Dee justified her view in favour of 1080 as she outlined how 1080 was able to support Māori in their cultural obligations based upon whakapapa connections to the natural world (Table 7.2), to ensure the health and vitality of all life (with the sole exception – the possum).

> *The proposed action for the control [of pests by using] 1080 is significant as society recommends that* ***based on the cultural relations to the poison, Māori have a strong sense of cultural connection to the natural world and feel part of it.*** *This is mainly due to* ***generating a sense of duty to nurture the mauri (essential life force) of all things in the natural world*** *and the human communities that depend on it.*

What is also evident in Dee's statement justifying her support for 1080 use is her awareness of the concept of mauri as an essential life force that connects humans with the natural world. Furthermore, Dee shows how this kinship connection to the natural world gives rise to obligations which she refers to as a 'sense of duty'. This duty is carried out under the requirements of Māori tikanga, a cultural concept which covers customary practices beliefs and protocols which in this context, are followed in order to nurture the mauri of the natural world. The removal of the possum by the use of 1080, would, according to Dee, allow people to discharge their customary obligations under tikanga which will enable the mauri of the natural environment and its inhabitants to be restored and its vitality returned.

Duality was also evident elsewhere in Dee's justifications. In addition to her dual stance on 1080 use, Dee used several mātauranga Māori concepts to justify both her support of and opposition to 1080. For example, in the previous quote, Dee justified the use of 1080 to support and enable the people to restore and revitalise the health of the environment – ostensibly through the removal of the possum – which she had earlier on agreed deserved respect and equal treatment and therefore should not be harmed or killed. This, in no way indicates that Dee's stance was confused. More to the point, it highlights her ability to clearly justify both her support and opposition to 1080 and able to back it up with evidence from a range of mātauranga Māori concepts appropriate to her justifications. It is therefore not surprising that Dee's previous comment that 1080 can be either 'useful or harmful' is an example of how she saw the issue and was readily able to furnish evidence to justify her view as either 'FOR' or 'AGAINST'.

The dual point of view appeared not to have arisen by accident, but rather it was a view that developed through the agentic process of navigating. As Dee actively sought and processed information, she was confronted with having to decide on its relevance and suitability as a support for her view towards 1080 use.

This was illustrated as Dee described at interview how she discovered opposing views towards the use of 1080, and as she did so, demonstrated the agentic process of navigating through the knowledge-world interface. Dee described encountering differing views and realised that she had identified opposing views towards 1080. For example, here she recalls the effect of researching the different viewpoints –

> ***I just because when I researched it up different viewpoints for the 'for' and 'against' that is when I started realising, OK so people do have different opinions instead of just having one opinion which is being for it all the time…***

Dee continued to elaborate and ponder as she questioned why 'researchers' appeared to be universally in favour of 1080, and, if so, why was there not an opposing point of view?

> *…because all I heard or seen [from] the researchers is that most the people would talk about being for it and like* ***why is there just a 'for' the issue; why isn't there against?***

In response to this question she posed as to the whereabouts of evidence for an opposing view towards 1080, Dee explained what happened once she went searching for this evidence and where she again demonstrated the agentic process of positioning.

> *And* ***then when I started researching more*** *then* ***I started realising where there is an 'against' as well….***

When asked to elaborate on her discovery of the opposing viewpoint, she stated her belief in a pre-eminent 'God' the creator which was synonymous with the view of Māori who she believed would oppose 1080 on similar grounds.

> *Like how* ***[Māori] people are against [1080] because they prefer possums as a living thing as well, such as us humans.*** ***God created us all as equals not differently****, well that's my belief!*

This view aligns closely with the mātauranga Māori concept of whakapapa as it relates to the close kinship of all living (and non-living) things.

Dee also called upon the agentic process of experiencing by including a vivid comparative recount of her visits with her classmates to two places directly related to the topic of her research assessment. The first trip took place shortly after the assessment period began when the class visited an urban stand of regenerating native bush at a reserve known locally as Murphy's Bush. The second visit took place soon after and was to the pest-free island of Tiritiri Matangi in the Hauraki Gulf. Dee described how visiting these two locations provided her with contrasting experiences which strongly influenced her support for 1080.

> ***This statement shows a strong point on my decision as well for being FOR the use of 1080*** *and,* ***also when I went to TiriTiri(sic) [Matangi] island and Murphy's Bush***

Dee followed this statement with a comment which described the beauty of the island environment and related this directly to the absence of pests which afforded safe haven for the island birdlife.

> *I realised that the* ***environment of the trees and forests were beautiful and cleansed of any pests,*** *and* ***the birds were safe.***

Dee was in no doubt that the island was pest free as a direct consequence of the use of 1080.

> ***… because of the use of 1080 … to control the possums.***

This contrasted with the visit to Murphy's Bush where no such sanctuary and protection of wildlife existed. Dee's reference in the earlier quote to a 'beautiful' environment 'cleansed of pests' demonstrated her understanding of two important mātauranga Māori concepts co-existing alongside her biological science knowledge about 1080 as a control method.

Firstly, the reference to a beautiful environment cleansed of pests relates directly to an understanding of the health of the forest reliant upon the maintenance of its innate life force – mauri – which can be damaged by the presence of pest organisms who can sap the vitality and strength from the inhabitants as they consume its goodness. Secondly, the cleansing of an environment by the active efforts of people demonstrate their role as kaitiaki (guardians) of the island. Furthermore, their concern for the environment as an expression of manaakitanga by the removal of the pest animal, showed a duty of care through behaviours towards the native inhabitants of the island environment that from a mātauranga Māori perspective are regarded as mana-enhancing.

Therefore, it was unsurprising that when Dee recounted her experiences during these visits, they added evidential weight to her support for 1080 use. This strong experiential aspect to Dee's agency illustrated her dynamic and active parallel knowledge-world interface (Figure 7.7). Holding views simultaneously supporting and opposing 1080, with sound justifications for both, reflected Dee's ability to exercise her learner agency by using all three agentic processes of navigating, positioning and experiencing. Dee's parallel knowledge-world interface (see Figure 7.6) was characterised by her holding firm and resolute to her dual point of view throughout as summed up by this final quote.

> ***This is my opinion of 1080 because I choose it. I am both for and against*** …. ***I have to be both.***

As a result of Dee's thorough assessment of the relevance, suitability and compatibility of the evidence she drew from both knowledge worlds, Dee saw this evidence as equally compelling and worthy of inclusion. Through this process, Dee demonstrated that both knowledge worlds can co-exist in parallel and can be drawn upon as required to support the holding of two apparently contradictory yet justified views on this issue. Dee's parallel knowledge-world interface is displayed in Figure 7.6.

Dee's Cultural Interface

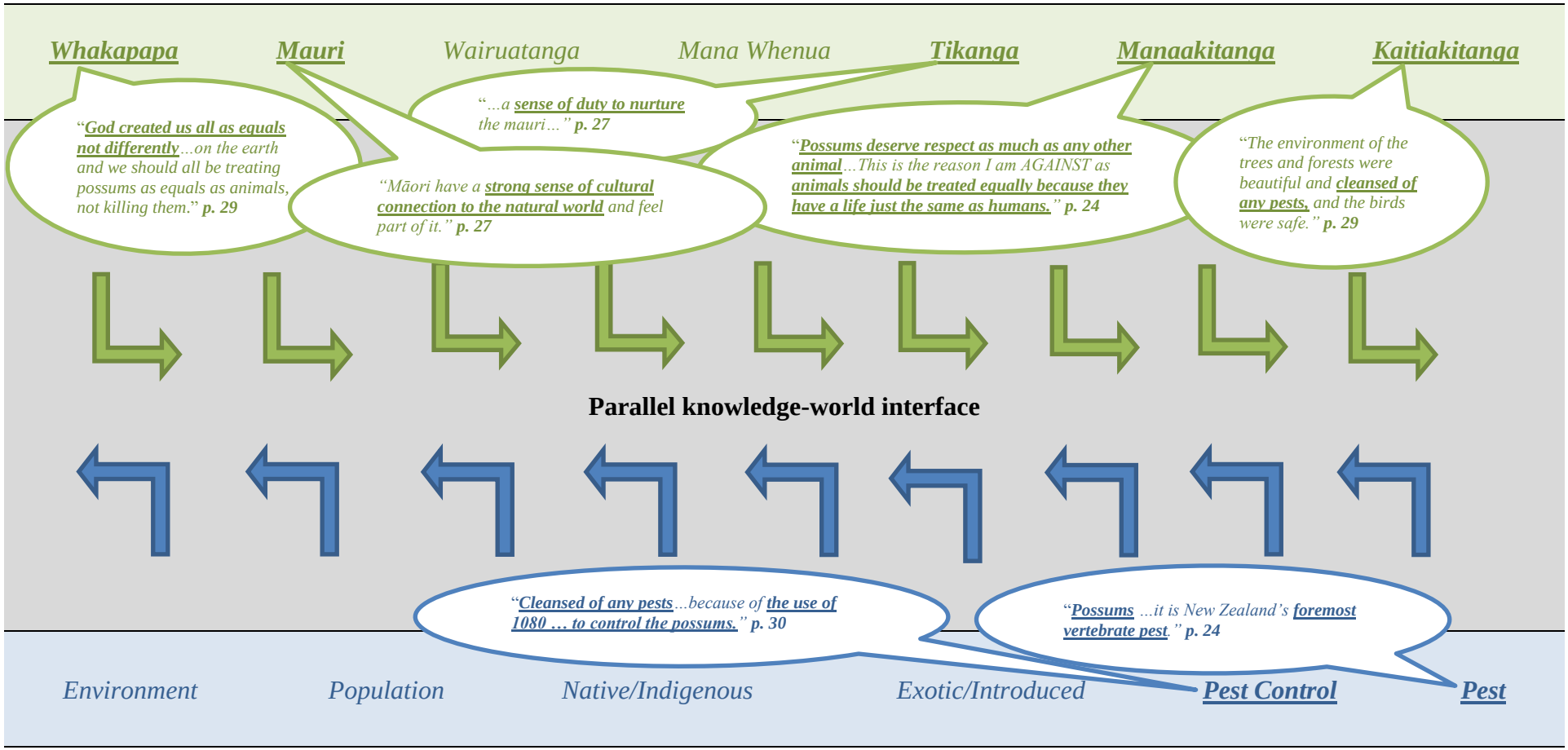


Figure 7.6. Dee's parallel knowledge-world interface.

7.8 The connected knowledge-world interface

It is proposed that the connected interface is where a participants' two knowledge worlds appear to co-exist and are interwoven (see Figure 7.3c). It is proposed, from the analysis of the epistemic learner agency displayed by Sam, Nadia, Lavinia and Chloe towards the information they gathered and responded to, that they occupied a connected knowledge-world when justifying their views towards 1080.

At this interface, these participants drew upon information from both knowledge worlds and connected both knowledge systems as they actively brought together and united information from both worlds to support their views towards the use of 1080. A detailed examination of evidence from Nadia and Chloe is presented next that will illustrate their connected knowledge-world interfaces.

Nadia's cultural interface

Nadia's justified view, as written in her assessment paper, supported the use of 1080. Analysis of her written assessment and subsequent interview transcript revealed that Nadia drew information from both knowledge domains. Nadia made twenty statements that covered all **six biological concepts**. She also made fifteen statements that covered **four mātauranga Māori concepts** (see Table 7.2).

Nadia demonstrated that she was able to weave together information from both knowledge worlds. To gain a deeper understanding of Nadia's developing knowledge-world interface, it is helpful to know how Nadia began her journey into the interface world as she recalled her limited scientific knowledge of pest control.

> *Before like I said I didn't know what 1080 was, so doing this research topic kind of introduced me to it and just **pest control** in general, I didn't know much about.*

Despite her admission of not knowing much about pest control in general, by the end of the research phase Nadia had drawn extensively upon the biological science knowledge world to express her support for the use of 1080 to control the rat population in the Hunua Ranges. Nadia's support was based on the positive effect the poison would have on local native bird populations by reducing the threat of pest animals against birds such as the kōkako.

> *My personal opinion, of Auckland Council's decision **to use 1080 to control the rat population** in the Hunua Ranges, is that **it is an effective method of pest control and will act to reduce the threat against New Zealand's biggest mainland population of the kōkako and their eggs.***

With relative ease, Nadia used the biological concepts of environment, population, pest and pest control to support her view towards 1080 use. For example, when she linked the natural environment to the ecosystem.

> ***New Zealand's native birds (including the kōkako)*** *have been* ***a target to pests such as rats, negatively affecting*** *New Zealand's* ***natural environment and ecosystem.***

Nadia backed her view that 1080 would be an ideal method of pest control by referring to empirical data on its effectiveness against the two most common animal pest populations.

> ***1080 would be the ideal method of pest control as not only is it 98% effective on rats, but also 90% effective on possums.***

Nadia was able to define pest is an animal such as the rat and possum, which had been introduced to an area by humans. Nadia critiqued her qualms as she navigated her way in a measured, balanced fashion through the justification of her support for 1080. The success rate of the poison ranked high in Nadia's estimation and proved pivotal in her subsequent decision to support the use of 1080. Applying the agentic process of positioning, Nadia took an evidenced-based approach, firmly grounded in the scientific knowledge domain. This was further reinforced in her final paragraph when Nadia restated her view.

> ***Re-establishing my position on the 1080 debate, I believe that 1080 is a reasonably safe method of pest control as long as the right precautions are put in place*** *and* ***that although there are some disadvantages that come with its use, these disadvantages can not only be reduced, but are clearly outweighed by the advantages.***

Nadia acknowledged that there was not a currently available method that was guaranteed to be completely successful against animal pests. Nevertheless, she was able to place this evidence in context alongside an awareness of the important cultural implications, which she saw as relevant as she agentically navigated forward. Here, Nadia demonstrates that she is aware of the complexity of the issue when she states the three implications at the heart of the controversy surrounding the planned 1080 drop. For example –

> *Although* ***there are some environmental, ethical and cultural implications*** ***that may stimulate controversy with the use of 1080.***

In this quote, Nadia has placed two knowledge-world concepts together (environment with culture) and provides a critique of both by introducing an awareness of an ethical rejoinder. This has the effect of uniting both worlds under the umbrella of controversy. Nevertheless, her support for 1080 use remained unflinching.

Exploring the cultural implications of 1080 use that Nadia has mentioned, the mātauranga Māori concepts of whakapapa and tikanga. For example, the concept of whakapapa resonated with her as she referred to the oneness and unity of the living and non-living worlds in Te Ao Māori.

> *To Māori, **humans and land are seen as one** in which **all living things are considered as equal.***

Nadia was keenly aware that from a mātauranga Māori perspective, eradication of the rat in this instance would transgress tikanga; a Māori values position, quite different to the Western view of this animal as a pest, which could result in conflict.

> *The use of 1080 to eradicate the rats in the Hunua ranges may cause conflict with Māori...as their perspective on nature is different to the western world in which **they find sacredness in all living things.***

Nadia, who supported the use of 1080, understood the importance of whakapapa relationships to Māori, which were at the core of their concerns regarding the use of 1080.

Nadia's understanding of whakapapa and manaakitanga was demonstrated when she used the concept of the ancestral links a North Island iwi has to the Polynesian rat (kiore). This iwi, who regard the kiore as sacred through its connection to their early tupuna (human ancestors), exercise manaakitanga (a duty of care and protection) towards the animal they regard as a tribal kaitiaki (guardian). She said –

> *Like for the kiore rat like there is a tribe that holds it significant because **it has roots to their early ancestors.** So, it's kind of like a cultural thing for them. So, **it's sacred and really important that it's not harmed** and stuff.*

The depth of Nadia's understanding of Te Ao Māori was further illustrated by her reference to the natural world as the primary source of human knowledge and its connection to whakapapa when she said.

> *Māori believe that **the natural world is able to "speak" to them and give them knowledge and understanding.***

Nadia also revealed her deepening levels of agentic processing when she discussed the issue from her cultural standpoint. Here, she combined the process of navigating with her experiences as a Pacific student. She did this by connecting her reasoning to cultural references based on her experiences and natural interest in people where Pacific culture was a strong feature of her life. For example.

> ***I'm more interested in the people side of the issue and culture is something that I can relate to because it's like strong in my life and so it's natural for me to write about.***

Flowing from this assertion, Nadia saw the 1080 issue as primarily an ethical one, linked to the mātauranga Māori concept of manaakitanga as she viewed the use of 1080 as an inhumane method of pest control.

> *I talked about* ***how 1080 can be seen as an inhumane way of pest control. So, it's an ethical issue as well as biological and scientific*** *and stuff.* ***So, I wrote a lot about culture because that is what is natural to me.***

Nadia's statement highlights the importance to her of bringing her experiences as a Pacific student to an understanding of how she sees the implications of using 1080.

From her cultural understanding as Sāmoan, Nadia connected her Pacific cultural worldview to a Māori worldview by way of comparison. Through an agentic process of experiencing, Nadia maintained her interest in the issue, as she explained.

> *So,* ***that is why learning about the Māoris(sic) was interesting because for us like the land is not as sacred, maybe in traditional Sāmoan families, but we don't hold the same like taboo and stuff like significance that the Māori do****. So,* ***it was interesting comparing them to [my life experiences].***

By doing so, Nadia empathised with Māori opposition to 1080.

> ***Yeah, like I can't relate to the 1080 topic but just different things that we hold sacred that is how I know why it might be a big issue for [Māori], because if someone tried to go against my culture, I would be angry too!***

The apparent ease with which Nadia agentically drew upon her experiences as a Pacific student by the inclusion of cultural references in support of her view towards 1080, opened the opportunity for her to consider points of view from the cultural knowledge domain opposing the use of 1080.

> *I said* ***that the cultural bit kind of made me think about the against points,*** *...it kind of made my research paper easy to write.*

Nadia was asked to elaborate on what specifically drew her in to an article she chose which she found interesting and covered a range of different viewpoints she used to support her stance. In response, Nadia outlined her strategy for navigating through the information from both knowledge worlds by advocating for a balanced approach towards understanding the

issue. Unprompted, Nadia provided an original explanation of why she believed a balanced perspective was important to her.

Nadia proceeded to draw a vivid mental picture reminiscent of a connected knowledge-world at the cultural interface by using the terms 'black', 'white' and 'grey' to illustrate her point. For her, it was not so much about seeing the issues solely in contrasting 'black and white', or 'good' verses 'bad' terms. Her preference was for a balanced, unbiased analysis that required a third option. This third option was to consider the views she referred to candidly as the 'little greys in between the black and the white', which Nadia likened to being 'on the fence'. Far from indicating any indecisiveness on her part, this fence-sitting option could also be interpreted as being able to see both sides at once. She explained it thus.

> *Because a lot of the time we just think* ***things are like black and white,*** *but we always forget like* ***the little greys in between*** *and I think with the 1080 like I said before, before I started the task like* ***I would have just said yes these are good points, these are bad points,*** *but reading this article…* ***it kind of puts you on the fence*** *like there are other things I didn't think about* ***that may influence my decision. So just learning about this different perspective like the cultural perspective of using 1080*** *is interesting.*

Nadia negotiated the information and positioned herself in the space between the knowledge worlds as this third option appeared to her, the one described as the 'greys between the black and the white'. While the 'black' versus 'white' remain fixed and opposed, Nadia recognised the existence at the knowledge-world interface of a hybrid network of views – her 'little greys'. For Nadia, these appear to be an amalgam of scientific and cultural views she regarded as important and undeniable especially as the latter cultural knowledge was sourced from her experiences growing up as a Pacific student of Sāmoan descent. Through these experiences Nadia was able to connect to both worldviews and the cultural perspectives of the issue.

> *Also,* ***because it is kind of relatable*** ***because as a Pacific, like I know we hold things, we have a different perspective of things compared to like other cultures****.*

At the knowledge-world interface, Nadia had discovered a third element to her navigational strategy used to assess the relevance and suitability of a range views from both knowledge worlds. She remained vigilant and open to views at the extremes (i.e. the black and white) as well as not forgetting the middle spaces in between (i.e. the little greys). It was as if to recognise the existence of a third hybrid space between two knowledge worlds which had merit and utility, based largely on her experiences as a Pacific student.

Nadia returned to the black-white-grey hybrid concept later in her interview when she elaborated on her view to support 1080 use. This further reinforced the connected knowledge-world interface she occupied. Nadia recalled how her discomfort with supporting the use of 1080, that she felt as a 'push' towards opposing the poison, was easily referenced back to her life experiences as a Pacific student that she believed gave her the ability to relate to the controversy and position herself based on her cultural worldview.

> ***When making my decision to pick a side the cultural thing was a thing that was kind of like pushing me to not supporting 1080, because like I said I can relate to it*** *and people like ultimately like the world is made of people*

Interestingly, as Nadia appeared to actively step back away from a 'close-up' view and favour seeing things from a broad perspective (perhaps from her perch on the fence?), she replaced a 'cultural' perspective with a 'human' perspective large enough to overwhelm the cultural views and, along with it, went her opposition to 1080. From here on, Nadia began to outline her path towards a final decision as to which position she will take on the issue.

> ***So that was the thing that kind of made me lean towards not [supporting 1080]****, but* ***then I had to think about everyone in general like not us as a [Pacific] culture, but humans sort of****. That kind of stuff like the long-term stuff* ***thinking long term that pushed me towards overcoming, like kind of overweighed the cultural bit.***

This statement not only affirms the fluid and dynamic nature of the connected knowledge-world interface that Nadia inhabited, but also how close in proximity the two knowledge worlds had become. To illustrate this, all it took for Nadia to settle on her final view towards 1080 was a slight 'lean' in one direction or the other. This was indicative of how close and interwoven the two knowledge worlds had become for her.

The agentic process of experiencing was strongly evident as Nadia elaborated with respect to her Pacific cultural views and contrasted a Pacific viewpoint towards the pest animal with a Te Ao Māori view.

> ***I know for me or like my family or my culture, pest control is not really a common thing and we don't really hold any significance to animals like we just eat them.*** *So,* ***that is why learning about the Māoris (sic) was interesting because for us like the land is not as sacred, maybe in traditional Sāmoan families, but we don't hold the same like taboo and stuff like significance that the Māori do. So, it was interesting comparing [Māori] to [my culture] and the differences [between them].***

As Nadia drew upon and recounted her experiences and knowledge as a Pacific student it enabled her to compare these types of experiences with those of Māori as she successfully navigated, connected with and understood the views of Māori opposed the use of 1080.

As Nadia navigated the knowledge worlds, she critiqued the information by using her Pacific heritage and personal life experiences as a filter. In addition, the agentic process of positioning saw Nadia make decisions as to what elements to include and which ones to discard. This strategy helped Nadia to consider the relevance and importance of the opposing views of 1080 use and, through a series of comparisons of these views with her own Pacific perspective, she was able to more easily decide on her final position.

Nadia's Cultural Interface

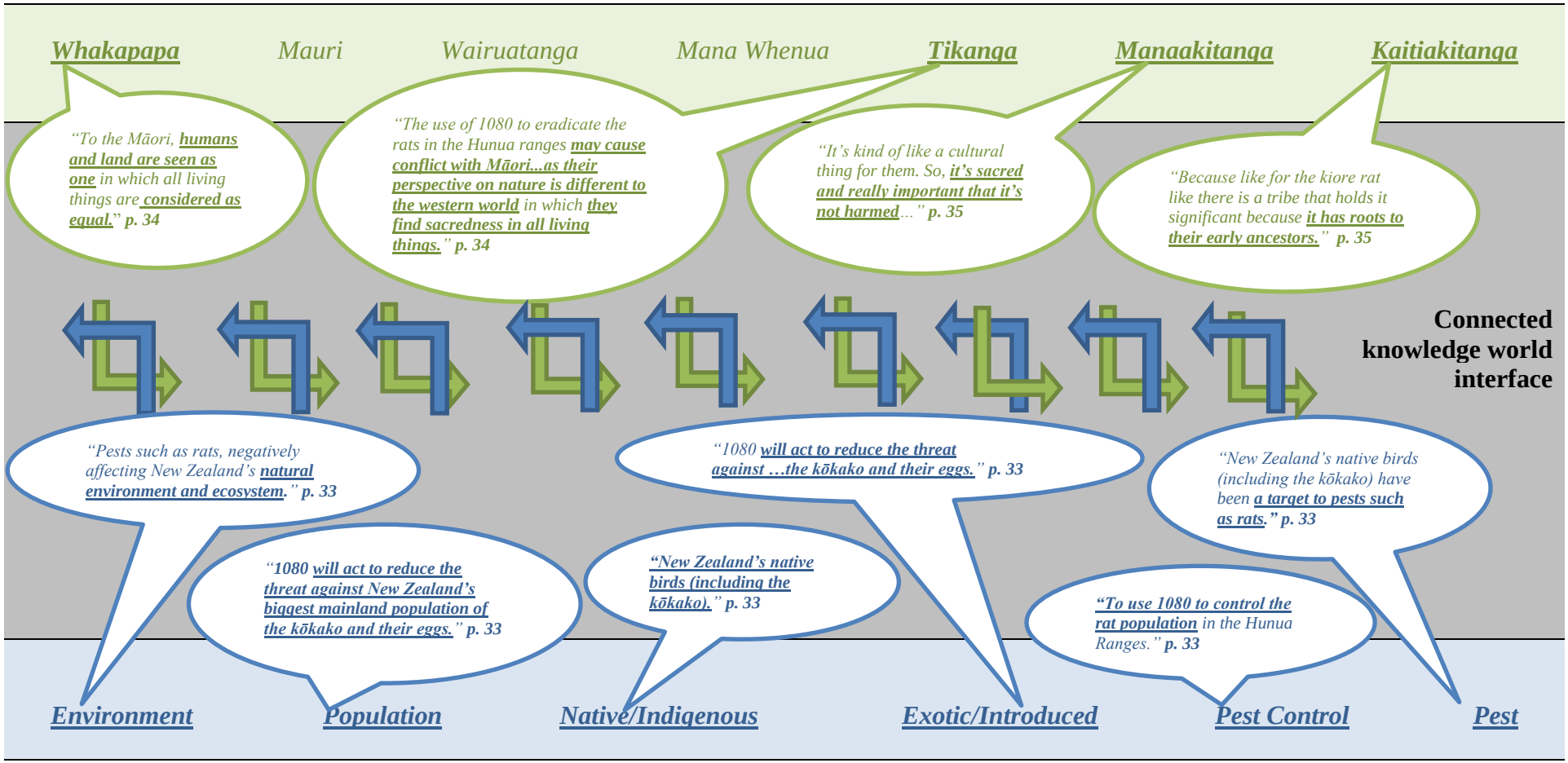


Figure 7.7. Nadia's connected knowledge-world interface.

Nadia used a unique way to deal with the conflicting information she was finding in her research. Characteristic of a connected knowledge-world interface, Nadia worked two strategies in tandem. The first was to take a helicopter view of the information and regard it all as 'human' which sat neatly with her second strategy which involved adding a third element to deal with the extreme oppositional views towards 1080 that she was encountering. Nadia did this by introducing an additional element she referred to as 'the little greys' which occupied a space between 'the black and white', a form of hybrid network, an amalgam of views from different knowledge worlds. Nadia's connected knowledge-world interface is displayed in Figure 7.7.

Chloe's cultural interface

Chloe's justified view, as written in her assessment paper, supported the use of 1080. Analysis of Chloe's written assessment and subsequent interview transcript revealed that she used information from both knowledge domains. Chloe made sixteen statements that covered all **six biological concepts**. She made twenty statements that covered **six mātauranga Māori concepts** (see Table 7.2).

Chloe demonstrated that she was able to weave together information from both knowledge worlds as she developed, clarified and justified her support for the 1080 drop based on the evidence she had gathered while researching the topic.

> *Personally, **I support the use of 1080.** **Whilst researching about the poison, I gained a clear perspective and was able to come to a conclusion about where I stood.** Having known nothing about 1080 or its purpose prior to this assessment, **I feel as if I am able to make a rationalised judgement.***

Chloe's ability to make what she called a 'rationalised judgement' on this issue relied on her navigational and positioning ability which confirmed her active, agentic approach towards gathering relevant information.

> ***Because there have been a mass amount of [scientific] research carried out by multiple organisations, I am allured to condoning the use of 1080.***

Chloe's justification for the use of 1080, that she wrote in her assessment paper, revealed the integrative approach she employed towards the information from the two knowledge worlds. She began by drawing from the biological science knowledge- world as she acknowledged the pest animal problem and the likelihood of it worsening if left uncontrolled.

The problem of these pests is only going to grow and grow and is only getting worse.

Drawing still further from the scientific domain, Chloe showed her agentic positioning when she referred to the method of pest control she favoured and related this to a rationale based upon her support for saving Aotearoa-New Zealand's native populations of birds and plants.

> *So, **methods like aerially dropping 1080 have to be put into action in order to save our native birds and plants.** **New Zealand lacks native mammals with the exception of the bat, so protecting our unique species** **needs to become our responsibility, and I believe 1080 is the most effective way to maintain and prioritise the survival of our native birds and plants.***

During her interview, Chloe elaborated on her final view supporting 1080 by navigating through several biological concepts. This showed not only her understanding of the environmental effects of the pest animal, but also the benefits to the environment and its inhabitants following the removal of the pest population using the poison that was lethal to rats.

> *I was like **poison rats died** like sort of **how I felt about it but when I sort of understood the huge risk rats have on our environment,** **I sort of understood why 1080 was being used…***

The rational approach Chloe took towards considering the use of 1080 was summed up in her acceptance of the need to exterminate the rat as the benefits to our native bird populations (such as the kākāpo and kōkako) of their demise, outweighed any slight concerns she had for the eradication of the threatening rat population.

> *…and even though it is sad that lots of rats have died, **it is beneficial for our environment in the long run** because, you know, **special birds like the kākāpo…kōkako.** They are able to sort of live easier without the rats because the **rats pose a huge threat to their population.***

When asked to elaborate on the special nature of the birds, Chloe referred to the scarcity of native populations of bird species as she called for their protection using the mātauranga Māori concept of kaitiakitanga, before she positioned herself in favour of the eradication of the rat pest.

> *I would say a special bird, not a special bird that's not really the right word, but I feel like we are **getting so scarce with the native birds** in our country and **what [small populations of] birds we do have left we would want to protect them in any way that we can.** So, **getting rid of the rats would be the best way to do that.***

Apart from applying the kaitiakitanga principle to protect the remaining populations of native birds, Chloe had not yet revealed the full extent of her cultural knowledge world. This was about to change when Chloe mentioned that she had experienced first-hand 'the impeccable greenery' of Aotearoa-New Zealand's forests and had seen for herself the negative impact of mammalian pests on our forest areas.

> *Growing up in New Zealand my whole life, **I have witnessed the impeccable greenery from the abundance of forest and local rivers. I have also witnessed the fast-growing problem of introduced mammalian pests such as rats pose on our environment.***

Chloe's statement alluded to yet another important agentic process of experiencing she used at the cultural interface. Until now, Chloe had been drawing from the biological knowledge world almost exclusively in her written assessment and interview discussion that have been referred to in the quotes analysed thus far. With respect to the mātauranga Māori knowledge domain, Chloe alluded to the concept of mauri when she referred to the role 1080 would play in restoring the health and vitality (i.e. mauri) of the forest.

> ***…to give our environment the chance to flourish once again.***

In subsequent comments, Chloe's rational approach again re-emerged when she made a direct reference to the importance to Māori of the respect required by tikanga and displayed in actions as manaakitanga towards the land and its bounty. For example –

> *I was talking about Māori and how **they respect the land, how they hold so much respect for the land…. The use of 1080 would disrupt [Māori] beliefs and cultural values…. Māori really take pride in their land and …treat it with respect.***

While this evidence indicated Chloe's deep level of understanding of both knowledge worlds, she had not yet provided sufficient first-hand experiential evidence to indicate she had connected and woven concepts from the two knowledge worlds together in such a way that would place her in a connected knowledge-world interface. Therefore, it was no surprise when, towards the latter part of Chloe's interview, she reflected on her assessment and talked about the decisions she made as she formed her justified view towards the use of 1080. As she did so, Chloe revealed information that linked the two knowledge worlds together.

Chloe linked the two knowledge worlds together by vividly recounting her experiences whenever she accompanied her grandmother into an area of regenerating native forest. Chloe explained that

the regular visits to the forest were to collect plant material from selected native flora for use in Rongoā Māori (traditional Māori medicines) by her grandmother who was a practitioner of Māori natural healing using traditional methods and materials. Chloe's experiences were earlier reported in Chapter 6 (see p. 133), where her evidence was used to illustrate the importance of wairua and spiritual safety through the recitation of karakia.

To illustrate the depth of Chloe's understanding and experiences and how these provided a link between the two knowledge worlds at the cultural interface, a full recount of the moment in the interview where this information was shared by Chloe appears below. The recount of her conversation cements Chloe at the connected knowledge-world interface and will be explained and discussed next.

Chloe was discussing at interview the strategy she used to organise her research material as she gathered together increasing amounts of information from both the scientific and cultural knowledge worlds. Stepping aside from explaining the content, and without prompting, Chloe revealed how she sorted the biological and cultural information into what she referred to metaphorically as her knowledge 'baskets'.

> *There was a lot of information in this little....**in my basket.** **I have my social basket,** **I have my 1080 basket, I have my biological basket,** that is what I do a lot actually…. **And incorporate it somehow into my report.***

Chloe acknowledged that she was referring specifically to knowledge baskets, which coincidently are synonymous with the Te Ao Māori concept of the three baskets of knowledge obtained by the forest god Tāne Mahuta in pre-human times. She then illustrated the agentic process of positioning by describing the contents of each knowledge basket. For example, she decided to place Māori cultural knowledge into her 'social basket'. This was followed by a rationale for this decision based on the agentic process of experiencing that she related to from her Māori worldview.

> ***Well, say I found something to do with Māori like how they see the land. I would put that in my social basket, because it sort of relates to community and how people react to 1080 and how they sort of view it.***

Here, Chloe used the mātauranga Māori concept of whenua (land) as an example to illustrate its social significance to Māori communities and which lies at the core of their opposition to the use of 1080. It was at this point, as if to draw from her 'social basket', in an active process of positioning, Chloe made direct reference to her Māori cultural and ethnic heritage, which led on

to her mentioning the strong connection her grandmother has to Te Ao Māori (Māori worldview) and upon whose experiences Chloe was about to reveal.

> ***…and because I'm Māori myself, I know that, well I'm not really in touch with the whole culture and land and I don't really understand the whole beliefs behind it****, but* ***my Nana is really like a really strong Māori like she grew up in that community****…. She is old school, old fashioned.*

Chloe then recounted in detail her experiences of going into the forest with her grandmother to help collect native flora material for use in making remedies based on Rongoā Māori - traditional Māori medicinal knowledge and practice.

> ***She makes this sort of medicine and when I used to go out and get the, I forget what it's called that she uses, but every time that she would take it she would always say a karakia*** *just to* ***ask basically the land god for permission.***

The recitation of karakia prior to the removal of plant material from the forest was a respectful customary practice that acknowledged the wairua of the forest in accordance with tikanga Māori. It is an active process to seek permission from the kaitiaki, spiritual guardians who inhabit the forest, to allow the mortal humans to safely remove the plant material. Chloe explained it like this.

> ***It's all natural and she cooks it up in a pot and my sister wants to go and get that plant that she uses, but my Nana said there's so much more than just go picking up the plant, because she believes you need to ask for permission*** *for all the stuff.*

Chloe's Cultural Interface

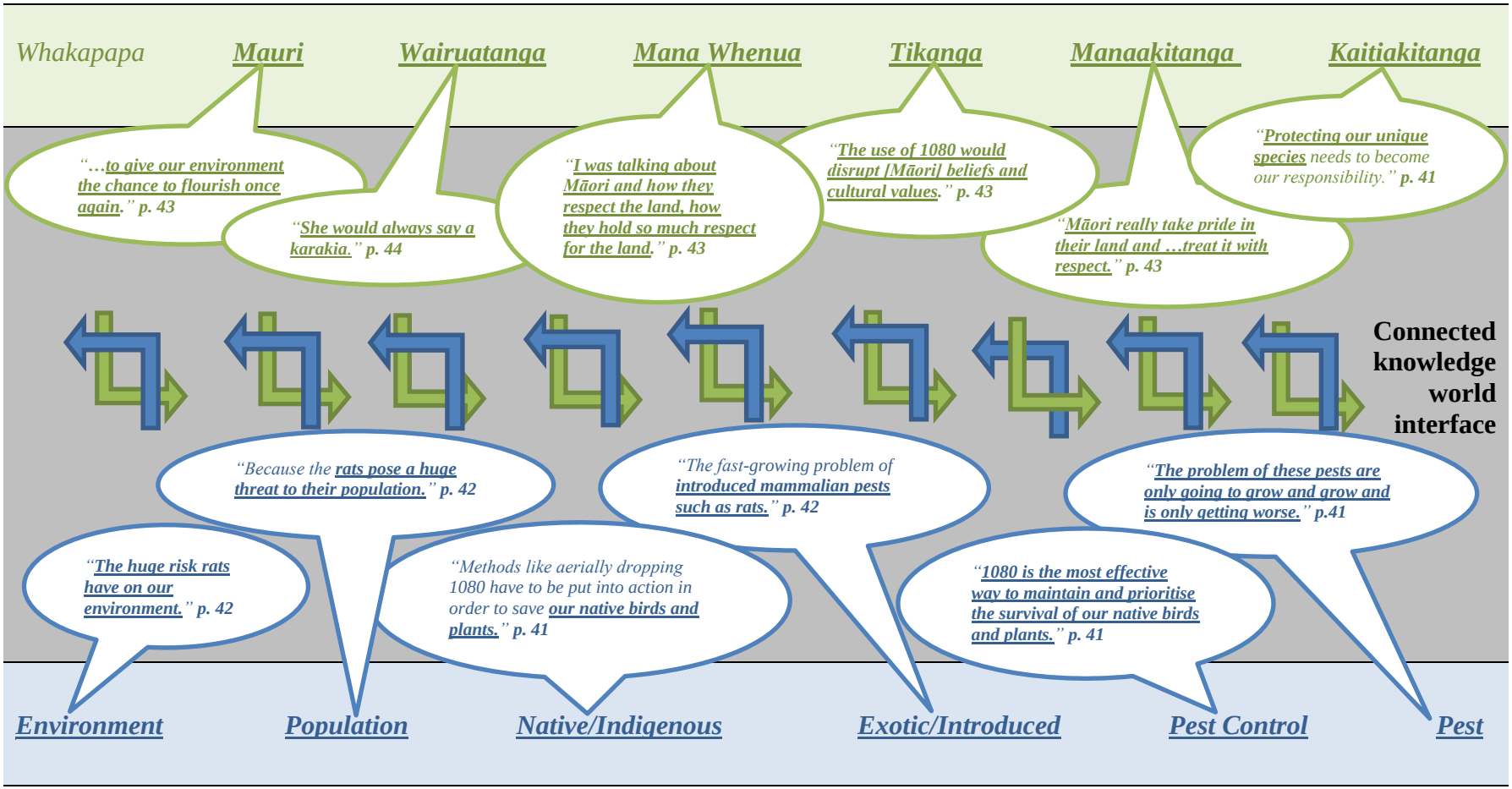


Figure 7.8. Chloe's connected knowledge-world interface.

Beginning with a wide range of biological concepts in her written assessment, followed by a rich verbal recount of Chloe's experiences from the mātauranga Māori knowledge domain, Chloe demonstrated how she integrated the two knowledge worlds. Not only did Chloe demonstrate a grasp of a full range of biological concepts, she seamlessly wove together an account based on her experiences and understanding of the natural world from a mātauranga Māori perspective.

The ease with which Chloe combined these two knowledge worlds firmly placed her at the connected knowledge-world interface.

When it came to settle on a view of either supporting or opposing the use of 1080, Chloe remained a fervent supporter of the use of 1080 for the control of animal pests in Aotearoa-New Zealand. As an active, agentic learner at the cultural interface, Chloe demonstrated the importance of experience as a way to connect the knowledge worlds of biology and mātauranga Māori. Her first-hand experiences combined with her 'three baskets' strategy were central to her ability to successfully navigate the biological science and mātauranga Māori knowledge worlds. Chloe's connected knowledge-world interface is displayed in Figure 7.8.

7.9 Agentic processes at the cultural interface

The analysis framework's three core agentic processes – **positioning** (**P**), **navigating** (**N**) and **experiencing** (**E**) (see Figure 7.2) revealed the participants' epistemic agency as they drew upon their understanding and experience (Kearney et al., 2014) from both knowledge worlds. Table 7.3 shows the number of agentic processes for each participant at their respective, named cultural interfaces. This is displayed in Figure 7.9.

In other words, at the interface, learners could display any one or a combination of these three processes: to engage with knowledge concepts from both knowledge worlds where they actively decide to include or discard information as they ***position*** (**P**) themselves. During the process they negotiate and critique the relevance, suitability or compatibility of the information as they ***navigate*** (**N**) along the knowledge landscape whilst recounting their own or others' ***experiences*** (**E**).

Table 7.3
Agentic processes at the cultural interface

	Cultural Interface	**Positioning**	**Navigating**	**Experiencing**
Manu	Conflicted	4	15	5
Spec	Parallel	10	12	4
Rose	Parallel	12	27	7
Dee	Parallel	9	11	10
Anders	Parallel	8	14	5
Sina	Parallel	2	5	2
Sam	Connected	15	21	4
Nadia	Connected	16	30	7
Lavinia	Connected	24	19	10
Chloe	Connected	43	29	15

For example, there were many instances where the participants made single statements which contained reference to a particular agentic process. On closer inspection it became evident and of interest that the participants also used combinations of two or three processes within a single statement. These were mostly paired statements but occasionally, there were single statements made by the participants which contained all three agentic processes in close proximity.

Upon further analysis of this feature, Table 7.4 was composed from the 10 participants' data to see if there were any trends or features evident and if it related to their particular knowledge interface.

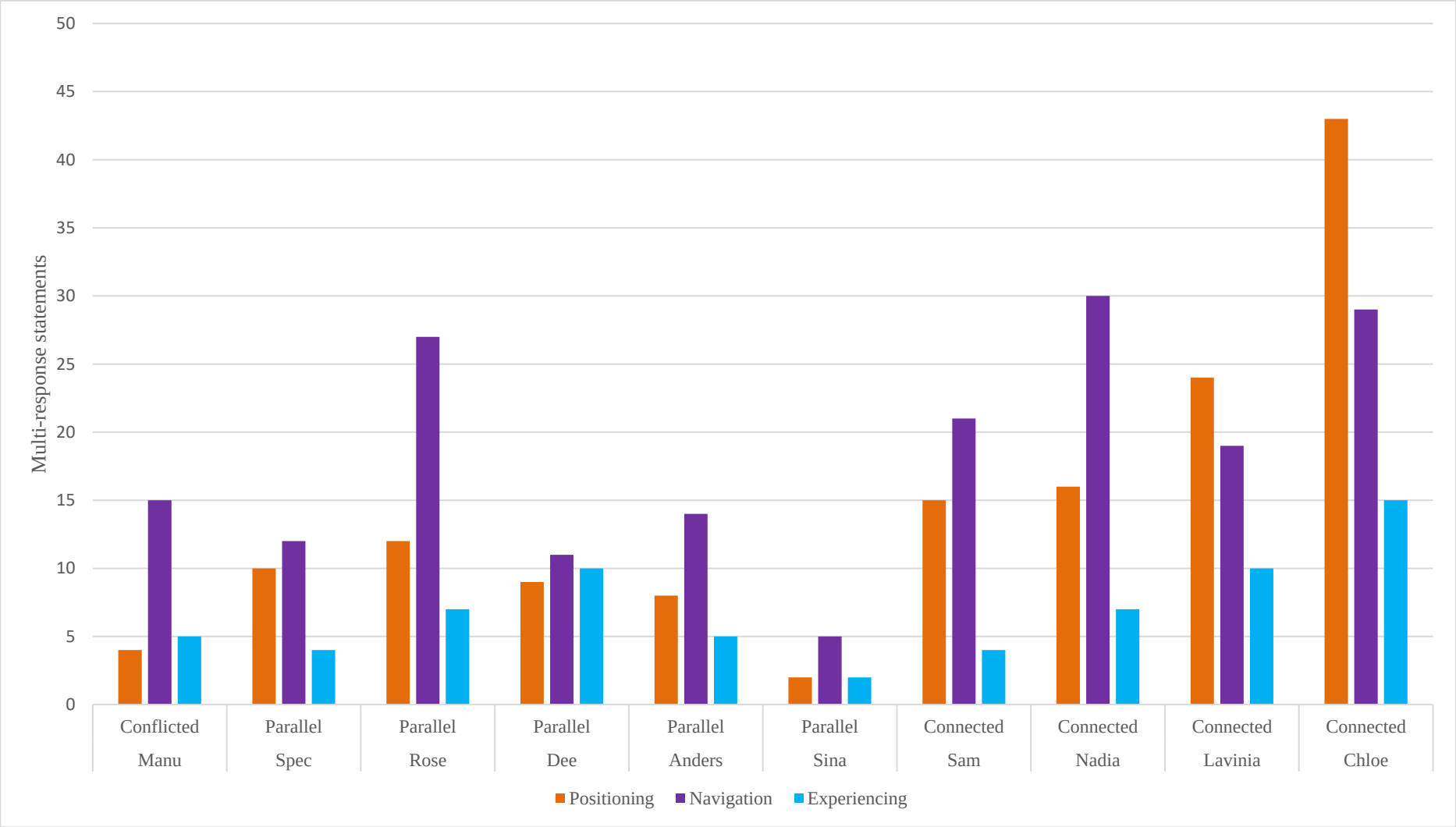


Figure 7.9. Agentic processes used at the participants' knowledge world interfaces

Table 7.4 shows that all the participants used at least two of the three agentic processes in various combinations within a single statement, (either **P** + **N**, **P** + **E** or **N** + **E**) and four participants (Sam, Nadia, Lavinia and Chloe) used all three, (**P** + **N** + **E**).

Table 7.4
The number of statements which combine at least two agentic processes in close proximity

	P + N	**P + E**	**N + E**	**P + N + E**	**Interface**
Manu	1	-	-	-	Conflicted
Spec	4	-	3	-	Parallel
Rose	3	-	-	-	Parallel
Dee	1	2	-	-	Parallel
Anders	5	1	-	-	Parallel
Sina	6	-	-	-	Parallel
Sam	8	2	3	1	Connected
Nadia	5	-	7	1	Connected
Lavinia	3	-	1	1	Connected
Chloe	2	2	-	3	Connected

Therefore, an important finding from this analysis is that a connected cultural interface is characterised by and in effect when:

- All three agentic processes are engaged in by the participants.
- All three agentic processes are used in close proximity within a single statement.

For example, these two comments by Nadia and Chloe illustrate the use of all three agentic processes in close proximity.

Nadia

> ***So that was the thing that kind of made me lean towards not [supporting 1080]****, but* ***then I had to think about everyone in general*** ***like not us as a [Pacific] culture, but humans sort of****. That kind of stuff like the long-term stuff* ***thinking long term*** ***that pushed me towards overcoming, like kind of overweighed the cultural bit.***

Chloe

> ***Well, say I found something to do with Māori like how they see the land. I would put that in my social basket, because it sort of relates to community and how people react to 1080 and how they sort of view it.***

This was a feature shared by all four connected knowledge world inhabitants. From this it may be concluded that the active and proximal combination of all three agentic processes is one important criterion for a connected cultural interface.

7.10 Conclusion

This chapter has presented findings related to research question 3 which asked:

> How do participants integrate mātauranga Māori concepts and biological science concepts as they develop and present a justified response to the socio-scientific issue?

Having established that 10 student participants drew information from both knowledge worlds, this chapter used the theoretical concepts of the cultural interface and student agency to analyse and interpret how each student experienced and navigated the two knowledge systems in the course of completing their assignment.

For all 10 cultural interface inhabitants; Manu, Spec, Rose, Dee, Anders, Sina, Sam, Nadia, Lavinia and Chloe, the epistemic agentic processes they used as they drew upon information from the biological science and mātauranga Māori knowledge worlds positioned each of them at their learner locales at their respective cultural interfaces.

Participant data were interpreted from the point of view of the student making decisions, negotiating the relevance, suitability and compatibility of the information as well as calling upon experiences that influenced them and helped them to justify their view towards 1080 use.

Evidence was presented to show that the knowledge the 10 interface participants drew from the both worlds could be represented in one of three different orientations at the cultural interface. For example, for Manu, the knowledge from the two worlds was conflicted and stood in opposition to each other – hence he occupied a conflicted knowledge-world interface. For Spec, Rose, Dee, Anders and Sina the knowledge from the two co-existent worlds was kept apart but in tandem – hence they occupied a parallel knowledge-world interface. Finally, for Sam, Nadia, Lavinia and Chloe, the knowledge from the two worlds were connected as they wove the information from both worlds together – hence they occupied a connected knowledge-world interface.

Chapter 8: Discussion, Conclusions and Educational Implications

8.1 Introduction

This research focused on how senior high school biology students used biological science knowledge and mātauranga Māori knowledge to create a shared knowledge space situated within the socio-scientific issue of 1080 (sodium fluoroacetate) poison use to control mammalian pests in Aotearoa New Zealand. This research journey was guided by three core research questions which were:

1. What biological science concepts are identified? And:
    - How do the participants use biological science concepts to justify their position within the socio-scientific issue?

2. What mātauranga Māori concepts are identified? And:
    - How do the participants use mātauranga Māori concepts to justify their position within the socio-scientific issue?

3. How do participants integrate mātauranga Māori concepts and biological science concepts as they develop and present a justified response to the socio-scientific issue?

Following this introduction, the significant outcomes of this research are discussed with reference to these questions. Within this chapter, Section 8.2 discusses the main biological science concepts and sub-concepts the participants *identified* within this issue to provide answers for the first research question. To aid the discussion, reference will be made where appropriate to national surveys of attitudes towards 1080 and introduced wildlife (Green & Rohan, 2012; Russell, 2014).

Green and Rohan (2012) analysed the submissions opposing the re-registration of 1080 taken from a survey by the Environmental Risk Management Authority (ERMA) in 2007. Russell (2014) reported on a survey compiled in 2012, from which he compared attitudes towards introduced wildlife and their management in Aotearoa New Zealand to the results from a similar survey in 1994. Section 8.3 discusses *how* the participants *used* biological science concepts to justify their position within the socio-scientific issue. Section 8.4 discusses the main mātauranga Māori concepts and sub-concepts the participants *identified* within this issue

to provide answers for the second research question. Section 8.5 discusses *how* the participants *used* mātauranga Māori concepts to justify their position within the socio-scientific issue.

Section 8.6 provides answers to the third research question and discusses findings from the analysis of the 10 participants who drew concepts from both knowledge worlds. Firstly, the discussion looks at what concepts were used by the participants to populate the shared knowledge space. Secondly, the discussion will focus on how this group *used* these concepts and further identified who, amongst them, *integrated* mātauranga Māori concepts <u>and</u> biological science concepts as they developed a justified response to the 1080 issue.

Section 8.7 discusses the conclusions and educational implications drawn from these findings. Section 8.8 presents a set of recommendations for further research within our culturally and linguistically diverse high school biology classrooms. Section 8.9 discusses limitations of this research and the chapter concludes the thesis with final reflections and a concluding statement.

8.2 Identifying the biological science concepts

This section answers the research question, "What biological science concepts are identified?" when participants justified their positions on 1080 use. The data analysis of the participants' written NCEA assessment scripts identified six key biological science concepts. These appear in the Positional Analysis Grid (Appendix N) and are recorded in Table 8.1 and displayed in Figure 8.1.

Overall, of the 244 multi-response statements which referred to these six biological concepts, 211 (86.5%) were supportive of 1080 use, while 33 statements (13.5%) opposed 1080 use. Although not a direct comparison with this multi-response data, the ERMA survey by Green and Rohan (2012, p. 188) reported that of the 1406 submissions, 881 (62.6%) expressed support for re-registration of 1080 while 525 (37.3%) were opposed. Those responses are indicative of the levels of support for 1080 nationwide.

Table 8.1
Biological concept multi-response statements

Concept	Supporting 1080	Opposing 1080	Total	Percent
Environment	27	2	29	11.9
Population	45	6	51	20.9
Native species	45	1	46	18.9
Introduced species	9	2	11	4.5
Pest species	35	10	45	18.4
Pest control	50	12	62	25.4
Total	211	33	244	

Table 8.1 presents the number of times participants identified biological concepts and is an indicative snapshot of the full data spread found in Appendix N. This information shows a breakdown of the 244 multi-response statements, which referred to these six biological science concepts. The biological concepts used by the participants were, in descending order: pest control (25.4%), population (20.9%), native species (18.9%), pest species (18.4%), followed by environment (11.9%) and introduced species (4.5%). These concepts used by the participants exhibit a broad, inclusive set of biological ideas related to two important factors which are important to consider in this discussion – the context and the assessment task.

The context of 1080 use in pest control set out in the assessment task, written by the participants' schools, predetermined that the students would use terminology and concepts from within the broad area of ecology and therefore include concepts related to the environment and the ecosystem. These topics would have been familiar to the students as they both featured as part of their introductory biology course the previous year and were revisited in class the following year through textbook and other materials the students had available to them throughout the assessment period.

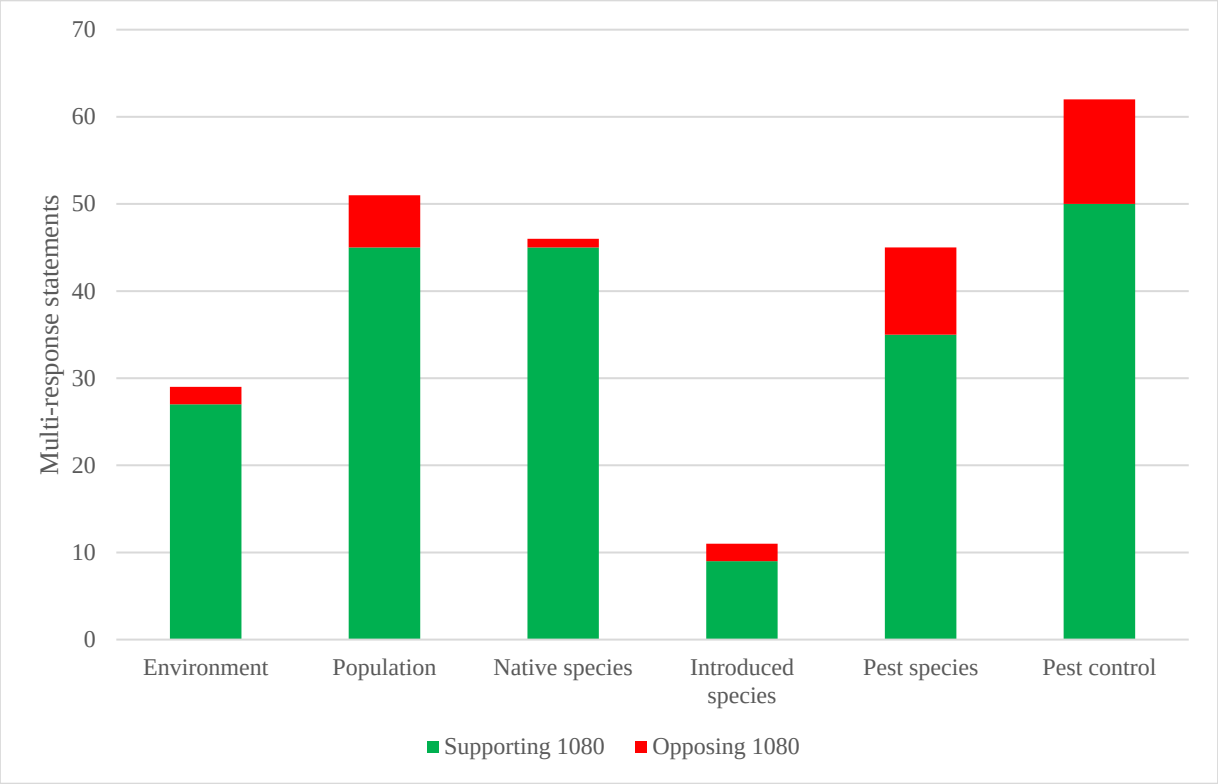


Figure 8.1. The six biological science concepts used by the participants in justifying their position on 1080 use.

Consequently, one could anticipate that the biological science knowledge they used would most likely include evidence of their understanding of the interactions of organisms with their environment. These would likely be present as a cluster of concepts (Brody, 1996) that represent what the student knows about this complex natural phenomenon. Specifically, this would include the relationships between biological communities and the physical factors of the environment and include mention of the biotic and abiotic factors in an area that affect the lives of named organisms.

Figure 8.1 shows the indicative spread of the numbers of statements made which used the biological concept and indicates the relative proportion of statements for each concept used in support of 1080 (in green) and the number of statements for each concept used in opposing 1080 (in red). It shows that for all concepts, there were noticeably more statements made by those in favour of 1080 compared to those statements opposed. The full data set presented in Appendix N shows how this research is giving voice to these biological science concepts used by the participants when in context and fills an important gap in our knowledge and understanding of *how* they are used by the participants when justifying their position on the 1080 use.

In addition to context, a second influential factor concerned the specifics of the assessment task the students were required to complete (see Appendix F & G). This determined the scope and relevance of the biological science knowledge concept pool that the students could draw from. The task required students to justify their position and discuss implications from a biological and a social perspective – which may be economic, ethical, cultural or environmental as specified in the Achievement Standard AS91602 (see Appendix E). This is in line with the accepted definition of scientific literacy whereby the scientific knowledge and the decisions made from its use are set in situations that have social or other dimensions to consider (OECD, 2000). Thus, the 1080 issue presented an authentic, controversial and multidimensional topic for the participants to study.

Therefore, a specific focus on establishing the concepts participants *used* to justify their position, enabled this research to contribute to a better understanding of the processes by which they *used* these concepts to engage with the issue and how they understood them. For, as Lewis and Leach (2006, p. 1267) point out, the ability of learners to engage in a reasoned discussion is strongly influenced by their ability to recognise key issues at the outset. This, in turn, requires a *relatively modest* (emphasis added) level of understanding of the relevant science – a significant component of scientific literacy which, as Abd-El-Khalick, (2003, p. 41) points out is largely the ability to make informed decisions regarding science-related personal, and societal issues. Therefore, the participants' use of knowledge when they justify their position gives clues to their understanding of the concept.

The literature review (see Section 2.3) established that students' knowledge of and about science is a pre-requisite that enables them to actively involve and position themselves in the debate of issues of local and global importance. This thesis argues that as a cornerstone of the participants' critical and applied thinking, the use of these biological concepts also reflects the participants' functional scientific literacy (Allchin, 2013), where they engage in argument in support of their position from scientific evidence they gathered within the social and cultural milieu of the socio-scientific issue (Moeed & Anderson, 2018). Next, Section 8.3 looks specifically at the six biological science concepts listed in Table 8.1 and discusses *how* the participants *used* these concepts in the justifications of their position towards 1080 use.

8.3 The use of biological science concepts

This section answers the research question, "How do the participants *use* biological science concepts to justify their position within the socio-scientific issue?" A breakdown of the multi-

response data presented in the Positional Analysis Grid (Appendix N) to examine participants' positions on 1080 is presented in Table 8.2 and displayed in Figure 8.1.

It is necessary at the outset to emphasise the importance to this discussion of the term 'use' as it relates to concepts and the term 'how' as it reveals the students' conceptual understanding and expression of the biological science concept.

How the concepts were used by the participants drives this research and lies at the heart of the definition of scientific literacy. For example, the definition of scientific literacy issued by the OECD (2000) begins with the phrase "Scientific literacy is the capacity to *use* scientific knowledge" (OECD, 2000, p. 12). Furthermore, the purpose of using this knowledge (which includes both the concepts and the processes by which this knowledge is developed) is elaborated on as "to identify questions and draw evidence-based conclusions" (OECD, 2000, p. 12), which describes processes of selecting and evaluating information and data to then draw conclusions.

The importance of being able to do so is "to understand and help make decisions" which implies the existence of a context in which these decisions are made has "social, political or economic dimensions" (OECD, 2003, p.134). Finally, these decisions relate to "the natural world and the changes made to it through human activity" (2003, p. 134), which refers to the physical setting, living things and the relationships among them" (OECD, 2003, p.134).

Therefore, the *use* of scientific knowledge is closely connected to decision-making. To illustrate this relationship, Milton (1996) discusses the concept of 'environmentalism' by referring to the roles of ecologists and environmentalists:

> Ecologists study the relationships between organisms and their environments. Environmentalists seek (among other things) to use the knowledge generated by ecologists to modify the relationships between organisms and their environments, in such a way as to minimize environmental damage (Milton, 1996, p. 37).

From a knowledge perspective we can infer from this passage that:

- Ecologists **gain knowledge** by **studying** the **relationships** between **organisms** and their **environment**
- This **knowledge** can be ***used*** for a **specific purpose**
- This **purpose** might be **beneficial**; e.g., to minimise environmental damage.

Starting with the biological concept of environment, the discussion turns to how each of the six biological science concepts were used by the participants to support their justified position on 1080 use.

The biological concept of environment

The comparatively high levels of overall support for 1080 use (see Table 8.1) reflected a belief amongst the participants that the killing of pests was deemed necessary to protect a greater good. However, they stopped short of direct references to the habitat of rare or endangered species, instead referring to the damaging effects on the 'environment' in general, on specific named populations of native species and the health of domestic animals (Morris & Weaver, 2002, p. 381) such as cattle infected with Bovine Tuberculosis (BTb).

This utilitarian view in everyday usage, is illustrative of the concept of environmentalism which, according to Milton (1996, p.27), typically refers to a concern that the environment should be protected from harm. A deeper analysis revealed that the participants who used the concept of the environment expressed their understanding in three distinctive ways: as an 'object', as a 'relation' and as a 'hierarchy'.

Firstly, the environment as an object. The biological concept of environment was used by the participants in ways which made it appear external to and disconnected from its living components – the organisms which occupy this space. From an organism's perspective, the physical environment was seen by the participants as external to it and not through any ways and means connected. The participants were aware of the need to account for the adverse impact that pests have 'on the environment' – which was most often measured by the impact of pests on the inhabitants, specifically on native plants and the populations of animals.

This could be interpreted as a form of binary described by Barry (2009, p. 118) as the 'environment/society disconnect' which he argues could manifest as an adversarial relationship between environment and society. As a non-specific entity external to the living organisms of which it was comprised, some participants' rather naïve conception is more in line with the views of Loughland et al. (2003) and reflects the environment as "something out there–a place, possibly including plants and animals, but essentially separated from themselves." (p. 4).

Second, the environment as a relation between people and the environment. This second element of the dualistic conception of the environment proposed by Loughland et al. (2003) is where participants recognised a need to protect the environment from destructive pest animals.

Specifically, statements from the participants calling for the environment to be protected from the ravages of the possum pest alludes to a perception of the environment from a relational point of view – as something that supports and enhances people's living, and which in turn requires care and support from them (2003, p. 14). These factors influenced the participants' social construction of the natural environment which, if returned to its pristine state, has instrumental value to humans who gain pleasure and possibly spiritual benefits from this exposure (Morris & Weaver, 2002, p. 369).

Thirdly, the environment as a hierarchy. The participants' use of the term environment included stark dualisms and references to hierarchies – what Loughland et al. calls "pets or pests, reflecting the anthropomorphic values of liberalism and modernity" (2003, p. 14). The participants revealed this hierarchical perception in their calls to prioritise the protection of the environment and its native inhabitants at the expense of pest animals.

Therefore, returning to Barry's notion of an 'environment/society disconnect', the biological science concept of environment as used by those participants who see themselves as separate from the natural world, could reflect a dominant position over the natural world (especially the pest animals). This dominance supports the Western scientific notion of an anthropogenic environment shaped by humans and their activities (Pretty et al., 2009). Placing the 'native' wildlife on a hierarchy above the 'pest' organisms (e.g. possums and rodents) demonstrates the participants' anthropomorphic view of the environment. This was illustrated by their altruistic call to 'protect' native wildlife – who are referred to by Russell (2014, p. 147) as our "charismatic native birds" – by removing 'pest' organisms from the environment. This might account for the overwhelming support shown in Table 8.1 the participants gave to 1080 use to control the pest population by way of 211 out of 244 statements (86.5%) expressed in favour of the use of 1080 poison.

The biological concept of population

The participants' use of the biological science concept of population affirmed the currently accepted Western scientific view that populations are comprised of named organisms whose numbers can change either because of changes in the numbers of other populations of organisms (biotic factors) or changes in the physical nature of the surroundings such as by the addition of a chemical poison (abiotic factors) such as 1080. Hence the participants' use of the concept of population was situated within a Western science epistemological framework.

For example, the call by the participants to remove pest organisms from the environment to allow the native wildlife to thrive strongly indicated that the participants understood the ecosystem concept of population in terms of a population's dynamic and fluid numerical quality. For these participants, it was important that the use of 1080 could cause quite noticeable changes in the numbers of pest animals. This, in turn, would result in a rise in the numbers of native birds in the area treated by 1080. Participants demonstrated their understanding of the relationship between the numbers of pest organisms and the corresponding numbers of native organisms and how 1080 could influence this dynamic.

The level of foundational scientific knowledge of the ecosystem concept of population was enough for the participants to be able to express their understanding of how the reduction in the numbers of one population (most often the pest species), would have a flow-on effect of most-often increasing the numbers of another population (non-pest species, likely native). This demonstrates that the participants understood the importance of the 'interactions and interdependence' (Jordan, Gray, Demeter, Lui & Hmelo-Silver, 2009, p. 40) aspects of ecological systems and processes. The participants were able to express their understanding of the nature of these interactions as a basis for their decisions to support 1080 use. This illustrates quite a sophisticated understanding of the dynamic nature of the interactions within an ecological system and system dynamics described by Jordan et al. (2009, p. 46) as a critical component of ecosystem function.

The biological concept of native (species)

Aside from being able to name a native species by using its common name when referring to birds (for example, kiwi, takahe, huia), the biological concept of native species was used by the participants in two main ways. Firstly, many referred to native organisms as exclusively resident in Aotearoa New Zealand who have been here since before human settlement. Secondly, a native organism was understood and discussed 'in relation' to pest organisms. Specifically, native organisms were the exclusive target of pest organisms. Pests were identified as introduced in to Aotearoa New Zealand from elsewhere (by humans) and were exclusively foreign in origin, mammalian, and predatory on native organisms – mostly birds.

The concept of 'native' species was used when participants discussed their peril in the face of 'predators'. This was often the rationale given for the removal of pest organisms. This was especially so once the participants established that these indigenous organisms were 'threatened' by the predator species, which made it necessary to remove the 'pest' with the aid of 1080, a cheap and effective poison. Interestingly, there was only a single reference in the

participants' entire data set to the concept of 'endemic', used by a student to refer to a local population of native birds in the Hunua water catchment area south-east of Auckland. Aside from this single example, the use of the concept of native was widespread and exclusive to the point of excluding any reference to localised populations of 'endemic' wildlife, native or otherwise; either here in Aotearoa New Zealand or beyond our shores.

These views are in line with those expressed by the general population detailed in the comparative report by Russell (2014). The survey reports that people are concerned about the impact of possums on both agriculture and conservation, suggesting that on either count management of possums would be acceptable to the community. Russell notes that attitudes have changed towards how native species are valued in comparison with introduced species, as measured by the pleasure people derive from them. For example, 92% of respondents to Russell's 2012 survey considered seeing possums as least pleasurable, whereas native species, including "charismatic" birds (kiwi and takahe) are still most valued (p. 147). According to Russell, such contrasting views reflect an ongoing negative bias in attitudes of New Zealanders to pest animals in line with a broadening appreciation of native fauna diversity in New Zealand, beyond those species that historically dominated conservation initiatives (Russell, 2014).

The biological concept of introduced (species)

In a similar way to *how* the participants described native wildlife as 'residents' of Aotearoa New Zealand, they expressed their understanding of the concept of introduced/exotic wildlife as having been intentionally brought into Aotearoa New Zealand by humans. Then, once established in an area, they prey upon native populations.

While the participants understood that these intentional introductions were originally for agricultural or recreational reasons, they were unaware that introduced species can also arrive unintentionally as "hitch-hiking commensal species (e.g. rodents)" (Russell, 2014, p. 136). Also, although the participants were unaware that introduced species can have commercial and recreational value as game animals (e.g. deer), they were aware that possums were valued for their fur despite their "negative impact on forests and agriculture" (Russell, 2014, p. 136).

The participants mostly used the concept of introduced in contrast to their understanding of the concept of native. For them, introduced meant *not* native and referred to animals new to an area already occupied by other wildlife which, if 'native', would lead to the non-native organism becoming a pest in that area. This 'if – then' condition was used by the participants

to characterise the relationship between introduced and native organisms with the former becoming a pest upon the latter. As a biological concept, the participants understood 'introduced' species as predator organisms that consumed native wildlife.

Therefore, participants' understanding of the sociocultural nature and severity of the impact of introduced wildlife was restricted to the contrasting origins of native and introduced species. Few participants recognised that the absence of most terrestrial mammals, which distinguishes Aotearoa New Zealand from continental environments (Russell, 2014, p. 137), as an important factor. Instead, the participants' understanding was more closely related to their perception of which group would be classified as pests and which group would not. For example, the participants universally understood that introduced animals can become pests that prey upon native animals and that the most commonly used example was the rat.

The biological concept of pest (species)

The participants' understanding of pest related to their perception of the negative impact of pest animals on native wildlife populations which related directly to their high priority for control.

The biological concept of pest species was understood by the participants in this research as related to their origin from beyond these shores and that these mammals preyed upon native species. Therefore, pest species were portrayed as organisms that needed to be controlled by using 1080 poison for the benefit of native species populations and because of the harm they cause to commonly-named (native) species, especially birds.

According to the participants, the 'harm' caused by these pest animals was almost exclusively ecological and described as targeting native flora and fauna. The negative impact of pests on native wildlife was largely restricted to a numerical impact of one (pest) population (for example rats) on the target (native) population (for example takahe). Agricultural harm was rarely expressed, and any impact economically and socially was seldom mentioned.

Russell's (2014) report revealed a view that a pest is an organism that detracts from the outdoors experience and identified as the highest priority for management (p. 147). While hunted large mammals (deer and chamois) were considered both a pest and a resource, rodents and possums were mostly considered pests (p. 141). Those animals considered as pests were most likely to be smaller animals and targeted for extermination rather than managed as a resource or controlled as in the case of the larger animals such as deer and pigs (p. 142). Unlike the respondents in Russell's report, the participants did not directly associate pest activity with

a consequential loss in the enjoyment of the outdoors. Instead, the participants' focus remained on the detriment they caused to named populations of native organisms, which needed protection from this harm.

The biological concept of pest control

The biological concept of pest control (not to be confused with the concept of biological pest control) used by the participants focused on the removal of target organisms by traditional methods such as shooting, by poisoning using 1080 or a combination of methods.

The participants frequently expressed their support of the use of 1080 was on the condition that it was to be used in conjunction with other 'traditional' methods of control and only until a safer but equally effective alternative is found. Russell (2014) noted that 1080 use has more acceptance if delivered in ground-based operations than the alternative 'indiscriminate' method of aerial application (pp. 147-148). However, amongst the participants their support or opposition did not appear to differentiate between these two methods of application – for them it was exclusively about the use of 1080 regardless of the method of application. There was no evidence from the participants in this research that the different methods of toxin delivery – aerial versus ground-based, featured in their justified positions on 1080 use.

National surveys reported that overall, people regarded small herbivores such as possums and predators such as rodents as pests and that there should be a focus on control or extermination using multiple methods – which included 1080 poison (Green & Rohan, 2012; Russell, 2014). For example, Russell (2014, p. 144) notes that in 2012, 42% of the respondents believed that poisons such as 1080 should be allowed, whereas 40% believed they should not be allowed. In the 2007 ERMA survey reported by Green and Rohan (2012, p. 188), 37.3% opposed the re-registration of 1080 and 62.6% supported doing so. This support for continued 1080 use is comparable with the position on 1080 use taken by participants in this research. This was especially so for the participants in favour of 1080 who used biological science knowledge to justify their position.

Russell (2014, p. 137) reminds us that attitudes of a wide range of people play an important role in the management of introduced wildlife. He records that the 1994 survey revealed that, overall, New Zealanders had more of a utilitarian (balancing the greater good) than protectionist (preservation for their own sake) attitude to introduced wildlife. For those who expressed this attitude, Russell notes they were also sensitive to global trends in biodiversity and conservation management (2014, p. 138), with respect to poison use and animal welfare.

It is inescapable that pest control is understood by those participants who used the term to refer to a range of methods to manage populations of possums and rodents. Pest control is justified on the basis that as pest animals, the negative impact of their activities on other (mostly native) species and our environment requires measures to attempt to exterminate them as reflected by the oft-quoted phrase "The only good possum is a dead possum." (Potts, 2009, p.2). According to Potts (2009) anti-possum rhetoric in Aotearoa New Zealand typified by this phrase has its origins in response to the environmentalist movement and a greater awareness and concern for native wildlife and habitats; and partly because the threat possums potentially pose to the country's economy (2009, p. 2).

Specifically, evidence contained in the views expressed by the participants supportive of 1080 seems to reflect two distinctive but parallel narratives described by Potts (2009) as the "foreign threat narrative" (p. 3) and the "revenge narrative" (p.7). In the "foreign threat narrative" the possum is a pest, a successful invader that has largely conquered New Zealand's forests and is a threat to the substantial farming sector. The possum spreads, infects, invades, attacks and kills (2009, p. 3).

Potts (2009) identifies as a related discourse the "revenge narrative" that condemns the possum for having deliberately caused such devastation. The rhetoric here favours revenge and punishment and more likely to be used as a reason to remove the possum. Potts argues that the possum is represented irrationally – as inherently malevolent and deliberately malicious a discourse described as denigrating and can counter-intuitively violate the rights of a species (2009, p. 3). Potts concludes that possums are as much victims of human colonisation and exploitation as the native animals of Aotearoa (2009, p. 18).

To better understand the origin of the view that a pest organism is one that must be controlled or exterminated is interesting and worthy of further consideration. According to Pierotti (2010), people who hold to the Western scientific tradition tend to regard themselves as prey (2010, p. 49) and hence try to exterminate any potential predator.

The Western attitude of hostility is used to portray the relationship between non-human predators and their prey (Pierotti, 2010, p. 50). Pierotti refers to the example of how the Western perception of humans as prey emerges from the Judeo-Christian tradition. For example, he refers to the description of Jesus Christ as "the lamb of God" who, as the Saviour of mankind, is regarded as a prey organism to be sacrificed. Based on the ethic of human domination over nature (Johnson, 1992), Pierotti argues that such belief systems have led to the extermination of wolves and other organisms deemed threatening as predators of human

prey or any other animal that appears under the protection of humans. From these types of examples, Pierotti concludes that they illustrate how scientific concepts of predator and prey begin to take on a cultural meaning whilst still retaining their original 'scientific' meaning. We begin to see the emergence of a co-existent cultural and scientific epistemology.

Finally, the use by the participants of these six biological science concepts have demonstrated their understanding of the complexity of interactions that take place between organisms and their environment. They also identified human impacts on a biological situation to develop a reasoned viewpoint based on critical thinking around ethical, social and biological implications of human activities.

8.4 Identifying the mātauranga Māori concepts used

This section answers the research question, "What mātauranga Māori concepts are identified?" when participants justified their positions on 1080 use. The seven key mātauranga Māori concepts identified from the data analysis of the participants' written NCEA assessment scripts and presented in the Positional Analysis Grid (Appendix N), are recorded in Table 8.2 and displayed in Figure 8.2.

Table 8.2
Mātauranga Māori concept multi-response statements

Concept	Supporting 1080	Opposing 1080	Total	Percent
Whakapapa	18	15	33	30.0
Mauri	7	6	13	11.8
Wairuatanga	2	1	3	2.7
Mana	7	1	8	7.3
Tikanga	22	3	25	22.7
Manaakitanga	7	3	10	9.1
Kaitiakitanga	13	5	18	16.4
Total	76	34	110	

Table 8.2 gathers the number of times participants made statements and is displayed in Figure 8.2. It is an indicative snapshot of the full data spread found in Appendix N. This information shows a breakdown of the 110 multi-response statements, which referred to these seven mātauranga Māori concepts. In total, 76 (69.1%) statements supported 1080 use, while 34 (30.9%) statements opposed 1080 use. In descending order, the mātauranga Māori concepts used by the participants were: whakapapa, 33 (30.0%); tikanga, 25 (22.7%); kaitiakitanga, 18 (16.4%), mauri 13 (11.8%); followed by manaakitanga, 10 (9.1%); mana, 8 (7.3%); and

wairuatanga, 3 (2.7%). These concepts used by the participants, exhibit a broad, inclusive set of mātauranga Māori concepts from within this issue.

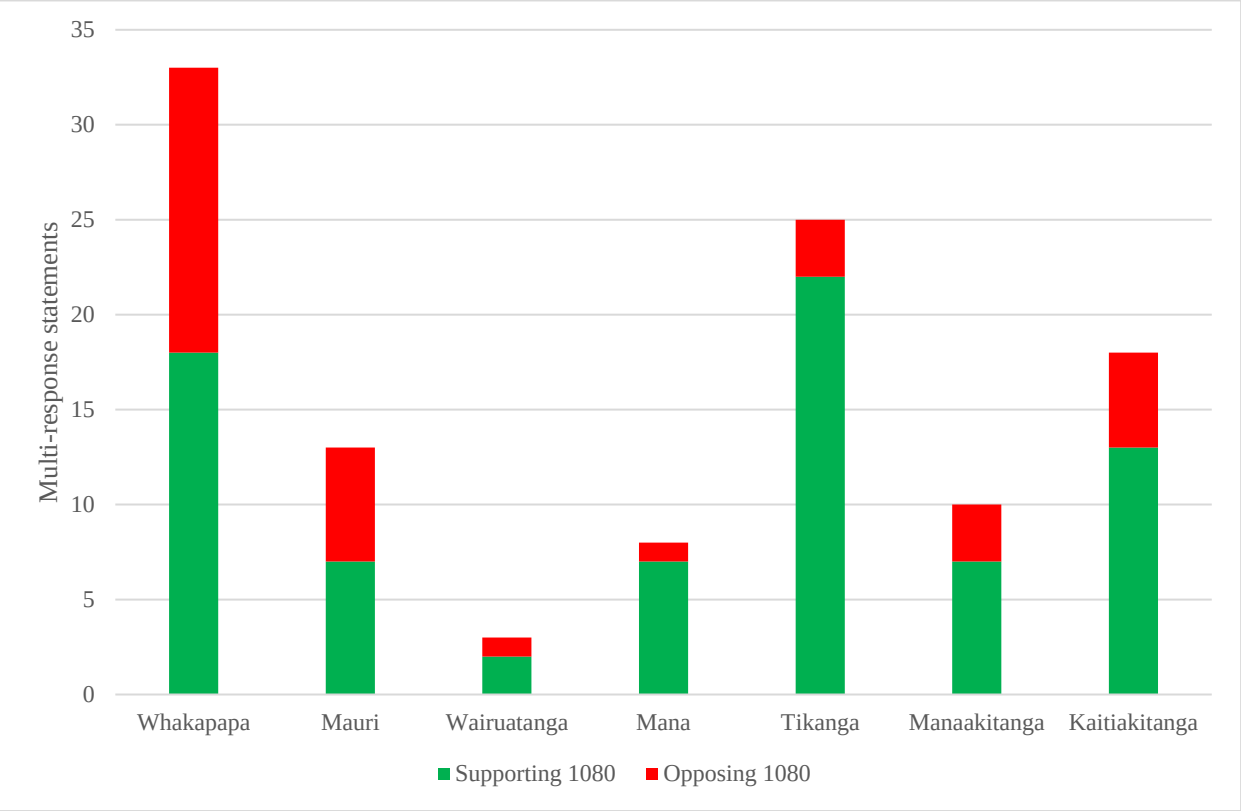


Figure 8.2. The seven mātauranga Māori concepts used by the participants in justifying their position on 1080.

8.5 The use of mātauranga Māori concepts

This section answers the research question, "How do the participants *use* mātauranga Māori concepts to justify their position within the socio-scientific issue?" To examine participants' positions on 1080 use, a breakdown of the multi-response data presented in the Positional Analysis Grid (Appendix N) is displayed in Figure 8.2. Of interest, Appendix N reveals that whereas the 76 multi-response statements referring to mātauranga Māori concepts in support of 1080 use were mentioned by eight of the participants, only two participants – Rose and Dee were responsible for all 34 multi-response statements opposed to 1080 use.

Figure 8.2 shows the indicative spread of the numbers of statements made which used the concept and indicates the relative proportion of statements for each concept used in support of 1080 (in green) and the number of statements for each concept used in opposing 1080 (in red). It shows that for some concepts (e.g. whakapapa and mauri) the number of statements for and against 1080 were approximately equal. Whereas for others (e.g. tikanga and kaitiakitanga), there were noticeably more statements made by those in favour of 1080 compared to those

statements opposed. The full data set presented in Appendix N shows how this research is giving voice to these concepts used by the participants when in context. It is proposed that this research fills an important gap in our knowledge and understanding of views towards 1080 from a mātauranga Māori perspective.

Until now there has only been some general survey research on the views people hold towards introduced wildlife (Russell, 2014) and 1080 use (Green & Rohan, 2012). Both surveys revealed that Māori views towards 1080 use are neither widely documented nor deeply understood. Up to now, the available research stops short of an in-depth analysis of Māori views on 1080 use. Specifically, there has been no concrete evidence of an attempt to understand the importance to and use of mātauranga Māori concepts when justifying a position on 1080 use. This opened the opportunity for this research to go further and investigate *how* mātauranga Māori concepts are used in support of participants' views on 1080 use.

The data presented in Appendix N is the first attempt to explore this use in detail and combines position, use and concept into one analysis. Starting with the data from the Positional Analysis Grid in Appendix N, the discussion turns to *how* each of the seven mātauranga Māori concepts were used by the participants to support their justified position on 1080 use, beginning with mātauranga Māori concept of whakapapa.

The mātauranga Māori concept of whakapapa

All participants considered whakapapa central to their worldview and called upon this concept to support their position. The data displayed in Appendix N and presented in Table 8.2 shows that almost a third (30%) of the total number of statements referenced the mātauranga Māori concept of whakapapa. Of these 33 statements, there was almost an equal number from participants opposed to 1080 use (15) as there were in support (18). The participants' universal use of whakapapa was unrelated to their position towards 1080. Instead, the concept was used widely by participants, by those who supported 1080 use and those opposed in approximately equal measure.

From the data presented in Appendix N, and analysed in Chapter 6, the universal functionality of whakapapa, and its non-disjunctive representation of the living and non-living elements of the natural world emerged. The participants expressed this through three key ideas: kinship of all living things descended from the gods; unity between humans and non-living elements of the natural world e.g. land; and, the source of knowledge inherited from ancestors.

First, is the kinship idea of all living things descended from the gods. Whakapapa was expressed by the participants in general terms as the descending of all living creatures from the gods and featured through references they made to god as the creator. This aligns with Māori cosmogony where all things are related (Roberts, 2013; Hikuroa, 2017) through descent from one set of primal parents – Ranginui and Papatūānuku.

For those participants who mentioned descent from the gods, the idea that there is a close relationship between human forms and other living creatures is not a distant concept to them. For example, Patterson (1992, p. 47) points out that the gods from which humans and all creatures are descended are at the core of Māori understanding about and caring for the natural environment. This comes from the core belief that these gods are not distant and remote but are all seeing and omnipresent. They do not exist in a distant realm, looking at us as if through "supernatural binoculars"; they are right here in the natural world we live in, i.e. in the forests and the waters (Patterson, 1992, p. 47).

Second, is the idea of unity among humans, living and non-living elements of the natural world. The notion that all things are related through descent from Ranginui and Papatūānuku leads on to the view that there is no distinction made between the inanimate and the animate or between abiotic and biotic (Tipa & Nelson, 2008, p. 314). Participants commonly used references to the connection humans have with land through whakapapa which echoes a TEK approach which affirms the participants' holistic view of the living and non-living elements of the natural world which are interconnected and cannot be understood or explained in isolation (Johnson, 1992, p. 7).

Participants viewed all life forms as interdependent through kinship and without an inherent right to control and exploit nature for their own interests at the expense of other life forms (Johnson, 1992, p. 7). Rooted in social context, the world is seen through social and spiritual relations between all life forms. As explained by Johnson, reciprocity and obligations towards community and other life forms and communal resource management is based on shared knowledge and meaning where the environment is not a discrete and compartmentalised entity, but as unified whole (Johnson, 1992, p. 8). For those participants who used the whakapapa concept, they understood this unity amongst all life forms.

From this understanding comes the duty of care passed down from ancestors to descendants, to nurture and protect places, natural resources and taonga as kaitiaki, and its related term kaitiakitanga (guardianship, stewardship and resource management) which is deeply embedded in tikanga (Muru-Lanning, 2016, p. 144). For the participants, they were aware of

the need to enact this duty of care and to extend this care to the living and non-living world. This is an example of the type of close relationship particularly with land, that Roberts (2012) points out, which is emphasised in genealogical (whakapapa) accounts and symbolised by the words 'tangata whenua' in which 'tangata' means people and 'whenua' placenta; thus, humans are the children of the earth mother Papatūānuku (p. 747).

Third, is that whakapapa is the source of *knowledge* inherited from ancestors. Participants were able to express the idea that humans gain knowledge and understanding from the natural world passed down from ancestors connected through whakapapa (Hikuroa, 2017, p. 6). This relates to the general principle that orders the universe (Salmond, 1991), which demonstrates an interconnectivity between everything (Salmond 2000), and is a cognitive genealogical framework connecting creation of the universe to everything that exists within via descent from ancestors (Marsden & Royal, 2003; Roberts, 2013). Here, the participants understood that humans gain knowledge through an ongoing, intimate contact with the resources of the natural environment.

The mātauranga Māori concept of mauri

Craig, Taonui and Wild (2012) describe mauri along with whakapapa as the physical life principle found in water, land and forests. Also found in mist, wind, soil and rocks – mauri is the force that interpenetrates all things to bind and knit them together (Marsden & Henare, 2002).

From the analysis of the participants' data presented in Appendix N and Table 8.2, four key ideas demonstrated their understanding and use of mauri. These are: a force that links the physical to the spiritual world; source of respect towards all things; vitality and fruitfulness of the natural environment; and, an enabler for everything to live in accordance with the conditions and limits of its existence.

Firstly, comes the idea that mauri is a force that links the physical to the spiritual world. Participants who referred to this idea typically used references to terms such as an equality or unity derived from whakapapa. For some, the link was expressed by describing the 'relationship' or 'cultural connection' between humans and the spiritual world. Marsden states that mauri is the life force that generates regenerates and upholds creation (Marsden & Royal, 2003). It is the bonding element that knits all the diverse elements together to give creation its unity and diversity.

Second is the idea that mauri is the source of respect that humans must show towards all things. Participants saw this respect as mutual and exercised through obligations to preserve and protect the environment from harm to actively nurture the mauri. This echoes the stance described by Marsden (Marsden & Royal, 2003) who notes that in human's relationship with the physical universe, mauri refers to the life force (and spirit wairua) that must be respected and supported.

While Marsden discussed the connection of the wellbeing of humans corresponding to the wellbeing of the earth (Marsden & Royal, 2003, p. 51), the participants referenced this aspect indirectly by stating that 1080 use is disrespectful and would be disruptive and disturbing to the 'connection' (i.e., the mauri) living things have with the physical environment.

Third, is the vitality and fruitfulness of the natural environment. This indicator of the presence of mauri also extended to understanding that a 'flourishing' environment signaled a vitality and strength of the mauri of the area. For some, their support for 1080 relied on their belief that by the removal of the pest organisms, removed the threat to the physical and spiritual strength of the environment – the restoration of mauri, order was restored. In the face of environmental destruction, restoring the balance and vitality of an area also restores the mauri (Hikuroa, Slade & Gravley, 2011, p. 2).

Fourth, is that mauri is an enabler for everything to live in accordance with the conditions and limits of its existence. With an understanding that mauri was a force or energy of living things (Marsden & Royal, 2003, p. 44), the participants who called for the removal of the pest organisms believed strongly that, by doing so, it would enable non-pest organisms to live free of the threat posed by the presence of the predators. The participants saw the restoration of the natural order of things as a sign of the return and strengthening of the mauri of the living and non-living elements of the landscape – an environment free of pests.

The mātauranga Māori concept of wairuatanga

Essentially this is spirituality, derived from whakapapa. From the analysis of the participants' data presented in Appendix N and Table 8.2, their use and understanding of wairuatanga was expressed through three key ideas: the material world is subordinate to the spiritual world; there is a spiritual connection to the land; and, this can be acknowledged and reinforced through ritual incantations to ensure spiritual oneness and safety.

Firstly, is the idea that the material world is subordinate to the spiritual world. As described by Harmsworth (2004, p. 10), wairuatanga tunes to an individual's spiritual side (wairua). It

is also an acknowledgement of a higher order world that precedes and is above the material, physical world of Te Ao Mārama (Māori equivalent to biodiversity). For example, 1080 opponent Rose succinctly expressed that the spiritual dimension for Māori as people ranked ahead of the economic dimension.

Spirituality is seen as synonymous with values which are the cornerstones of the Māori worldview – how Māori see it and believe it to be (Macfarlane 2004 p. 41). For example, Māori understand that material possessions and objects are physical treasures (taonga) and have intangible spiritual qualities, imbued with mana and tapu – sacredness due to the presence of spiritual forces from creation (Craig, Taonui & Wild, 2012, p. 1033). These participants also understood the primacy and origin of the spiritual elements derived from a whakapapa connection to the spirit ancestors when using the concept of wairuatanga.

Second, there is a spiritual connection to the land. Land as a tangible taonga has a complex psycho-spiritual relationship between Māori, their ancestors, ancestral lands and waters (Craig, Taonui & Wild, 2012, p. 1034). To understand this perception is to accept that the natural surroundings of Māori include the physical and spiritual landscape; and that the spiritual and material world are connected. Hence, Māori regard their physical, spiritual, social and cultural well-being as linked to Papatūānuku; that is, to be the personification of the land as the earth mother of all life (Craig, Taonui & Wild, 2012, p. 1030). Arising from their understanding of this connection, the participants were aware of the effects that 1080 could have on the living and non-living taonga of the environment, specifically, to the things "highly prized, tangible and intangible, material and spiritual" (Craig, Taonui and Wild, 2012, p. 1036).

Third, karakia/incantations can ensure spiritual safety. This idea manifested in participants' stories that showed the importance to them of valuing the primacy of the spiritual world during encounters with the physical world. They were clear that they were required in accordance with tikanga to perform ritual incantations to the unseen forces of creation and that by doing so ensured a spiritual oneness and safety. This is in line with the tangible and intangible spiritual qualities imbued from creation described by Craig, Taonui and Wild (2012, p. 1033). They state that the possession of a taonga is related to mana (prestige, status or authority), but also a spiritual authority to command tapu or spiritual qualities or forces of creation (Craig, Taonui &Wild, 2012, p. 1036). For example, Chloe clearly demonstrated this understanding in her description of how she witnessed the reciting of karakia in a forest setting prior to the removal of plant material for use in Rongoā Māori (Māori natural healing remedies).

This research shows that these incantations described in Chloe's recollection of the forest visit acknowledged that the taonga of land and its bounty are simultaneously material and spiritual (Craig, Taonui & Wild, 2012). Chloe's description affirmed a degree of indivisibility of the plant material (tangible form of taonga) from its spiritual qualities (Craig, Taonui & Wild, 2012). Karakia and incantations also affirmed the importance of spiritual safety (Warren, Webster & Kiriona 2006, p. 193), and confirmed her understanding of how the spiritual dimension is closely connected to health-related products in ways described by Durie (1994, p. 69) as "unseen and unspoken energies."

The mātauranga Māori concept of mana/mana whenua

The concept of mana is described by Marsden as a divine authority delegated from the gods to their human agent (Marsden & Royal, 2003, p. 40). From the analysis of the participants' data presented in Appendix N and Table 8.2, two key ideas demonstrated their understanding of mana: mana is the power of the gods, ancestors, land and the individual; and, that mana whenua is the authority/control over the management of natural resources.

First, is the idea that mana is the power of the gods, ancestors, land and the individual. The possession of a taonga is related to mana (prestige, status or authority), but is also a spiritual authority to command tapu or spiritual qualities or forces of creation (Craig, Taonui & Wild, 2012, p. 1036). For the 1080 opponent Rose, the relationship humans have with 'nature' is the source of the power associated with mana, and that this relationship imbued individuals with status and prestige.

Second, is the idea that mana – specifically mana whenua – is a power and/or control or authority over land and its resources. Several participants, for example, the 1080 supporters Lavinia and Sam, referred to mana as exercised over natural resources and typically used terms such as power or the authority or control a tribal group has over an area and its resources.

Mana was interpreted and applied by the participants to the 1080 issue in terms of behaviours and actions which were inclusive and consultative. This was especially important for participants such as Anders and Sam who recognised procedural shortcomings from Auckland Council. They called for open dialogue with local iwi prior to any proposed 1080 drop. This authority was recognised whenever participants called for an inclusive consultation with the local Māori inhabitants who were in most cases the people who had mana whenua over the area where the proposed 1080 drop was planned to take place. This illustrated that these participants understood the practical application of the mana concept – both as an authority

over resources and how, by including local iwi in all elements of the 1080 operation from beginning to end, consultation enhanced the mana of everyone involved.

The mātauranga Māori concept of tikanga

As the practical face of Māori knowledge (Mead, 2006), all tikanga Māori are firmly embedded in mātauranga Māori and puts this knowledge into practice. From the analysis of the participants' data presented in Appendix N and Table 8.2, two key ideas demonstrated their understanding of tikanga as an expression of values and as customary practices, beliefs, rituals and protocols.

Firstly, is the idea that tikanga represents a values position of accepted behaviours and views towards 1080, the target organism and the environment. The value participants placed on the pest animal lay at the heart of this. They recognised and gave priority to their belief that the possum is a living creature to be valued ahead of its status as a pest organism. The possum was valued as having life itself and, along with all other living creatures, deserved valuing. Valuing a species relates to the concept of taonga. Therefore, by valuing a species, the participants were expressing an understanding of the species as taonga – an inclusive holistic term for an object of 'good or value' (Marsden & Royal, 2003, p. 38).

Those participants who saw the effects of 1080 on the animal and regarded the use of 1080 as an inhumane control method, which caused the unnecessary suffering of the organism, further broadened this ethical/values laden perspective. Manu, Dee and Nadia who argued from this perspective expressed a strong degree of empathy. This affirms the importance of a 'Māori ethic' related to tikanga explained by Marsden as one that 'focuses on the right way of doing something' (Marsden & Royal, 2003).

Second, is the idea that tikanga represents a customary set of ritualised, accepted practices and protocols. Although commonly interpreted by scholars as quite specific actions or behaviours that are correct, right and appropriate (tika) (Royal, 2004, p. 217), participants were non-specific with reference to tikanga as a concept. The participants were quite adamant that 1080 use would run counter to accepted tikanga practices. Specifically, these concerned the accepted, culturally determined behaviours humans were required to demonstrate when they interact with the environment and to respect the general guidelines of acceptable behaviour (Mead, 2006).

These guidelines, or protocols, associated with the correct practice of a tikanga can control interpersonal relationships and provide ways for groups to meet and interact, and can even

determine how individuals identify themselves (Mead, 2006). The participants, for example Anders and Lavinia, referenced the importance of acknowledging the mana of individuals and groups as they called for open dialogue and inclusion, understood the importance of tikanga as a guide to managing these encounters.

The reference to tikanga in this way confirms the observations made by Warren, Webster and Kiriona (2006, p. 195) who describe tikanga from a youth perspective as including "customs, protocol, common sense, protection, different tikanga for different places, maintenance of identity, and guidelines for what should and shouldn't be done in life." For these participants, such as Anders and Lavinia, it was all about the 'demeanour' required for acceptable behaviour towards land as an example of tikanga in action. Respecting and adhering to tikanga and ritenga provides an essential safeguard particularly when embarking on a new venture (Roberts et al., 2004, p. 22). Through tikanga, Māori are "empowered to participate in the management of biological resources" (Millner & Sciascia, 1997, p. 2).

With specific reference to 1080, participants such as the 1080 opponents Rose and Dee strongly believed that its use is contradictory to and a breach of Māori customary belief structures, which can cause moral or spiritual offence. This view was expressed regardless of the position taken by the participants who acknowledged the negative impact the use of 1080 would have on Māori customary beliefs. Finally, this justification was widely held by the participants for example Sam and Chloe who maintained their support for 1080 use despite their acknowledgement that its use would contradict Māori customary practices.

Furthermore, the participants were able to apply their understanding of important elements of socially acceptable behaviours when calling for actions that involved efforts to gain local Māori support by direct dialogue prior to a 1080 operation. To understand the significance of this, Roberts et al., (2004, p. 22) offers the following observation that "While adherence to tikanga reduces the risks to both individuals and society from abnormal behaviour or wrongdoing, sometimes it is by deliberately flouting culturally embedded norms that important and beneficial changes are brought about." Therefore, what may appear to be a contradictory position, participants seem to be quite able to see and state the benefits of applying their interpretation of socially acceptable practices, as the situation requires.

The mātauranga Māori concept of manaakitanga

Essentially, manaakitanga is predominantly about reciprocation and is exercised in several different ways. This is about ensuring safety (cultural, personal, spiritual, mental, and social)

(Warren, Webster & Kiriona, 2006, p. 193). From the analysis of the participants' data presented in Appendix N and Table 8.2, three key ideas demonstrated their understanding of manaakitanga: acts of caring by showing respect and kindness, holistic nurturing of relationships through reciprocation, and, by demonstrating mana-enhancing behaviours.

Firstly, the idea of manaakitanga is at the core of acts of caring through showing respect and kindness. The participants such as 1080 opponent Dee, demonstrated the importance of respecting all living elements of the natural world by not differentiating between native and introduced organisms. The participants respected both groups as living inhabitants of the natural world, although Dee also expressed support for 1080 with her belief that to remove pest organisms from the environment such as on pest-free islands represented acts of care and respect for the native wildlife ahead of the possum and rodents.

Secondly, holistic nurturing of relationships through reciprocation acknowledges worth and ensures safety. This is the idea that manaakitanga is relational and expressed through kinship and whanaungatanga. This was demonstrated by the acknowledgement of worthiness through acts of kindness. For example, the 1080 supporter Manu drew an analogy between the perceptions we hold as humans towards animals whom we regard as pests because of the negative impact they have on the environment whilst ignoring human impacts on a far more devastating scale. For Manu, all living creatures should be treated with care and compassion and be shown respect and kindness as part of the biodiversity of natural world – Te Ao Mārama.

Thirdly, demonstrating these acts of kindness enhanced the mana of the individuals involved and of the plants and animals who benefitted from these actions. For example, equal treatment for all animals was at the centre of 1080 opponent Dee's call for the respectful treatment of possums. For her, this represented respect of the mana inherent in all living organisms. Yet when it came to protect the bird life on Tiritiri Island sanctuary, Dee regarded the removal of all mammalian pests as an act of 'cleansing' for the island. She believed that doing so also enhanced the mana of two groups – firstly, those involved in the eradication of the pests and second, the resident birds who gained the freedom of the island because of pest eradication.

The mātauranga Māori concept of kaitiakitanga

The origins of kaitiakitanga come from a Māori belief that all elements of the natural world connect through descent from Ranginui – the sky father, and Papatūānuku – the earth mother and their children. Māori believe they have a familial relationship with the environment and

all its component parts (Kennedy, 2008, p. 5). From the analysis of the participants' data presented in Appendix N and Table 8.2, three key ideas demonstrated their understanding of kaitiakitanga. These are: active guardianship of the environment in accordance with tikanga, protection of the natural environment and its taonga, and, there are human, non-human and spiritual kaitiaki.

First, kaitiakitanga is a form of active environmental guardianship in accordance with tikanga. Participants were very clear that the removal of pest organisms from places such as Tiritiri Island demonstrated the role of kaitiaki in action. This pest removal demonstrated the enacting of a duty of care to the natural world and its resources. However, opponents saw 1080 use as directly contradicting the duty of care ethic which, for them was to care for all elements of the natural world as kin. Understandings like this are critical in shaping Māori management and use of the natural environment and its resources (Kennedy, 2008, p. 5). Once again, values featured strongly in the justifications of those opposed to 1080 use. This appears to show that the participants demonstrated a broad interpretation of the kaitiakitanga concept in line with Māori interpretations of kaitiakitanga as guardianship as suggested by Kawharu (2000, p. 352). However, as shown by the comments by 1080 supporter Sina, once participants were satisfied that kaitiaki adhered to culturally appropriate mechanisms whilst discharging their obligations to iwi, participants expressed support for 1080 use.

Second, kaitiakitanga involves the protection of the natural environment and its taonga. The participants viewed the exercise of kaitiakitanga as a duty Māori have to restore and protect the mauri of the natural world. Participants were aware of numerous examples of where people were the active guardians of the environment and they discussed the outcomes of these actions. For example, some participants such as the 1080 supporters Chloe and Spec, focused on the role of kaitiaki as protectors. The focus of human efforts to remove pests from offshore islands such as Tiritiri Matangi by using 1080 performed both a protective and environmentally cleansing function hence restoring the mauri of the area. Their examples represented an understanding of a wider definition of kaitiakitanga, as advocated by Kawharu (2000, p. 349), from 'guardianship' to 'resource management'.

Kaitiakitanga embraces social and environmental dimensions – human, material and non-material elements are all to be kept in balance. According to Kawharu, current use of kaitiakitanga has tended to emphasise conservation and protection (2000, p. 349), reflected by those participants who made references to Tiritiri Matangi and by Manu and those who called for tangata whenua to protect New Zealand's forests. This closely ties in with *how*, in their

written justifications, the participants *used* the kaitiakitanga concept when calling to 'save our native birds'.

Third, kaitiaki can be either human, non-human or spiritual. As an overarching traditional environmental principle for Māori, kaitiaki were spiritual guardians with responsibility for protecting elements, resources or places while contemporary environmental management kaitiaki responsibilities fall largely to tangata whenua (Kennedy, 2008, p. 6). For example, there were those participants, such as Rose who opposed 1080 because certain iwi regarded the kiore (Pacific rat) as a kaitiaki.

To conclude, the seven mātauranga Māori concepts used by the participants demonstrate their understanding of the appropriateness of the concept in Te Ao Māori and its application in support of their justified position on 1080 use.

8.6 Coexistent mātauranga Māori and biological science knowledge

This section answers the research question, "How do participants integrate mātauranga Māori and biological science concepts as they develop and present a justified response to the socio-scientific issue?" From the data of all 37 research participants displayed in Appendix N, 10 participants were identified who drew concepts from *both* knowledge worlds. By doing so, they created a common ground of shared knowledge space (Stephens, 2001), populated with numerous similarly expressed concepts and valid notions from *both* (Table 7.1).

This thesis argues that these actions validate the common ground as a multi-conceptual space whose inherent validity resides in the coexistence of Western scientific and indigenous mātauranga Māori knowledge concepts. Application of the concept of epistemic agency reveals *how* the participants *integrated both* knowledge systems and populated the cultural interface by drawing upon biological concepts *and* mātauranga Māori concepts to justify their support or opposition to the use of 1080. This section concludes with a reconceptualisation of the concept of the locale of the learner (Nakata, 2007).

Shared knowledge spaces

Within the 1080 controversy, dialogue in the public domain occurs when people articulate views on both sides of the issue. Within this space and within our biology classrooms, Western scientific discourse has been the dominant narrative. This research has demonstrated that a shared discussion space occurs where more than a single discourse can coexist within the controversy as shown by the voices of these 10 participants as they participated in the 1080

debate. Firstly, this section discusses which knowledge concepts have populated this shared space followed by how these concepts have been utilised in this shared space. Second, this section will argue that, consequently, we have gained a better understanding of the shared knowledge spaces at the cultural interface (Nakata, 2002).

Patterns within shared knowledge spaces

A closer inspection of the data presented in Appendix N, Figure 7.3 and Table 7.1 reveals several interesting patterns to the spread of concepts used. For example, analysis identified 10 participants who drew concepts from *both* knowledge worlds. This set them apart from the other participants. Each member of the group of 10 had their own unique numerical combination of concepts (see Table 7.1).

Furthermore, that it appears from this data spread that the third space described by Homi Bhabha (1994) is also far more complex "hybrid of multiple discourses" than originally proposed. For example, whereas some participants used a concept to support 1080 use, others used the same concept to oppose 1080 use. These initial observations suggest that this common ground space as a multi-patterned hybrid is far more complex than the dualistic notion of two shared knowledge worlds would suggest.

Therefore, this observation presents an early challenge to the use of the term 'integration' in the original research question that was stated at the outset of this research. Convergent knowledge spaces by their very existence are always not necessarily under any circumstances 'integrated'. Hence, the title of this section has been changed by substituting the word 'integrated' for the current term 'coexistent'. This signals an acceptance that while we have coexistent knowledge concepts, the degree to which they are integrated is yet to be determined.

Thus far, all that can be said is that we have identified those students who have drawn concepts from biological science knowledge *and* mātauranga Māori and that this has revealed a space filled by the participants with unique combinations of these concepts. A deeper level of analysis would be required to uncover evidence as to the existence of fully integrated knowledge concepts to indicate that any degree of hybridisation had occurred.

It is to be determined that amongst these 10 participants, evidence exists for them having integrated the concepts into their knowledge base (Wallace, 2004). If found, we would then be better positioned to assert that within this hybrid third space (Bhabha, 1994), we have evidence for how the production of new hybrid forms of biocultural knowledge occurs and what this new extended form of scientific literacy looks like. We would then have enough

evidence to offer an answer to the research question and offer a reply to the question raised by Roberts (2007) who asked, "What counts as scientific literacy (SL) today?" An answer to this question is proposed by Aikenhead (2007) who discusses Roberts' heuristic framework which he proposed for understanding and defining ideologies of SL which Roberts presented as a continuum between two extremes which he called Vision I and Vision II.

On the one hand we had Vision I which was described as scientist-centred and focused on decontextualised science subject matter (which Aikenhead termed Eurocentric science literacy). Its aim was to enculturate students into scientific disciplines (pre-professional training) and had as an outcome the traditional status-quo school science, or assessments based on narrowly defined scientific literacy. On the other was Vision II which was student-centred, and context driven. Its aim was to enculturate students into their local, national, and global communities (as many other school subjects do).

In both, Aikenhead notes that despite these aims, the scientific literacy achieved was firmly Eurocentric in nature. Aikenhead (2007, p. 68) called for an expansion of this dualistic representation by adding a third dimension to Roberts' heuristic framework by proposing a Vision III SL ideology which in this research is more in line with an integrated knowledge world and context-driven, pluralist notion of science literacy. The evidence presented in this research thus far that indicates the presence of patterns resulting from the multiple combinations of knowledge concepts from the biological science *and* mātauranga Māori knowledge worlds that could suggest evidence of a Vision III scientific literacy.

Up to this point, we have established the patterns of the concepts used by the participants. The second major finding is discussed next, as we explore *how* these concepts were used by looking closely at the participants' epistemic agency and the cultural interface.

Epistemic agency at the cultural interface

Martin Nakata (2002, 2007) theorised the formal learning space of the cultural interface by describing "the place where we live and learn, and relationships develop, the place that conditions our lives and shapes our futures, where we are active agents in our own lives and where we make decisions – our life world" (Nakata, 2002, p. 285). While this interface has been described as a multi-layered, multi-dimensional space of dynamic relations where different systems of thought and different knowledge systems converge (Kahu & Nelson, 2018), we do not know very much about what these dynamic relations look like. In addition, while the cultural interface concept developed the notion of the common ground to be a space

where knowledge concepts converged, the question, discussed in the next section, will be how this convergence takes place.

Until now, while we can say that by populating the cultural interface with their knowledge concepts when justifying their position on 1080, the actions of the participants have confirmed the interface as a knowledge convergence space; there is an opportunity to learn more about how these concepts from the two knowledge worlds interact.

To do this, Nakata's notion of the cultural interface as an agentic space gave this research the opening to use the concept of learner agency to explore *how* the participants *used* these concepts and to explain the patterns found in the data set. Nakata's (2002) view of the interface as a place where learners are active agents as decision-makers sets up the concept of the cultural interface as an agentic space where the importance to learners of their personal agency is recognised.

It is within this space that the literature argues there is a 'free-flowing interaction' (Meredith, 1999) between the knowledge worlds where learners negotiate 'the expanse in between'. Therefore, this definition was extrapolated in this research to encompass students' negotiation of knowledge concepts when they enacted their epistemic agency (Zimmerman & Weible, 2018) by engaging with and mobilising their knowledge resources in an authentic situation in ways that are new for them (Varelas, Settlage & Mensah, 2015, p. 439).

It was established and shown in Chapter 7 that at the cultural interface the participants displayed any one or a combination of these three processes: to engage with knowledge concepts from both knowledge worlds where they actively decide to include or discard information as they ***position*** (**P**) themselves. During the process they negotiate and critique the relevance, suitability or compatibility of the information as they ***navigate*** (**N**) along the knowledge landscape whilst recounting their own or others' ***experiences*** (**E**).

How the participants used the knowledge concepts as they applied these agentic processes characterised their cultural interface as conflicted, parallel or connected. Table 7.4 showed the relationship between the combinations of the agentic processes and their cultural interface. For example, there were many instances where the participants made single statements which contained reference to a specific agentic process. On closer inspection, it became evident and of interest that the participants also used combinations of two or three processes within a single statement. These were mostly paired statements but occasionally, there were single statements made by the participants which contained all three agentic processes nearby.

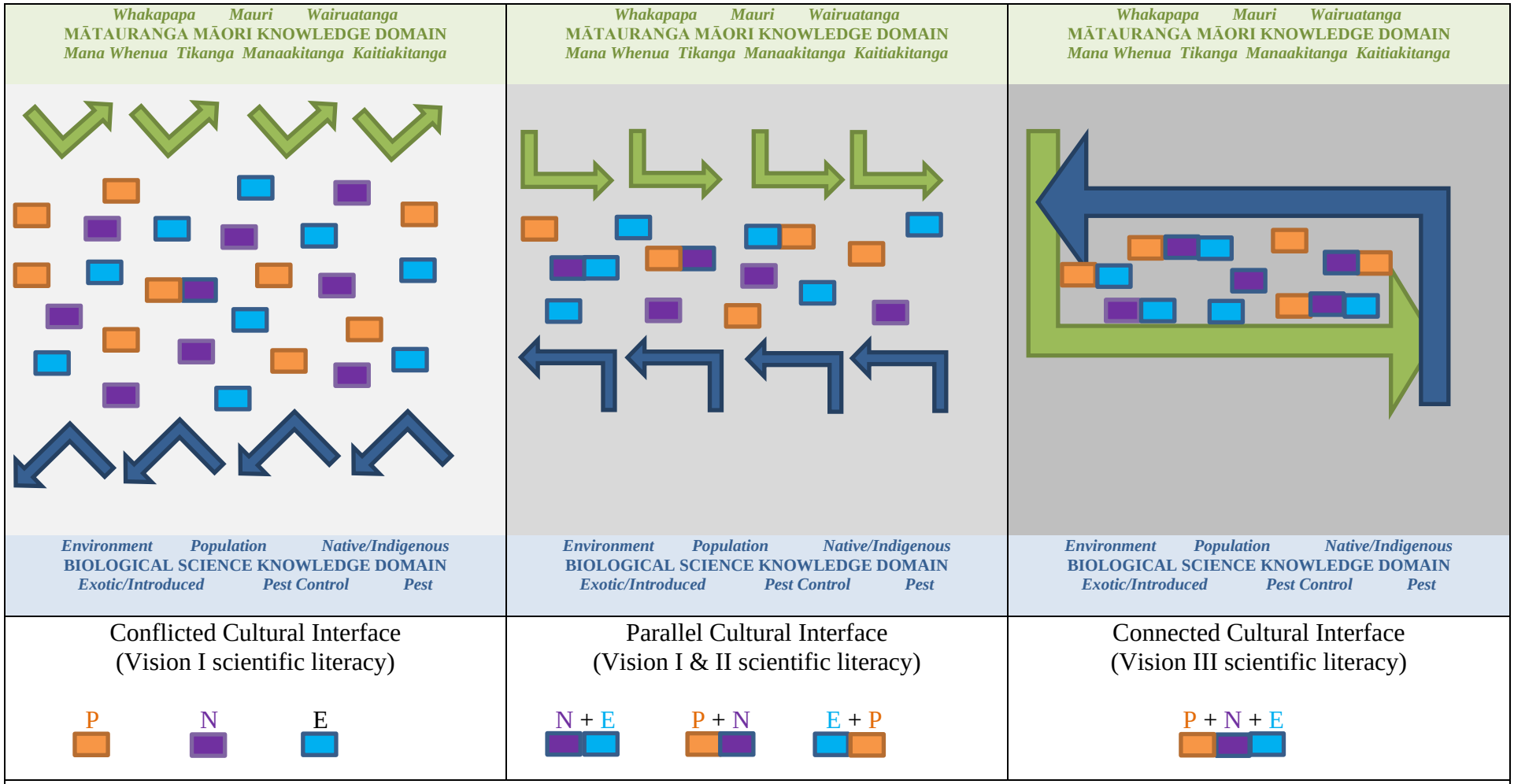
Upon further analysis of this feature, Table 7.4 was composed from the 10 participants' data to see if there were any trends or features evident and if these bore any relationship to their knowledge interface. It shows that all the participants used at least two of the three agentic processes in various combinations within a single statement, (either **P** + **N**, **P** + **E** or **N** + **E**) and four participants (Sam, Nadia, Lavinia and Chloe) used all three, (**P** + **N** + **E**). Therefore, the trends and features revealed at each interface were:

- At a conflicted interface.
    - That is for Manu, he used each of the processes in single un-combined statements with one exception when he combined position and navigation (**P** + **N**). Apart from this, he did not combine any other agentic processes in close proximity. Hence, **P**, or **N**, or **E** were, with a single exception, exclusively used as separate stand-alone statements.
- At a parallel cultural interface.
    - The participants combined two agentic processes such as either **P** + **N**, **P** + **E** or **N** + **E**.
- At a connected cultural interface.
    - The participants engaged all three agentic processes: position, navigation and experiencing (**P** + **N** + **E**).
    - All three agentic processes are used in close proximity within a single statement.

This was a feature shared by all four connected knowledge world inhabitants. From this it may be concluded that the active and proximal combination of all three agentic processes is one important criterion for a connected cultural interface.

It has also been established that epistemic agency is primarily a decision-making process which is enhanced when participants include evidence of their own or others' experiences when faced with deciding which knowledge concepts to use to support their justified position on the issue. Experiences are especially important for interface learners at the connected knowledge-world interface. These experiences were an enabling factor for those who combined all three agentic processes at the connected interface. Sam, Nadia, Lavinia and Chloe exhibited the complete interface experience that saw them able to fully connect and weave together relevant scientific and cultural concepts using all three agentic processes of positioning, navigating and experiencing as they mobilised their knowledge resources.

From this, it can be proposed that we now have sufficient information concerning the agentic processes the participants applied to their use of knowledge concepts. Therefore, we can now characterise each cultural interface in terms of epistemic agency. This is shown in Figure 8.3.



Trends from left to right: 1. Increasing proximity and combination of concepts from both knowledge worlds. 2. Increasing hybridisation of knowledge concepts, and 3. Increasing complexity of agentic processes from single processes to combinations of two, then to include all three.

Figure 8.3. Epistemic agency and scientific literacy at the cultural interface.

The importance of this socio-scientific issue

From the evidence presented, this SSI served to give the participants the freedom and opportunity to exercise their epistemic agency and reasoning skills as they debated the issue and presented a justified position on 1080 use (Lindahl & Linder, 2013, p. 2300). This aligns with a contemporary definition of scientific literacy (Aikenhead, 2007; Roberts, 2008; Zeidler & Sadler, 2010), which is, in short, to develop a critical stance towards knowledge claims and use knowledge to actively participate in discussions and logical arguments. Further still, this research has found that it is possible to extend and deepen the classical definition of scientific literacy and move this towards a Vision III definition of scientific literacy as the participants have shown their agentic ability to traverse a pluralist knowledge environment through their decisions to utilise certain knowledge resources. Equally important, we can deepen this definition by reflecting on the participants' decisions to include knowledge resources or apply specific combinations of agentic processes when critiquing cultural <u>and</u> biological knowledge resources to support their position.

To elaborate, the use of 1080 in pest control as the topic chosen by both schools for the formal in-school NCEA assessment gave the participants a contemporary and potentially fruitful SSI context which provided them with opportunities to engage in informal reasoning as they tried to negotiate possible solutions to the problems they encountered (Lindahl & Linder, 2013, p. 2327). This demonstrates another important element that extends and deepens the classical definition of scientific literacy and moves it more towards the Vision III pluralist notion of scientific literacy. That is, this research provided evidence to extend our understanding of how the role learner agency plays when students use knowledge to support for their positions on a socio-scientific issue and by doing so demonstrate a pluralist approach to scientific literacy.

The 10 participants who drew information from both knowledge worlds demonstrated the power of creating dialogues that extended their argumentation beyond the purely scientific (as in a Vision I notion of scientific literacy), and more towards a pluralist Vision III notion of scientific literacy (see Figure 8.3). Sam, Nadia, Lavinia and Chloe demonstrated this plurality, and showed that by the agentic combination of biological science and mātauranga Māori knowledge concepts, they were able to craft a hybrid dialogue and present a biocultural argument to justify their position on 1080 use in pest control. It therefore can be argued that these four came closest to demonstrating an effective integration of knowledge concepts which is reflected in their connected knowledge world interfaces.

However, before a definitive conclusion can be reached, it would be a useful postscript to this assessment to consider these findings against the international literature which suggests that there exist four obstacles to the successful integration of concepts from science and non-science knowledge systems (Mazzocchi, 2018). These are: conflicting interpretations of reality; power imbalances; the "scientification" of the non-scientific epistemology, and, sterilising the epistemic diversity that the two knowledge systems can contribute.

In this research, a reflective look at the 10 participants' evidence was revealed by the application of the agentic conceptual framework. This gives an indication as to firstly, whether the participants encountered any or all these obstacles; second, how the participants responded to and overcame these obstacles to develop an integrated, connected knowledge world interface. Finally, were there any new obstacles they encountered and responded to?

Answers to these questions will confirm the significant findings of this research and are considered next.

With respect to the four obstacles pointed out by Mazzocchi (2018, p. 20), evidence overall suggests that the obstacles appear to have been most successfully overcome by those participants who applied <u>all three processes</u> of their epistemic agency to the knowledge resources available to them; hence their occupancy of the connected cultural interface. For others, these obstacles appear to have prevented them from fully integrating their knowledge resources which was reflected in the representation of their cultural interfaces (Figure 8.3). Consider the following examples to show how the four obstacles to integration were dealt with.

Manu provides evidence for how he dealt with the first obstacle to successful integration which is the existence of conflicting interpretations of reality. Manu responded resolutely to these conflicting interpretations by actively distancing himself from his cultural world-view as he responded to the evidence he was gathering prior to putting his justifications to paper. He did this by actively separating the knowledge concepts into two distinctive categories that he termed 'factual' on the one hand, which represented his scientific concepts, and on the other were those which represented any 'non-scientific' concepts which included mātauranga Māori knowledge that he referred to as 'cultural'. By separating the concepts and keeping them apart in two distinctive categories, Manu's actions presented an obstacle to the integration of the two knowledge worlds. The strategy he employed to deal with this conflict went further than separating the concepts as he spoke of distancing himself from his Māori heritage and maintaining both worlds at a distance.

The second obstacle to successful integration is an awareness of the power imbalances between the knowledge worlds. Again, Manu's open distancing from his Māori ethnicity was further confirmed when he described at interview how the NCEA assessment standard represented the dominance of Western thinking over his Māori cultural view. His candid comments could indicate a likely rationale for his decision to actively keep the knowledge worlds apart and distinct. For Manu, this was his recourse to action when faced with two knowledge worlds that for him were increasingly conflicted. It appears therefore, from Manu's justification that we cannot assume that just because the participants have drawn on concepts from both knowledge worlds that these are perceived as equally valid and exist in a balanced power relationship. Manu's description and strategy reminds us that this would be a false assumption to make. Manu provides evidence that while knowledge concepts may converge, we cannot assume that they will automatically hybridise into a connected cultural interface.

The third obstacle mentioned, and one to be aware of when integrating knowledge worlds, is the "scientification" of the non-scientific epistemology by isolating and decontextualising bits of information from the overall sociocultural setting – described by Mazzocchi (2018, p. 20) as a form of "methodological reductionism." From the evidence, it appears this area may need further investigation in future research as no evidence was located showing from amongst the participants that any form of this type of reductionism took place. Rose, who utilised biological science knowledge concepts in her initial support of 1080 use, developed her final position opposed to 1080 exclusively upon the evidence she gathered during her research from mātauranga Māori. Rose held that her evidence supported both her initial view supporting 1080 use and her final view as opposed. Therefore, Rose resisted allowing one knowledge world to influence the other and only allowed the knowledge worlds to influence her position towards 1080 and maintaining the concepts contextualised and intact.

The fourth obstacle mentions a caution which is to be aware of sterilising the epistemic diversity that the two knowledge systems can contribute. For example, by evaluating the indigenous knowledge system by the criteria of the competing system of Western science. Again, while no clear evidence appears that the 10 participants' use of *both* knowledge worlds was such that it resulted in this type of sterilised epistemic diversity, Dee appears to have resisted any likelihood that she might encounter a situation where she would have to decide that the knowledge from one system required a rating and assessment by her against the criteria of the other. She adopted a relatively quick solution – she maintained a dual position both "FOR" and "AGAINST" the use of 1080 and proceeded to provide justifications using evidence from both knowledge worlds.

However, while this may be true for the 10 participants at the interface, it is not to say that for the other 27 participants, their exclusive use of Western science concepts in their justifications may indicate a form of epistemic sterilisation. This interesting area remained outside the scope of this research but could be a fruitful area for future research projects to explore.

Conclusion and major findings

And so, to conclude this thesis, there are two major findings that enrich our understanding of the importance of recognising the theoretical space of the cultural interface for our diverse learners in our science classrooms. These came about in response to the major focus of this research which was to seek answers to the question of how biology students use knowledge concepts when discussing a controversial socio-scientific issue. Specifically, the research aimed to discover what concepts the students used and how they did so.

With respect to these aims, the first major finding is to confirm that for some, diverse learners' knowledge world interfaces do exist within the dialogic spaces of a socio-scientific issue. The second is that within these knowledge spaces, learners in this research exhibited a set of behaviours that characterised their epistemic agency which emerged when they drew upon and utilised knowledge concepts from the biological science *and* mātauranga Māori knowledge worlds. This in turn characterised their cultural interface.

Significantly, this research combined the conceptual notions of the cultural interface and the locale of the learner with the notion of their active personal agency as decision-makers. Specifically, epistemic agency was operationalised and applied to the question of conceptual knowledge use by a small group of learners who were identified as residing at the cultural interface. The ways that this smaller sub-group of 10 participants negotiated the expanse 'in between' revealed evidence for what counts as scientific literacy for them as they have moved away from the classical Vision I 'scientist centred' Eurocentric definition of scientific literacy. An even smaller subgroup of four demonstrated a Vision III scientific literacy by their application of agentic processes to integrate biological science knowledge and mātauranga Māori – context-driven, pluralist scientific literacy.

Aikenhead (2007) reminds us that "School science is a negotiable enterprise, open to debate over what counts as scientific literacy today" (2007, p. 68). This is an appropriate question for this research to reflect on, as this thesis argues that the 10 participants in the final research sub-group have successfully negotiated the 'expanse in between' (Nakata, 2002) the two knowledge worlds. The evidence presented points towards gaining a better understanding of

what Vision III scientific literacy might look like in practice. This is especially so for the four participants at the connected cultural interface whose epistemic agency enabled them to enter the debate, draw upon knowledge from both worlds and use this knowledge to build their argument and justify their position. They critiqued evidence and reflected on the experiences of themselves and others to support and justify their position towards 1080 use.

Finally, a reminder that within cultural interface resides the theoretical concept of the 'locale of the learner' (Nakata 2007), which describes where and how indigenously aware individuals position themselves and are positioned by others at the interface, and how they experience and navigate different knowledge systems in their everyday lives and relationships (Nakata, 2007).

Therefore, it is another major finding of this research that *what*, *where* and *how* the participants negotiated the 'expanse in between' has been shown as agentic and that the 'locale of the learner' has been identified and described for each of the 10 interface inhabitants through their agentic use of knowledge concepts from *both* knowledge worlds. The characteristics of their epistemic agency with respect to knowledge use has effectively mapped the position of their individual learner locales at their cultural interface (see Figure 8.3), that is, the knowledge concepts have been given both voice and position defined by the participants' agentic articulation of these concepts. The research findings have a range of educational implications and the possibilities for future research will now be discussed.

8.7 Educational implications

From this data analysis we now have a clearer understanding of how epistemic agency can positively impact learners' scientific literacy through the mobilisation of knowledge resources. Also, with respect to knowledge, there are significant implications for the way we can view knowledge now and into the future that this research affirms is possible.

The Royal Society Report (2012) titled the Future of Science Education in New Zealand asked what is meant by the term "The knowledge society." Central to their thesis is an acknowledgement that how knowledge is thought about and used will change. Knowledge will change from being "something to accumulate" to "something that does things". It will require a reorientation to view knowledge as a verb (as something we do) as suggested by Gilbert (2005), rather than as a noun (as something we have).

The findings of this research indicate that this reorientation has been demonstrated by the 10 interface participants who have shown how this knowledge reconceptualisation might look in practice. The findings of this research give an insight into what this reconceptualised

knowledge means in an education setting as these learners demonstrate a future-focused Vision III styled scientific literacy. This can be demonstrated by looking at three of the several ways the Royal Society report suggests, to encourage this type of reorientation to knowledge considering the findings of this research.

Firstly, the report calls upon educators to "produce people who have a different orientation to knowledge" (2012, p. 4). To do so we must first be able to demonstrate the capacity of education to accommodate those who may have a latent capacity to do so, but who have remained silent in current classroom settings awaiting the opportunity to engage with scientific knowledge by entering spaces where their knowledge and worldviews can coexist with scientific knowledge in a complementary and coequal fashion. This research has shown how a group of culturally and linguistically diverse learners can reorientate to view knowledge (both scientific and non-scientific) as pluralistic, coexistent and able to provide them with a rich vein of concepts to call upon.

Second, it calls upon schooling to "Equip people to do things with knowledge, to use knowledge in inventive ways, in new contexts and combinations" (2012, p. 4). The findings from this research confirm the capacity of some learners to 'use' purpose-driven, innovative combinations of knowledge concepts to support their positions towards the use of 1080 in this instance.

Third, "To equip people to enter and navigate the constantly shifting networks and flows of knowledge that are a feature of 21st century life (2012, p. 4). This research demonstrated how a group of senior high school biology learners entered and navigated a constantly shifting network of knowledge concepts flowing from two knowledge worlds. By applying their epistemic agency, they were able to decide on the usefulness or otherwise of information, which they critiqued for suitability before applying it to support their argument – all the while navigating along this constantly moving conceptual landscape with relative ease for most.

Implications for teachers and practitioners

This research offers ways to address equity in assessment in Science, Technology, Engineering and Mathematics (STEM) subjects by encouraging a broad, inclusive focus on knowledge world contributions that will encourage/enable a panoramic landscape of knowledge concepts to unfold. From this foundation, there are two useful pedagogical practices that could be adopted by science teachers which would enable this to take place.

This model could be the starting point to develop learning activities that encourage students to learn and apply agentic processes to the use of knowledge concepts from Western science and non-Western epistemologies. For those learners who already apply agentic processes to the use of knowledge they would extend their repertoire of skills whilst at the same time their approach to learning and knowledge is validated and rewarded.

For teachers this would require them to be upskilled in ways that would both enable the epistemic agency of their students to flourish but as well to develop their pedagogy to be able to teach learners the processes and skills of agentic learning in their classrooms. Specifically, this development could target the three agentic processes in the following ways when faced with knowledge concepts from Western science and non-Western epistemologies.

- Positioning. Learners could be taught decision-making skills they could apply to deciding to keep or discard information
- Navigating. Learners could be taught how to critique the relevance, suitability and compatibility of this information
- Experiencing. Learners need to be exposed to the value of experiences and to have these as part of their learning journey or to be able to call upon the experiences of others through story, which provide meaningful resources to work with and allow them to connect these experiences to their own.

Finally, this can also extend to exposing the students to the widest possible range of views on the controversy which could come from people invited to share their experiences and views with the students.

A critical role in providing the foundational conceptual knowledge for students is that potentially played by members of their immediate and extended family. Their critical role concerns the support they can give to provide a knowledge world perspective which can act as a springboard for the student in the classroom and in assessments which can be enhanced by the contributions made by additional knowledge worlds to science learning. The commitment in time and the provision of resources available in this digital age will provide the fuel to ignite epistemic agency.

8.8 Further research possibilities

This project investigated to use of knowledge concepts by senior biology students in their justifications for their position towards 1080 use in controlling mammalian pests in Aotearoa

New Zealand. Further research possibilities could yield valuable insights into students' understanding and application of knowledge.

Specifically, a major area for further research could take the form of a test of the potential for the analysis framework model to be used in different SSI contexts to test its utility and application to current SSIs, for example, replicating the study in different SSI contexts and settings. As it is a requirement of the assessment guidelines that the SSI chosen must be contemporary (i.e. is current) and is one that has direct relevance to Aotearoa New Zealand, and with one further requirement that it be of direct relevance to indigenous communities and/or culturally and linguistically diverse learners in New Zealand high schools (NZQA, n.d.).

An example of a context that meets these criteria and could work for learners in ways demonstrated by the participants in this research is the immunisation debate and its links to the current measles epidemic in Aotearoa New Zealand and Sāmoa. This issue would provide a context for discussion and debate and foreground knowledge from Western science and non-Western science (including Pacific indigenous knowledge) to uncover the cultural interface in a Pacific context.

Attention towards Pacific epistemologies in this context would enable a specific focus on the cultural interface for Pacific learners using Western science within a Pacific issue. In this context, issues of power and control and the validity of knowledge epistemologies would come into sharp focus as Pacific holistic therapies still rely on mostly plant-based treatments and massage. This would be very similar to traditional Rongoā Māori (traditional Māori medicines) like those described by Chloe in this research, are brought together in the common ground space. While issues such as these would further test this model and lead to its refinement, of most importance the outcomes would contribute to enriching our understanding of Pacific learners in our mainstream high school biology and science classrooms. But just as the participants in this research unknowingly contributed to our understanding of their scientific literacy, the focus on Pacific epistemologies and use of these knowledge concepts alongside Western scientific knowledge could also be just as instructive to educators as were the findings of this study. In the spirit of Ako, we have as much to learn from our students as they from us.

8.9 Limitations of this research

Upon concluding this research there have been identified possible limitations. The first relates to a constraint on this study's generalisability outside the biological science and mātauranga Māori knowledge domains. There are many different sciences ranging from the natural to the physical sciences which presents a wide domain of conceptual knowledge. Equally this could apply to cultural knowledge systems under the umbrella of indigenous knowledge, specific to context. Notwithstanding this as a possible limitation, this research has achieved the incorporation of epistemic agency into the science/indigenous knowledge research arena which may ameliorate any concerns for the generalisability of this research internationally from its origins in Aotearoa New Zealand.

Also, the reliance on paper-based data and individual interviews may be perceived as restricting the different ways that the participants could express their response to questions asked of them is a valid concern. It was accepted at face value that the assessment scripts written by the participants and passed to me for analysis were completed under the assessment guidelines issued by NZQA for the management of internal assessments. As this process is regularly audited by NZQA quality assurance processes, it can be assumed that the assessment scripts were completed in accordance with these requirements.

The individual follow-up interviews were arranged in conjunction with the schools and were timed to minimise impact in class contact time. This ensured that all available time was given to the interviews and these took place at various times at the schools to accommodate the participants.

Finally, as a New Zealand born male of European ethnicity, uppermost throughout the entire research process was an awareness of a perception from outside this project that the information, specifically the culturally significant knowledge the participants shared for analysis was in some way appropriated for the prime purpose of my benefit and not for the benefit of the participants or the student body they represented – then, now or into the future. I invite the reader of this research to reflect on this having now read the content and analysis in full. I believe that this research project took full account of any potential for a breach of culturally appropriate protocols by explicitly following the proposal as approved by the ethics committee before beginning. I will leave the rest to the reader's judgement.

8.10 Final reflections and concluding statement

This research project is the culmination of my search for answers to questions which have puzzled and perplexed me throughout my lifetime. My research journey has been transformative for me both personally and professionally. It has provided numerous moments of discovery and quiet reflection. With a 30-year gap between my last post-graduate study and the commencement of this doctorate, there was much to learn and many stumbles along the research highway to arrive at its penultimate milestone. I have learnt the value of persistence and the invaluable quality of patience and perseverance.

This research experience took me back to those childhood days of wonder and fascination when the adventures I read of in books by Jules Verne took me beyond the present world and into a surreal space where I was safe and secure. Here, my imagination shielded me like an invisible force field from the hurt and harm of the real world. It also gave me strength and taught me that beyond the present physical world there were imaginary places within easy reach. Mr. Kerr's approach to teaching took me to these places. He kept me spellbound with stories from Te Ao Māori that were rich in metaphor and that to an outsider would have seemed foreign and distant but that to me was an experience that enveloped me.

Returning from a dream

Alice's adventure in *Through the Looking-glass* reminded me of how close these surreal worlds can be to us and what they offer should we dare to enter them.

This thesis began with Alice curious to know what beautiful things lay beyond the bright silvery mist of the looking-glass interface as she sought a way to cross over, through the boundary marked by the glass and into the world beyond. As with Alice, this research began with a very similar curiosity that I had to discover what things were to be found beyond the biological science knowledge world interface. Especially for senior biology students from diverse linguistic and cultural backgrounds, and for whom my efforts in education have been focused throughout a teaching career spanning more than 30 years. I was determined to learn more about ways to tap into the knowledge worlds of the students to see how and indeed if their 'home' knowledge could impact their ability to develop an argument within a socio-scientific issue of pest control using 1080 poison which was of topical interest to senior biology students and assessed as part of their high school final year qualification.

As it was for Alice who told her story in the world beyond the Looking-glass, this research had a deliberate focus on the participants and their stories of their world 'in between' culture

and science. As it was for Alice, some of the participants unwittingly passed through the bright silvery mist and told of the world at their cultural interface. Even more, they positioned themselves through their agentic use of knowledge concepts which in turn positioned them at their learner locality.

Although the space traversed by Alice existed in the realm of her dreamland it required of her to demonstrate a range of skills to survive and interpret elements of the world she was in beyond the silvery mist. Alice reveals a determination to move forward – as one would in a game of chess, towards her goal of becoming a queen, and where Alice is "decidedly active, logical and self-directed" (Rackin, 1991, p. 74). The participants in this research were similarly active, logical and self-directed.

The quest for knowledge is as omnipresent as the spaces in which it occurs. While physically present at the beginning of the story, Alice imagines the world beyond the looking-glass and in her dream-state enters the world where her adventure begins. The entry point is the mirror through which she must pass in a cognitive sense, though we are shown this physically and, in her descriptions and narrations of the journey that unfolded, we are taken with Alice as she plays the chess game in her quest to be queen. Alice's imaginings were firmly grounded in her childhood experiences and with the aid of the story, she was able to show us her imaginary world.

Along with the teacher, students enter the physical world of the science laboratory and at the commencement of the lesson they are invited to enter the cognitive world of science. Spaces real and imagined combine and for the next hour or so these worlds exist together in time. For some participants in this research, these worlds existed together with knowledge concepts they brought into a shared space from where fewer participants showed how they produced new knowledge combinations and interactions. They showed us what a possible future scientific literacy might look like. Just as Alice did, the participants described their experiences in ways that have enlightened our understanding of how knowledge is used. The challenge for educators now and into the future was laid down by those participants who kept the two knowledge worlds exclusive and apart. What prospect their success if what they could offer remains in the shadows? What future without it?

Educational philosopher Gert Biesta proposed that if we take a literal view of education as the interaction between the teacher and the learner, then "Education, in other words, takes place in the gap between the teacher and the learner." (Biesta, 2004 pp. 12-13). Furthermore, Biesta asserts that the gap, or Third Space (Bhabha, 1994), is unrepresentable but, nevertheless,

challenges teachers to find the gap within the communication space. Any such attempt, Biesta cautions, entails both risk and opportunity but it is the opportunity of agency; "a fragile, enunciative agency for both the teacher and the student" (2004, p. 22), which has the potential for the most reward. This research has found this gap and represented it through the participants' epistemic agency between two knowledge worlds at the cultural interface.

Finally, while knowledge is "obtained in a physical space, it reflects the learner's inner (cognitive) space; which, in turn, is expressed in human communication" (Paradis et al., 2013, p. 1). The research participants communicated their experiences and demonstrated their epistemic agency in ways that has given us a glimpse into the world of the student-scientist. From this, we have gained an understanding of their scientific literacy and knowledge-building practices at the cultural interface. The participants took us into the gap, into their Looking-glass world beyond the silvery mist – and have shown us the beautiful things within it.

Kua takoto te Mānuka.

The leaves of the Mānuka tree have been laid down.

Rise to accept the challenge!

Appendices

Appendix A: Advertisement to Invite Interest from Schools

SCHOOL OF CURRICULUM AND PEDAGOGY
Te Kura o te Marautanga me te Ako

THE UNIVERSITY OF AUCKLAND
FACULTY OF EDUCATION
Te Kura Akoranga o Tāmaki Makaurau
Incorporating the Auckland College of Education

ADVERTISEMENT TO SCHOOLS

The following advertisement was prepared by me and sent out at the beginning of February 2015:

HODs and TICs of Biology. Brent Wagner is looking for a school in the Auckland region interested in taking part in a research project that explores Year 13 students' responses to a socio scientific issue, particularly from a cross-cultural standpoint, as they complete Biology 3.2 AS91602. If you or your department would like to learn more about the project, and also the ways it could enhance student learning, email Brent at bwag001@aucklanduni.ac.nz or phone on 027 3667230.

Appendix B: Participant Information Sheet (Students)

SCHOOL OF CURRICULUM AND PEDAGOGY
Te Kura o te Marautanga me te Ako

THE UNIVERSITY OF AUCKLAND
FACULTY OF EDUCATION
Te Kura Akoranga o Tāmaki Makaurau
Incorporating the Auckland College of Education

PARTICIPANT INFORMATION SHEET (Students)

TITLE: *Ngā Haerenga:* Students' exploration of Māori and Pasifika cultural spaces of a socio scientific issue.

RESEARCHERS: Brent Wagner, Associate Professor Bev France and Professor Elizabeth McKinley

Kia ora. Talofa lava. Malo e lelei. Kia orana. Fakalofa lahi atu. Bula vinaka. Greetings.

Dear Year 13 Biology Student of _____ School

Who is the researcher and what is this research about?
My name is Brent Wagner and I am a full time Doctoral student studying at the Faculty of Education at the University of Auckland. My research is focused on how Year 13 biology students use cultural knowledge and scientific knowledge-specifically Māori and Pasifika cultural knowledge-to develop, present and justify a position on the issue of controlling pest animals in New Zealand's forests. This requirement is part of the *Achievement Standard: 91602 (Integrate biological knowledge to develop an informed response to a socio scientific issue (3 Credits).*

Research Question:
How do students integrate Māori and Pasifika cultural knowledge as they develop and present an informed response about a socio-scientific Issue?

What choice do I have?
I am inviting you to take part in my research. Your participation is voluntary, and you can change your mind at any time up to two weeks after I have finished collecting your ideas. Your Principal has given an assurance that your decision to take part in my research or not will have no effect on your relationship with the school or your grades. Your teacher has also given an assurance that your decision to take part or not will have no effect on your grades.

Taking part is entirely your choice. As you are likely to be over 16 years old, you can make a decision about taking part in my project by yourself. You do not need to have your parents' or caregivers' permission. However, I do think it is important that your parents or caregivers know about your participation. So if you do decide to take part, I have written a letter for your parent/caregiver/whānau so they know about my research and that I am asking you to take part. The data collection methods will acknowledge and uphold your status (*mana tangata*) by using face-to-face personalized communication strategies, co-operative learning and sharing activities. The first *hui* (gathering) will begin establishing relationships (*whanaungatanga*) in a culturally appropriate way as we share a common interest in the research and journey together.

What am I being asked to do?
When you participate in my research, which will largely take place during your normal teaching programme, you will be asked to complete some tasks and with your permission, your written responses will be collected (See Student Consent Form A) and your verbal responses will be audio-recorded (See Student Consent Form B). Your Consent Forms can be left inside the labelled drop box, which I have placed in your classroom. The project acknowledges and upholds the principals of partnership, participation and protection under the Treaty of Waitangi. Your knowledge, as a *taonga* (treasure) will be treated respectfully and sensitively.

The research is organised in to six stages:
Stage One: You will be invited to respond in writing to a series of photos related to the issue of animal pest control in New Zealand's forests.
Stage Two: Then you will be taught for 2-3 periods on the topic of *Kaitiakitanga* (the cultural concept of Guardianship).
Stage Three: You will repeat Stage One after the teaching sessions.
Stage Four: After the completion of the teaching sessions, at an appropriate time and after you have had time to research this further, I will organise your class in to groups to take part in a 'sharing circle' activity. The groups will be made up of those who choose to discuss the issue and those who do not want to take part. You will bring to the circle a resource item that helped your understanding of the issue. You will talk about this to the group. Only those groups composed of students

who have agreed to participate will have their group discussion transcribed. The circle activity will be culturally inclusive and demonstrate the notion of *manaakitanga* (ethic of care) to all participants

Stage Five: Following the handing in of your completed assessment task, I will photocopy your assessment before it is marked. This is because I am interested in your ideas rather than the grade you achieve.

Stage Six: Once the unmarked assessments are handed in and copied, I might select you to take part in an individual interview with me. I will be choosing 15-20 students based on the way you have used Māori and Pasifika cultural knowledge in your assessment task. If you have indicated you are interested in taking part, I will contact you by email and we can discuss what it means as outlined in Consent Form B (Verbal). The interviews will take place outside of your class time in a quiet room at your school. It will take between 30-45 minutes. The interview will be audio-recorded. You do not have to answer every question and can have the audio-tape turned off at any time. I am going to have the recording transcribed by a professional transcriber. The transcriber has agreed to keep the information confidential. Once your recording has been transcribed, I will give it to you for editing. You will have two weeks to make any changes and return it to me.

What are the benefits and risks of participating?

This work will not interfere with your NCEA study since you will be able to use your written comments, resources and ideas about *Kaitiakitanga* as part of the Level 3 NCEA biology internal *Achievement Standard: 91602 (Integrate biological knowledge to develop an informed response to a socio-scientific issue, 3 credits)*. The sharing circle activity will give you the opportunity to clarify your thinking and reflect on the ideas you are developing as you write your final assessment.

How will your privacy be protected?

It is important that you feel comfortable about expressing your ideas and views about this topic. I will keep all information confidential by removing your name from any papers you give me and disguise your identity in my doctorate. To do this, I will ask you to choose a pseudonym. I will also make sure that the school is not identified. However, as there are only a small number of students involved in my research and because you may be well-known in your school community, I cannot guarantee that your identity will be completely disguised because someone might recognise something that you say or write.

What will happen to the information you provide?

This research information is very precious and will be kept safely in a locked cupboard or on a password-protected computer for six years at the Faculty of Education. After that the electronic data will be permanently deleted and the hard copy data shredded. I will be using your ideas in my doctoral thesis and will share this with you and your families personally at a hui to take place at the completion of the project. The results may also be used to write journal articles and presented at conferences.

What do you need to do to take part?

If you would like to take part, please complete the enclosed consent forms and place them in the collection box provided. There are two Consent Forms: Consent Form A is for your written responses and final assessment task material. If you are interested in talking about your ideas please give me your email address so I can contact you and discuss what the interview phase will involve. Consent Form B is for your verbal interview responses.

I hope you will take part in this research. If you have any questions or would like more information about this study, please contact me or my supervisors at the Faculty of Education, The University of Auckland either by phone or email.

Yours sincerely,

Brent Wagner
Doctoral Student
School of Curriculum and Pedagogy
Faculty of Education
The University of Auckland
Private Bag 92601 Auckland
bwag001@aucklanduni.ac.nz
Tel: 09 373 7599 ext. 48406

Associate Professor Bev France
School of Curriculum and Pedagogy
Faculty of Education
The University of Auckland.
Private Bag 92601 Auckland
b.france@auckland.ac.nz
Tel: 09 623 8899 ext. 48439

Professor Elizabeth McKinley
Melbourne School of Graduate Education
University of Melbourne
234 Queensberry Street
Carlton, Victoria 3053
elizabeth.mckinley@unimelb.edu.au
Tel: +61 3 8344 8285

For any queries regarding ethical concerns you may contact the Chair, The University of Auckland Human Participants Ethics Committee, The University of Auckland, Office of the Vice Chancellor, Private Bag 92019, Auckland 1142. Tel (09) 373-7599 ext. 83711.

Approved by The University of Auckland Human Participants Ethics Committee on 18 April 2015 for a period of three years. Reference Number 014028

Appendix C: Consent Form A: Student – Written

SCHOOL OF CURRICULUM AND PEDAGOGY
Te Kura o te Marautanga me te Ako

THE UNIVERSITY OF AUCKLAND
FACULTY OF EDUCATION
Te Kura Akoranga o Tāmaki Makaurau
Incorporating the Auckland College of Education

CONSENT FORM A
(Student - Written)

THIS FORM WILL BE HELD SECURELY FOR A PERIOD OF 6 YEARS

TITLE: *Ngā Haerenga:* Students' exploration of Māori and Pasifika cultural spaces of a socio scientific issue.

RESEARCHERS: Brent Wagner, Associate Professor Bev France and Professor Elizabeth McKinley

I have read the Participant Information Sheet and have understood the reasons for this research and why I have been asked to take part. I have had the opportunity to ask questions and have them answered to my satisfaction.

I agree to take part in this research.

I agree that the researcher can collect and photocopy my written responses to the photos in the pre and post intervention activities.

I agree that the researcher can collect and photocopy my unmarked completed final assessment and resources before it is marked and returned to me.

I understand that:

- My participation is voluntary, and I will receive details of the project at a hui to be organised at the start of the term.
- My Principal has given an assurance that my decision to take part or not will have no effect on my relationship with the school or my grades.
- My teacher has given an assurance that my decision to take part or not will have no effect on my grades.
- I am free to withdraw my written data up to two weeks after the completion of data collection.
- I will complete two written tasks and participate in the intervention activities required by this research during my normal biology classes and my pre and post intervention responses will be collected as part of the research data:
    - Pre-Intervention-that will take about 30 minutes
    - Intervention-that will be co-taught with my teacher for 2-3 biology periods,
    - Post-Intervention-a repeat of the first task which will take about 30 minutes
- I will choose a pseudonym (or one will be provided by the researcher) to protect my identity in any reports and details about the school will be disguised.
- I can choose to be involved in the next stage of the research a follow by also completing Consent Form B.
- All data will be kept for six years, after which it will be destroyed.
- Data will be used in the researcher's doctorate, other publications and in conference presentations.
- I will receive a summary of the research findings at a hui to be arranged at the conclusion of the project.

Pseudonym chosen: ……

My contact email for interview information: ……

Name: ……..

Signed: …… Date: ……

Approved by The University of Auckland Human Participants Ethics Committee on 18 April 2015 for a period of three years. Reference Number 014028

Appendix D: Consent Form B: Student – Verbal

SCHOOL OF CURRICULUM AND PEDAGOGY
Te Kura o te Marautanga me te Ako

THE UNIVERSITY OF AUCKLAND
FACULTY OF EDUCATION
Te Kura Akoranga o Tāmaki Makaurau
Incorporating the Auckland College of Education

CONSENT FORM B
(Student - Verbal)

THIS FORM WILL BE HELD SECURELY FOR A PERIOD OF 6 YEARS

TITLE: *Ngā Haerenga:* Students' exploration of Māori and Pasifika cultural spaces of a socio scientific issue.

RESEARCHERS: Brent Wagner, Associate Professor Bev France and Professor Elizabeth McKinley

I have read the Participant Information Sheet and have understood the reasons for this research and why I have been asked to take part. I have had the opportunity to ask questions and have them answered to my satisfaction.

I agree to take part in this research.

I agree to take part in a group sharing circle as part of the intervention that will be audio-recorded.

I agree to take part in an interview that will be audio-recorded.

I understand that:

- My participation is voluntary. My participation is voluntary, and I will receive details of the project at a hui to be organised at the start of the term.
- My Principal has given an assurance that my decision to take part or not will have no effect on my relationship with the school or my grades.
- My teacher has given an assurance that my decision to take part or not will have no effect on my grades.
- I will participate in the intervention activity that will be co-taught with my teacher for 2-3 biology periods
- If I decide to take part in the sharing circle activity and then change my mind, I can keep quiet and/or leave. However, my previous comments cannot be withdrawn from the transcript.
- I might be selected to take part in an individual interview with the researcher.
- The interview will take about 30 minutes and take place outside of my class time at school.
- The interview will be audio-recorded, and I can choose not to answer any questions and have the audio-tape stopped at any time and/or choose to withdraw from the interview phase of the research.
- If I ask for the audio-recorder to be turned off, the researcher may continue to take notes during the interview.
- The audio-recording will be transcribed by a professional transcriber who has agreed to keep this information confidential.
- The transcription will be returned to me for editing and I have two weeks to make any changes (delete or add further information to the draft transcripts) and return it to the researcher.
- I will choose a pseudonym to protect my identity in any reports and details about the school will be disguised.
- Because a small number of students are involved in this research, it might be possible for others to recognise my comments.
- All data will be kept for six years, after which it will be destroyed.
- Data will be used in this doctorate, other publications and in conference presentations.
- I will receive a summary of the research findings at meetings to be arranged at the conclusion of the project.

Pseudonym chosen: ……

My contact email for interview: ……..

Name: …….

Signed: ……. Date: …….

Approved by The University of Auckland Human Participants Ethics Committee on 18 April 2015 for a period of three years. Reference Number 014028

Appendix E: AS91602 Achievement Standard

Subject Reference	Biology 3.2				
Title	Integrate biological knowledge to develop an informed response to a socio-scientific issue				
Level	3	**Credits**	3	**Assessment**	Internal
Subfield	Science				
Domain	Biology				
Status	Registered	**Status date**	4 December 2012		
Planned review date	31 December 2016	**Date version published**	4 December 2012		

This achievement standard involves integrating biological knowledge to develop an informed response to a socio-scientific issue.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Integrate biological knowledge to develop an informed response to a socio-scientific issue.	• Integrate biological knowledge to develop a reasoned informed response to a socio-scientific issue.	• Integrate biological knowledge to develop a comprehensive informed response to a socio-scientific issue.

Explanatory Notes

1 This achievement standard is derived from *The New Zealand Curriculum,* Learning Media, Ministry of Education, 2007, Level 8 within the Science learning area. It is aligned with the following achievement objective from the Nature of Science strand.

- Participating and contributing, 'Use relevant information to develop a coherent understanding of socio-scientific issues that concern them, to identify possible responses at both personal and societal levels'.

It is also related to the material in the *Teaching and Learning Guide for Biology*, Ministry of Education, 2010 at http://seniorsecondary.tki.org.nz.

2 *Integrate biological knowledge to develop an informed response* involves:

- presenting a personal position, developed using relevant biological knowledge
- proposing action(s) at a personal and/or societal level.

Integrate biological knowledge to develop a reasoned informed response involves:

- explaining why the position and the action(s) have been chosen.

Integrate biological knowledge to develop a comprehensive informed response involves:

- justifying the personal position and proposed action(s) by analysing and evaluating the biological knowledge related to the issue. This may include:
  - comparing the significance of implications
  - considering the likely effectiveness of the proposed action(s)
  - commenting on sources and information, considering ideas such as
    - i validity – currency, peer review status, scientific acceptance
    - ii bias – attitudes, values, beliefs.

3 *Integrate* refers to selecting and collating relevant biological knowledge to develop an informed response.

4 A *socio-scientific issue* has both biological and social implications. The issue is one for which people hold different opinions or viewpoints. Social implications may be economic, ethical, cultural, or environmental.

5 *Biological knowledge* includes:

- biological concepts and processes relating to the issue
- biological and social implications of the issue
- differing opinions or viewpoints about the issue.

6 Conditions of Assessment related to this achievement standard can be found at www.tki.org.nz/e/community/ncea/conditions-assessment.php.

Replacement Information

This achievement standard replaced unit standard 6319 and AS90714.

1 Quality Assurance

1 Providers and Industry Training Organisations must have been granted consent to assess by NZQA before they can register credits from assessment against achievement standards.

2 Organisations with consent to assess and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Consent and Moderation Requirements (CMR) reference 0233

Appendix F: Student Assessment Activity Task Secondary School

Achievement Standard Biology 91602: Integrate biological knowledge to develop an informed response to a socio-scientific issue (v1).

Resource title: The 1080 Debate

Credits: 3

Achievement	Achievement with Merit	Achievement with Excellence
Integrate biological knowledge to develop an informed response to a socio-scientific issue.	Integrate biological knowledge to develop a reasoned informed response to a socio-scientific issue.	Integrate biological knowledge to develop a comprehensive informed response to a socio-scientific issue.

Student instructions

Introduction

Hunua rat plague threatens the kokako

2:17 PM Wednesday Apr 8, 2015 New Zealand Herald

A rat plague in the picturesque Hunua Ranges is threatening New Zealand's biggest mainland population of the kokako and prompted Auckland Council to carry out a 1080 poison operation.

Tens of thousands of rats are thriving in the Hunua Ranges southeast of Auckland, reaching a 15-year high.

The rodents eat the endemic kokako eggs from their nests, and also pave the way for more pests, including stoats, possums and feral cats, which prey on adult birds.

The pest explosion has now resulted in "dismal" results for the 2014-15 kokako breeding season.

The arrival of humans in New Zealand has presented a challenge for the native species, causing the extinction of several. This is predominantly because many species in New Zealand have evolved in the absence of mammalian predators for the last few million years thus losing the responses needed to deal with such threats. Humans brought with them to New Zealand (intentionally or otherwise) a host of attendant species, starting with the Polynesian rat, and now including stoats, weasels, black rats, Norway rats, brushtailed possums, and feral cats and dogs. Of these, the rats, ferrets, cats, stoats and dogs have all

seriously impacted the New Zealand fauna, driving many species to extinction. *(from Wikipedia).*

Control of these mammalian predators has proved particularly tricky with no one perfect control method currently available.

Task

This assessment activity requires you to integrate biological knowledge to develop a personal response to the socio-scientific issue of the decision by the Auckland Council to use 1080 to control the rat population in the Hunua Ranges. Your response must be reasoned and informed. You must present a personal position, propose action(s) at a personal and/or societal level and explain why you chose this position and action(s). You must also analyse and evaluate the relevant biological knowledge related to the issue to justify your position and action(s).

A socio-scientific issue is one for which people hold different opinions or viewpoints. The issue will have both biological and social implications. Social implications may be economic, ethical, cultural or environmental. You will produce a report (including references).

Conditions

You will work individually and have 8 weeks to complete the research. You will find relevant information and websites to get you started on aggs.net.nz.

You need to organise your research notes and copies of research material into a logbook, scrapbook, or portfolio. This needs to be handed in to show the sources of your information and for authenticity purposes.

Milestone 1: By Friday 8th May, Week 3, show your teacher your brainstorm and focus questions

Milestone 2: By Friday 22nd May, Week 5, provide evidence that you have your research notes and copies of research material in a scrapbook

Milestone 3: By Friday 5th June, Week 7, provide evidence that you are selecting and organising relevant information

Milestone 4: By Friday 26th June, Week 10, provide evidence that you have planned a response to the issue by completing a paragraph plan template

You will have three periods of class time in Week 11 in which to complete drafts and the final report. All your research material can be used when preparing the report. Laptops will be available for use. At the end of each period you will be required to hand in all your researched material and all electronic and paper versions of your report.

You will also need to hand in your all research material and a reference list to show the sources of your information.

You are assessed on the comprehensiveness of your report and how well you select and integrate relevant **biological** information to develop your reasoned informed response to the issue.

Preparation for research

The focus of your research is to collect information so you can develop an informed personal position about the **decision of the Auckland council to use 1080 to control rat populations in the Hunua Ranges**. In your research you should be collecting biological information to enable you to select and organise relevant biological knowledge to develop a personal response to the issue and then identify possible action(s) that could be taken by you or by wider society.

Start by brainstorming:

What do you already know about this topic?

What do you want know i.e. what questions do you have about this topic?

Where do you think you could find the answers?

Do some initial reading / research to refine this topic down to a series of questions to focus your research.

Task

Research the issue of the **decision of the Auckland council to use 1080 to control rat populations in the Hunua Ranges.**

While the specific issue you will focus on is the decision of the Auckland council to use 1080 to control rat populations in the Hunua Ranges, your research can go wider than this in order to get sufficient biological information.

Select and organise relevant biological knowledge to develop an informed personal response to this issue in order to propose a possible action(s) that could be taken by you and/or by the wider society.

All your researched material needs to be kept in a research logbook, including a reference list. Your research logbook must be handed in with your completed presentation, as it is used to assess how you have processed and integrated the biological knowledge you have gathered during your research.

The format for your assessment will be a **written report.**

In your report you need to integrate information (bring together information from different sources and rewritten in your own words) in your report to include *each* of the following:

- the biological knowledge that includes the:
  - biological concepts and processes relating to use of 1080 for rat control (e.g. the effect of 1080 on rats)
  - biological implications (e.g. impact of 1080 on other animals in the Hunua Ranges) and social implications (e.g. economic, ethical, cultural or environmental) of using 1080 to control rats.

- different opinions or viewpoints that **named** people, groups or organisations have about the use of 1080 to control rats in the Hunua Ranges (consider how bias may influence these opinions)

- use the biological knowledge you have gathered to present your personal position and proposed action(s) by you and/or society about the issue of the decision of the Auckland council to use 1080 to control rat populations in the Hunua Ranges.

- give reasons (with supporting evidence) to explain why you chose this position and proposed action(s)

- analyse and evaluate the biological knowledge related to the issue to justify your position and proposed action(s) by:

  - comparing the significance of the biological and social implications of the issue

  - considering the likely effectiveness of your and/or society's proposed action(s)

  - commenting on your sources and information by considering ideas such as:

    - validity(date/currency, peer review status, scientific acceptance),

    - bias (attitudes, values, beliefs) i.e. weighing up how science ideas are used by different groups

Include a list of all the references you have used with your report.

Reference List and Authenticity of Ideas, Facts and Quotations used in the body of the report:

Even though your report is written in your own words, it is important to acknowledge the sources of all information / facts / ideas / data / quotes / pictures / diagrams used to write your report in a reference list. You will not be assessed on this but does provide an authenticity check and evidence of integration.

As well as a reference list, you need to link your references to the point where the source is used in your report. This can be done in two ways:

1. Author's surname, date of publication, page numbers (or internet site), in brackets. e.g. (Smith, 1998, p293). This appears in the text of your report immediately after the sentence in which the material has been used.

   e.g. The Whale Liberation Society believes that whales are sacred animals and should never be killed ....(New Zealand Herald, Jan 10th, 2006)

2. This may also be done in the form of <u>footnotes</u>. This involves the use of a number in the text next to your quoted material which refers to the author, data of publication and page numbers (or Internet site) listed at the bottom of the page.

   e.g. The Whale Liberation Society believes that whales are sacred animals and should never be killed 1

[1]New Zealand Herald, Jan 10th, 2006

Appendix G: Student Assessment Activity Task High School

Achievement Standard Biology 91602: Integrate biological knowledge to develop an informed response to a socio-scientific issue

Resource reference: Biology 3.2A Version 1

Resource title: Using 1080 to control possums in New Zealand

Credits: 3

Achievement	Achievement with Merit	Achievement with Excellence
Integrate biological knowledge to develop an informed response to a socio-scientific issue.	Integrate biological knowledge to develop a reasoned informed response to a socio-scientific issue.	Integrate biological knowledge to develop a comprehensive informed response to a socio-scientific issue.

Student instructions

Introduction

This assessment activity requires you to integrate biological knowledge to write a SPEECH responding to the socio-scientific issue of using 1080 in New Zealand. You will present a personal position and propose action(s) at a personal and/or societal level.

You will be assessed on the comprehensiveness of your response and on the extent to which you justify your response by analysing and evaluating relevant biological knowledge.

You will work independently and have 5 weeks to complete the assessment. Your teacher may provide you with extra resource material and/or suggest relevant information sites or possible new directions for your research.

Your timeline of specific daily activities has been laid out for you on the attached sheet.

You will need to hand in your research notes and a reference list to show the sources of your information.

Your final portfolio will contain the following, in the following order:

- Assessment sheet (This will be added by when your work is submitted)
- Student Instructions
- Logbook sheet/s
- Speech notes and A4 colour copies of any posters/pictures used/required OR

  speech notes accompanied by Powerpoint presentation OR

  speech notes accompanying an actual video presentation by yourself
- Any printed matter which you may have used in compiling your speech
- A reference list of ALL resources accessed over the 5 week period

Task

A socio-scientific issue is one for which people hold different opinions or viewpoints. The issue will have both biological and social implications. Social implications may be economic, ethical, cultural or environmental.

Follow the steps below to produce speech notes (including references) on the use of 1080 to control possums in New Zealand that could be presented during a debate to Year 13 students who do not study biology. Keep a logbook documenting your research. Include references.

Conduct research

Research the issue of using 1080 to control possums in New Zealand.

Select and organise relevant biological knowledge that can be used to develop an informed response to this issue.

Keep a record of your research in a logbook. Include a reference list. Your research logbook must be handed in with your completed presentation, as it may be used to assess how you have processed and integrated the biological knowledge you have gathered during your research.

Write your speech

How are possums effecting the economy

Using your research as a basis, write a speech. In your speech:

- outline relevant biological knowledge such as:
  - biological concepts and processes that relate to the use of 1080 in New Zealand (e.g. effect of 1080 on possums)
  - biological implications (e.g. effect of 1080 on other organisms) and social implications (e.g. economic, ethical, cultural or environmental) of the use of 1080 in New Zealand
  - different opinions or viewpoints (for and against) that named individuals, groups or organisations have about the use of 1080 in New Zealand (consider how bias may influence these opinions).

  Make a comment on the ethics of 1080
- use the biological knowledge you have gathered to present your:
  - personal position
  - proposed action(s) by you personally and/or by society on the use of 1080 in New Zealand.
- give reasons (with supporting evidence) to explain why you chose this position and proposed action(s)
- analyse and evaluate the biological knowledge related to the issue to justify your position and proposed action(s) by:
  - comparing the significance of the biological and social implications of the issue
  - considering the likely effectiveness of your and/or society's proposed action(s)
  - commenting on your sources and information by considering ideas such as:
    - validity (date/currency, peer review status, scientific acceptance),
    - bias (attitudes, values, beliefs), i.e. weighing up how science ideas are used by different groups.

Hand in your written speech along with your research logbook.

Appendix H: Question Guide: Student Participants

SCHOOL OF CURRICULUM AND PEDAGOGY
Te Kura o te Marautanga me te Ako

THE UNIVERSITY OF AUCKLAND
FACULTY OF EDUCATION
Te Kura Akoranga o Tāmaki Makaurau
Incorporating the Auckland College of Education

Individual Interview

An individual interview will take place following the completion of the assessment. Before the assessment is marked, the student scripts will be photocopied and will be used as the basis for the following questions which will explore how the students position themselves on the issue, how biological and cultural knowledge is represented in the student responses and the ways they integrate this material as they develop and justify their position on the issue.

Indicative questions: (Position, representation, integration)
Tell me about your assignment. What parts of the assignment are you proud of?
Perhaps you might like to tell me about the different points of view that you discovered when researching this topic.
Were there any stories that you were told that you found interesting/ pertinent/ relevant that helped you develop an appreciation of different points of view. Please tell me about them**.**

Overall view of the task - Reflections:
Tell me about your first thoughts when you saw the assessment task at the start of the term?
What does the term Socio mean in your words? What is your interpretation of the term 'Socio Scientific issue'? Has it changed? If so tell me how it changed.
Can you recall any experiences you had at the start of the topic that helped you to understand the task? Please explain.
Early on, did you talk to anybody about the issues? What did they tell you?
Can you tell me about this conversation?

Developing Your Arguments:
Tell me about how you ended up using the resource that you brought to the circle session?
If your earlier position has changed since the beginning, can you tell me or give me some examples of how your thinking has changed towards this topic?
Tell me about any new discoveries you made and how you decided they were useful to you?

Supporting Your Position:
I would like you to choose a passage from your writing that best describes your position on the issue

Tell me how you came to this position
Can you recall the way you found evidence to support your view?
Can you recall the decisions you had to make about what was relevant and what was not?

This is really interesting evidence. Perhaps we could look at this more closely so that you can explain how you used this evidence.

You mention in your written response… (Student to elaborate on their use of any scientific information to support their argument)
You mention in your written response…. ((Student to elaborate on their use of any cultural information to support their argument)

It is interesting to read how you supported your argument/justified your position.

Please can you tell me about some examples where you have relied on culture to support your position?

Please can you tell me about some examples where you have relied on science to support your position?

Proposed Action

You will remember in the notes that it was suggested that you might propose some action about this socio-scientific issue.

Was this issue important enough for you to think about taking some action? Please explain your position on this.

Please tell me about any action that you have proposed?

Perhaps you could tell me how it relates to what you know about the issue?

Appendix I: Researcher Reflective Journal Sample

Sat 20.6.15.

Thinking

- Motion succeeding as motion...
- Pamphlet, students, succeeding as pamphlet...

Talking with my doctoral colleagues this afternoon about my data, and describing the range of input for the students to the circle — the variety, the standpoints from which they came and brought their information to the circle —

The initial frustration I had experienced following the circles initially — it was because I had my teacher view — my cultural lens — but needed to turn 180° from my position to 'see' the experience from the students 'standpoint' — that expressed as follows:

1. Their object and their description and understanding of how the 'object'/resource related to the topic in terms of its utility / usefulness / and how that could support their analogy arguments (justification) and ultimately their position in respect of 1080 & possum control in Aotearoa/NZ.

"What the students are saying is how they succeed as ...."

"Listen to the data = it will speak its truth" = Look behind the surface, ⟺ Look into (trying to mine)

Transcription continues... the journey; Nga haerenga... o-nga tauira."

"Like holding up a postage stamp — or a banknote and seeing the invisible watermark in the light..... the invisible becomes visible." "Look into the mirror... to the other side...

"We are seeing at first glance the raw data spoken to us by the students — what we search for is the meaning hidden in the 'watermarks' of their message — the light shed by the frame of the analysis — chosen by and effected by the observer —"

Saying: "Kimihia te mea ngaro" — "Seek that which is lost"

Appendix J: Culturally Responsive Approaches (Māori)

Consistency of this Research with the Principles of the Treaty of Waitangi

TITLE: *Ngā Haerenga:* Students' exploration of Māori and Pasifika cultural spaces of a Socio Scientific Issue.

RESEARCHERS: Brent Wagner, Associate Professor Bev France and Professor Elizabeth McKinley.

This research project seeks to incorporate the spirit of the Treaty of Waitangi respecting its principles of partnership and sharing. This research will be based upon a collaborative, relational, culturally responsive methodology as outlined by Berryman et al, (2013) and Macfarlane (2004) being ever mindful of the question asked by Russell Bishop (2006) "How is our research work helping Māori students succeed as Māori?" This research seeks to answer this question by adhering to the following principles:

1. ***Whakawhanaungatanga* (building relationships)** In the early stages the researcher will make contact with those who have indicated a willingness to be involved and share information during *hui* (a gathering where certain rituals apply) arranged at times and places of convenience to the prospective participants. These *hui* will, affirm the cultural rituals of encounter and begin with *karakia* (prayer), *mihimihi* (greetings) and *waiata* (song)to open the forum at the *hui whakatahi* (general introductions) and conclude with a sharing of *kai* (food). The importance of *kanohi-ki-te-kanohi* (face-to-face) personalised contact where possible and the use of *Te Reo Māori* (Māori language) will build trust and sharing and be a standard feature of the researcher's way of working which will nurture the credibility of the researcher and the participants to the advantage of all students. These processes will value the connectivity of the people involved in this research, add authenticity to the process and involve Māori as participants and accord them *mana tangata* (the power of the individual) as individuals as well as honour the responsibilities and commitments this brings. Co-operative learning strategies will be used in the intervention to represent *whakawhanaungatanga* in the classroom. This will give the research project a firm foundation upon which this prospective partnership will flourish. The research presentation and findings will be presented from a respectful, inclusive and deferential stance (Berryman et al, 2013, p. 14).
2. ***Tino Rangatiratanga* (self-determination).** The status of the project and the *mana tangata* of the participants will be upheld throughout the project through effective and respectful engagement, good culturally inclusive teaching and interactions that are guided by the participating schools and their students with the intervention complimenting the classroom programme and adding to the students resource base as they move to express their positions towards the socio scientific issue under discussion (Macfarlane, 2004).
3. ***Manākitanga* (the ethic of caring).** The showing of respect, kindness and hospitality under the notion of an 'ethic of care' will demonstrate reciprocity in action. The lessons prepared and delivered as part of the intervention will reciprocate the students' participation and sharing of their stories as they reflect on their learning (Macfarlane, 2004).
4. ***Kotahitanga* (unity, togetherness and bonding).** The notion of unity of purpose through the principle of partnership has been exemplified in this research with the collaboration I have had working alongside my co-supervisor Professor Elizabeth McKinley, formally of the Faculty of Education; now a Professor at the University of Melbourne. As an eminent authority on Māori and Science education, she has from the very outset of this project been the source of inspiration

and advice. At her request she maintains her supervision responsibilities and I value her input and guidance. Along with my supervisor A/P Bev France, we have in this project a cross-cultural collaboration rarely seen in science education internationally and especially so in *Aotearoa* New Zealand.

The researcher will ensure that the purpose is clear from the outset and that all students will benefit. Whether they choose to participate or not, all students will participate in the intervention lessons and work as a group to achieve successful outcomes for themselves in NCEA and for the research project. The knowledge shared by the participants will be acknowledged as a valuable *taonga* (treasure) shared by the participants.

5. ***Pūmanawatanga* (pulsation).** This all-embracing concept 'breathes life' into the journey as a whole. The tone, morale and attitudes prevailing through this research will be united and be enacted in this research through the acknowledgement of the interconnectedness of the researcher and the participants united by the shared desire for success (Macfarlane, 2004). Concerns and issues of the participants will be addressed sincerely, and their voices heard through dialogue. Personal experience and narrative will feature, and it will be the participants' voices as co-inquirers that will feature in the narratives and stories that will emerge from this research (Bishop & Berryman, 2006).
6. ***Ko wai ahau?*** My master's research project, which investigated the impact of a Māori language programme on a South Auckland primary school community, took me into the classrooms, homes and *marae* (Māori community setting) of urban and rural Māori communities throughout the North Island. My ability to speak conversational Māori has since been enhanced through decades of speaking and teaching the language, including experience developing and teaching English-Māori bilingual science.

   As a *Pākehā* (European) New Zealander with 30 years of teaching priority learners, my personal and professional life has been enriched through these opportunities. In addition to this I have the ability to speak Sāmoan to a reasonable fluency following my more than 30-year association with Sāmoa. I have demonstrated the ability to competently and confidently live and teach in more than one world with a unique perspective on life and its challenges. This background will allow me to remain 'sensitive to the continuous flux, the ebbing and flowing of events occurring whilst in the field stage of the data gathering phase' (Scott & Garner, 2013, p. 200) and engage positively, productively with people on this research journey.

References:

Berryman, M., SooHoo, S., & Nevin, A. (2013). *Culturally responsive methodologies*. Bingley, England: Emerald Group Publishing.

Bishop, R. A., & Berryman, M. (2006). *Culture speaks: cultural relationships and classroom learning.* Wellington, New Zealand: Huia Publishers.

Macfarlane, A. H. (2004). *Kia Hiwa Ra! Listen to Culture: Māori students' plea to educators.* Wellington: NCER.

Scott, G., & Garner, R. (2013). *Doing Qualitative Research: designs methods and techniques.* Boston, MA: Pearson.

Appendix K: Culturally Responsive Approaches (Pacific)

Consistency of this Research with the Pasifika Education Research Guidelines- Report (2001)

TITLE: *Ngā Haerenga:* Students' exploration of Māori and Pasifika cultural spaces of a Socio Scientific Issue.

RESEARCHERS: Brent Wagner, Associate Professor Bev France and Professor Elizabeth McKinley.

This research project seeks to incorporate the principles and guidelines of the *Pasifika Education Research Guidelines- Report* (2001). This research will be based upon a collaborative, relational, culturally responsive methodology and adhere to the guidelines and principles contained in the report. The importance of Pacific worldviews underpinned by Pacific values, belief systems, and ways of sharing knowledge are embedded in this project.

1. Consultation: The researcher will consult with the Pacific Advisor in the Faculty of Education to receive advice and guidance. The schools and their attached Pacific parent networks will be approached and invited to meetings to outline the project, invite participation and answer any questions. This consultation will continue throughout the project and form an important part of the final dissemination of the research findings. The lines of communication will remain open and reciprocal. This will ensure 'buy-in'.
2. Methodologies: It is acknowledged that importance be given to and reflected in, the need for the data collection processes be sensitive to Pacific contexts, acknowledge collective ownership, and allow for culturally safe sharing of thoughts and ideas. The qualitative nature of the methods proposed for this study-with opportunities for written and verbal data gathering afford the participants to tell their stories as the journey through the internal assessment. This project will be sensitive to the language utilised, the framing of questions and the implementation of these questions.
3. Interview Protocols: In a Pacific context the interviewer will observe the protocols necessary for the full and active participation of the participants or audience. This will also form part of the closing of any gathering or interview setting. The interviews will be fully outlined ahead of the sessions and rapport will be built and maintained by the researcher through regular contact, visibility, and availability throughout the data collection phase. Reciprocation in the form of food will feature as its cultural significance is acknowledged. Rapport and reciprocation build and maintain the trust required in order to effectively put the interviewee at ease prior to an audio-taped interview.
4. Handling Data: All transcripts will be made available to participants to review or change to maintain the integrity of the data. At the outset the steps and ethically appropriate steps taken to ensure the confidentiality of the information gathered. This will reduce any participants' feelings of familial shame attached to their identification.
5. Gifting: In Pacific settings, gifting is the tangible expression of reciprocity, love and respect. This research project acknowledges and will attend to this with sensitivity. In particular, the presentation and sharing of food at meetings attended by families, participants and at the conclusion of the project when the findings are shared, food will be available for all to share.
6. Data Analysis: Cultural Advisors will be sought to capture the cultural nuances which may be present in the interview data. This is important in order to capture 'the cultural and personal specificities of the experiences of those interviewed' (Report pg. 42). The non-English quotes of

the participants will be retained and may be translated as necessary. This will 'capture the richness and integrity of the interview context' (Report pg. 43).

7. As a *Pākehā* (European) New Zealander with 30 years of teaching priority learners, my personal and professional life has been enriched through these opportunities. In addition to this I have the ability to speak Sāmoan to a reasonable fluency following my more than 30-year association with Sāmoa. My wife, who is Sāmoan, and I along with our two adult daughters have over the last 27 years been active and contributing members of our extended family and have close ties to them here and in Sāmoa. Through this association I have demonstrated the ability to competently and confidently live and teach in more than one world with a unique perspective on life and its challenges. I have well developed linguistic and cultural abilities that fit well with this research. This background will allow me to remain 'sensitive to the continuous flux, the ebbing and flowing of events occurring whilst in the field stage of the data gathering phase' (Scott & Garner, 2013, p. 200) and engage positively, productively with people on this research journey.

References:

Anae, M., Coxon, E., Mara, D., Wendt-Samu, T., Finau, C (2001) *Pasifika Education Research Guidelines: Final Report*. Auckland: Uniservices for MOE

Scott, G., & Garner, R. (2013). *Doing Qualitative Research: designs methods and techniques.* Boston, MA: Pearson.

Appendix L: Transcriber Confidentiality Agreement

SCHOOL OF CURRICULUM AND PEDAGOGY
Te Kura o te Marautanga me te Ako

THE UNIVERSITY OF AUCKLAND
FACULTY OF EDUCATION
Te Kura Akoranga o Tāmaki Makaurau
Incorporating the Auckland College of Education

TRANSCRIBER CONFIDENTIALITY AGREEMENT

PROJECT TITLE:
Ngā Haerenga: **Students' exploration of Māori and Pasifika cultural spaces of a socio scientific issue.**

RESEARCHER:
Brent Wagner

SUPERVISORS:
Associate Professor Bev France
Professor Liz McKinley

Transcriber:

I agree to transcribe the digital voice recordings for the above research project. I understand that the information contained within them is confidential and must not be disclosed to, or discussed with, anyone other than the researcher and his supervisors.

Name: ……..…

Signature: ……..

Date: ……

Appendix M: AS91602 and Data Collection Timeline (Combined Schools)

AS91602 High School (HS) & Secondary School (SS) **Combined Data Collection Timeline**						
Week	Day	Date	School Day	Period	Start time	Planned Activity
0	**Thur**	**7/5**			**2:20pm**	**Thursday 7 May, (2:20pm-3:20pm):** ➢ **Introduction of project to class. Hand out of student PIS & CFs also Parent/Whānau PIS** ➢ **Date to complete and hand in Consent Forms (in box) by Wed 13 May**
1	Mon	11/5	5	3	11.25	Hand out paperwork on AS91602 This will contain a logbook sheet and Student Instructions for the Achievement Standard. Read through and point out specific timelines which tie in with this document
	Tue	12	6	1	8.40	Exploration of "What is 1080" as was done for "Possum knowledge questions and research" Questions to answer will be: What is 1080? What does it do? How does it work? How is it administered? How safe is the distribution or administering of 1080? What are the effects if it is accidently spread? Any other questions of interest…
	Wed SS	**13**			**9:30am**	**Wednesday 13 May, (9:30am-10:30am): CONSENT FORMS DUE SS**
	Wed	**13**	**1**	**4**	**12.30pm**	**Mr Brent Wagner to come in and collect consent forms 'vault' ☺DUE HS** **Mr Wagner and _____ off to check out Murphy's Bush for Field trip.**
	Fri	15	3	1	8.40am	Library research around all aspects of topic, including Ecosystems, Indigenous wildlife, Pests, Rabbits in NZ, kiwi, Predator-prey relationships, Biological control
	Sat/Sun	16/17				
2	Mon	18	4	2	10.05am	Library research continued
	Wed	20	6	1	8.40am	NO LESSON – 10am START
	Thur	21	1	5	12:30pm	Murphy's Bush excursion 12.30pm – 3.00pm Observation of a suburban bush.
	Fri	**22**	**2**	**5**	**2:10pm**	Pooling of information gleaned from Murphy's Bush Excursion
	Sat/Sun	23/24				
	Tue	**26**	**4**	**2**	**10.05am**	**TiriTiri Matangi Excursion – Full Day** **Observation of a monitored and protected environment.**
	Wed	27	5	3	11.25am	Discussion and pooling of information from the observation of two habitats. Completion of worksheet comparing two environments to Thursday
	Thur	28	6	1	8.40am	Worksheet completion from excursions.
	Sat/Sun	30/31				
4	Mon	1 June				NO LESSONS – QUEENS BIRTHDAY HOLIDAY
	Thur	4/6	4	2	10.05am	Collating of information/research notes
	Sat/Sun	6/7				
5	Mon	8/6	6	1	8.40am	Collating of information/research notes
	Wed	10/6	2	5	2.10pm	Collating of information/research notes
	Thur	11/6	3	1	8.40pm	Collating of information/research notes
	Fri	12/6	4	2	10.05am	Writing up of final report
	Sat/Sun	13/14				
	Mon SS	**15/6**	5	3	11.25am	Writing up of final report **Monday 15 June, (11:05am-12:35pm): Sharing Circles**
	Tue	16	6	1	8.40am	Writing up of final report
	Wed	17 June	1	4	12.30pm	SUBMISSION OF FINAL REPORTS

Appendix N: Positional Analysis Grid for All Participant Data

		HS 01	HS 02	HS 03	HS 04	HS 07	HS 08	HS 09	HS 10	HS 11	HS 12	HS 13	HS 14	HS 16	HS 17	HS 18	HS 19	HS 20	SS 22	SS 23	SS 24	SS 25	SS 26	SS 27	SS 28	SS 29	SS 30	SS 31	SS 32	SS 33	SS 34	SS 35	SS 36	SS 37	SS 38	SS 39	SS 40	SS 41		
	BIOLOGICAL CONCEPT	Kay	Blue	James	Manu	Anrib	Omar	Dotti	Moana	Lana	Spec	KitKat	Justin	Tee	Tibs	Lasi	Rose	Dee	Kris	Ava	Nora	Mia	Raizada	Sam	Nadia	Charlee	Freya	Katie	Anders	Dawn	Sina	Luke	Victoria	Lavinia	Valkyrie	Chloe	Ashe	Ofa	**SUPPORT**	**OPPOSE**
	ENVIRONMENT																																							
a	The environment as a non-specific entity	1		2						1	1				1									1	2							1	1			2			13	
b	The environment is separate from living organisms	1		1												1	1									1								1		1			7	
c	The environment is comprised of living, named organisms			1									1				1								1											1			4	1
d	The environment comprises living (biotic) and non-living (abiotic) factors			1								1								1																			2	1
	POPULATION																																							
a	A group of named organisms living in an area		1	1	1		1	1						1	1		1		1		1	1	1	1	1		1		1						1			1	16	2
b	Population numbers can change		1	1	2		1	2			3			2	2						1	1	2	2	2		1		2									2	23	4
c	A change in the numbers of pests influences the numbers of the native population				1												1						1	1	1				1										6	
	NATIVE/INDIGENOUS																																							
a	Native species is named				1+1												1		1				1		2	2													8	1
b	Native species belong to New Zealand	1		1	1										1		1		1			1		1	3	1	1	1	1	1						3			19	
c	Native species are targeted by introduced species	1	1	2		1											1		1	1			1	1	3	1	1	1	1							1			18	
	EXOTIC/INTRODUCED																																							
a	Introduced rats are mammalian pests																			1								1								1			3	
b	Introduced rats negatively affect native populations																			1																			1	
c	Humans brought the pest in to the habitat				1				1										1											1									2	2
d	Introduced pests can be predators		1																	1			1																3	
	PEST																																							
a	The pest is named as an animal		1				1+1	1				1						1		1			3		3			1		1	1					1		1	14	4
b	The pest animal is identified as a mammal																							1				2								1			4	
c	The pest is an animal introduced from elsewhere; by humans					1			1										2									1		2						1			6	2
d	Pests are harmful to a named species		1					1										1	1	1			3		1		1	1		1									10	2
e	Humans are also pests				1		1					1																											1	2
	PEST CONTROL																																							
a	A target species can be targeted	1					1	1		1												1	1	1	1		1	1	1	1	1		1	1		1	1	1	17	1
b	1080 is a poison that can kill		2	1				2		1		2		1	1		2	1					1				1		1			2				1			13	6
c	1080 can control pest population numbers			1				1			1			1									1				1				1									5	2
d	Alternative methods of pest control			1			1+1	2		1	1				1		1							1			2	1			1		2				2		15	3
	CULTURAL CONCEPT	HS 01	HS 02	HS 03	HS 04	HS 07	HS 08	HS 09	HS 10	HS 11	HS 12	HS 13	HS 14	HS 16	HS 17	HS 18	HS 19	HS 20	SS 22	SS 23	SS 24	SS 25	SS 26	SS 27	SS 28	SS 29	SS 30	SS 31	SS 32	SS 33	SS 34	SS 35	SS 36	SS 37	SS 38	SS 39	SS 40	SS 41		
		Kay	Blue	James	Manu	Anrib	Omar	Dotti	Moana	Lana	Spec	KitKat	Justin	Tee	Tibs	Lasi	Rose	Dee	Kris	Ava	Nora	Mia	Raizada	Sam	Nadia	Charlee	Freya	Katie	Anders	Dawn	Sina	Luke	Victoria	Lavinia	Valkyrie	Chloe	Ashe	Ofa	**SUPPORT**	**OPPOSE**
	WHAKAPAPA																																							
a	Kinship of all living things descended from the gods				2												5	5							5									4		2			13	10
b	Unity among humans, living and non-living elements of the natural world (eg. land)																1	3							1									2					3	4
c	The source of knowledge inherited from ancestors																1								1									1					2	1
	MAURI																																							
a	Force that links the physical to the spiritual world																1	1																1					1	2
b	Source of respect towards all things																	1																		2			2	1
c	Vitality/fruitfulness of the natural environment																	2																1		1			2	2
d	Enabler for everything to live in accordance with the conditions and limits of its existence																	1																		2			2	1
	WAIRUATANGA																																							
a	Material world is subordinate to spiritual world																1																							1
b	A spiritual connection to land																														1			1					2	
c	Karakia/incantations to ensure spiritual safety																																			1			1	
	MANA/MANA WHENUA																																							
a	Mana – the power of the gods, ancestors, land and the individual																1																	1					1	1
b	Mana whenua - authority/control over the management of natural resources																							1					2					2		1			6	
	TIKANGA																																							
a	An expression of values				1													1							4						1			2		1			9	1
b	Customary practices, beliefs, rituals and protocols				2												1	1						3	2									1		6			14	2
	MANAAKITANGA																																							
a	Acts of caring by showing respect and kindness				1													2																1					2	2
b	Holistic nurturing of relationships through reciprocation, by acknowledging worth and ensuring safety				1													1							1									1					4	
c	Demonstrating mana-enhancing behaviours																	1+1																					1	1
	KAITIAKITANGA																																							
a	Active guardianship of the environment in accordance with tikanga				2						1						1	2							1						1					1			6	3
b	Protection of the natural environment and its taonga				2						1																									2			5	
c	There are human, non-human or spiritual kaitiaki				1												1	1																		1			2	2
		HS 01	HS 02	HS 03	HS 04	HS 07	HS 08	HS 09	HS 10	HS 11	HS 12	HS 13	HS 14	HS 16	HS 17	HS 18	HS 19	HS 20	SS 22	SS 23	SS 24	SS 25	SS 26	SS 27	SS 28	SS 29	SS 30	SS 31	SS 32	SS 33	SS 34	SS 35	SS 36	SS 37	SS 38	SS 39	SS 40	SS 41		
		Kay	Blue	James	Manu	Anrib	Omar	Dotti	Moana	Lana	Spec	KitKat	Justin	Tee	Tibs	Lasi	Rose	Dee	Kris	Ava	Nora	Mia	Raizada	Sam	Nadia	Charlee	Freya	Katie	Anders	Dawn	Sina	Luke	Victoria	Lavinia	Valkyrie	Chloe	Ashe	Ofa		

KEY

1	Represents a single statement supporting 1080 use
1	Represents a single statement opposing 1080 use
2	Represents two statements supporting 1080 use
2	Represents two statements opposing 1080 use
1+1	Represents two statements (1 in support & 1 opposed) to 1080 use

References

Abd-El-Khalick, F. (2003). Socio-scientific issues in pre-college science classrooms: The primacy of learners' epistemological orientations and views of nature of science. In D. L. Zeidler (Ed.), *The role of moral reasoning on socioscientific issues and discourse in science education* (pp. 41-61). Boston, MA: Kluwer Academic.

Abd-El-Khalick, F. (2004). Over and over again: College students' views of nature of science. In L. B. Flick & N. G. Lederman (Eds.), *Scientific inquiry and nature of science* (pp. 389-426). Dordrecht, Netherlands: Kluwer Academic.

Abd-El-Khalick, F. (2012). Nature of science in science education: Toward a coherent framework for synergistic research and development. In B. J. Fraser., K. G. Tobin., & C. J. McRobbie (Eds.), *Second international handbook of science education* (pp. 1041-1060). Dordrecht, Netherlands: Springer.

Aikenhead, G. S. (2006). *Science education for everyday life: Evidence-based practice*. NY: Teachers College Press.

Aikenhead, G. (2007). Expanding the research agenda for scientific literacy. In, *Promoting scientific literacy: Science education research in transaction. Proceedings of the Linnaeus Tercentenary Symposium, May 2007* (pp. 64-84). Retrieved from http://eprints.qut.edu.au/12883/1/Linnaeus_Tercentenary_Symposium.pdf#page=62

Aikenhead, G. S., & Elliott, D. (2010). An emerging decolonizing science education in Canada. *Canadian Journal of Science, Mathematics and Technology Education, 10*(4), 321-338. https://doi.org/10.1080/14926156.2010.524967

Aikenhead, G. S., & Michell, H. (2011). *Bridging cultures: Indigenous and scientific ways of knowing nature.* Toronto, ON: Pearson Canada Inc.

Aikenhead, G. S., & Ogawa, M. (2007). Indigenous knowledge and science revisited. *Cultural Studies of Science Education, 2*(3), 539-620.

Åkerblom, D., & Lindahl, M. (2017). Authenticity and the relevance of discourse and figured worlds in secondary students' discussions of socioscientific issues. *Teaching and Teacher Education, 65*, 205-214.

Allchin, D. (2011). Evaluating knowledge of (whole) science. *Science Education, 95*(3), 918-942.

Allchin, D. (2013). *Teaching the nature of science: Perspectives and resources.* St. Paul, MN: SHiPS Education Press.

Allen, W., Ogilvie, S., Blackie, H., Smith, D., Sam, S., Doherty, J., … Eason, C. (2014). Bridging disciplines, knowledge systems and cultures in pest management. *Environmental Management, 53*(2), 429-440. https://doi.org/10.1007/s00267-013-0180-z

Anderson, D., & Moeed, A. (2017). Working alongside scientists. *Science & Education, 26*(3-4), 271-298.

Arnold, J., & Clark, D. J. (2014). What is ‘Agency’? Perspectives in science education research. *International Journal of Science Education, 36*(5), 735-754.

Averill, R., Hindle, R., Hynds, A., Meyer, L., Penetito, W., Taiwhati, M., … Faircloth, S. (2014). It means everything doesn’t it? Interpretations of Māori students achieving and enjoying educational success" as Māori". *Set: Research Information for Teachers*, (2), 33-40.

Ballenger, C. (1997). Social identities, moral narratives, scientific argumentation: Science talk in a bilingual classroom. *Language and Education*, *11*(1), 1-14.

Bandura, A. (1999). Social cognitive theory: An agentic perspective. *Asian Journal of Social Psychology*, *2*(1), 21-41.

Bandura, A. (2006). Guide for constructing self-efficacy scales. *Self-efficacy beliefs of adolescents*, *5*(1), 307-337.

Barlow, C. (1991). *Tikanga whakāro: Key concepts in Māori culture.* Auckland, New Zealand: Oxford University Press.

Barry, C. (2009). The environment/society disconnect: An overview of a concept tetrad of environment. *The Journal of Environmental Education*, *41*(2), 116-132.

Bayley, M. (2005). *Patterns of life for NCEA level 2 biology*. Auckland, New Zealand: Pearson Longman.

Bell, B. (2005). *Learning in science: The Waikato research.* Oxford, England: RoutledgeFalmer.

Bell, R. (2004). Perusing Pandora’s Box: Exploring the what, when and how of nature of science. In L. B. Flick & N. G. Lederman (Eds.), *Scientific inquiry and nature of science* (pp. 427-446). Dordrecht, Netherlands: Kluwer Academic.

Benson, G. D. (1989). Epistemology and science curriculum. *Journal of Curriculum Studies, 21*(4), 329-344. https://doi.org/10.1080/0022027890210403

Berryman, M., SooHoo, S., & Nevin, A. (2013). *Culturally responsive methodologies*. Bingley, England: Emerald Group Publishing.

Bhabha, H. K. (1994). *The location of culture*. New York, NY: Routledge.

Biesta, G. J. J. (2004). “Mind the Gap!” Communication and the educational relation. In C. W. Bingham, & A. M. Sidorkin (Eds.), *No education without relation* (Vol. 259), (pp. 11-22). New York, NY: Peter Lang Publishing, Inc.

Birdsall, S., & France, B. (2018). Lifting the cover: Developing an analytical tool to unravel environmental education resources. *Environmental Education Research, 24*(11), 1546-1564.

Bishop, R. (2011). *Freeing Ourselves.* Rotterdam, The Netherlands: Sense Publishers.

Bishop, R. A. (2019). Māori education needs more than task force has proposed. Retrieved from https://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=12208679

Bishop, R. A., & Berryman, M. (2006). *Culture speaks: Cultural relationships and classroom learning.* Wellington, New Zealand: Huia.

Blair, D. V. (2009). Learner agency: To understand and be understood. *British Journal of Music Education, 26*(2), 173-187.

Bloomberg, L. D., & Volpe, M. (2012). *Completing your qualitative dissertation: A road map from beginning to end* (2nd ed.). Thousand Oaks, CA: Sage.

Boeije, H. (2010). *Analysis in qualitative research.* Los Angeles, CA: Sage.

Brandt, C. (2008). Discursive geographies in science: Space, identity and scientific discourse among indigenous women in higher education. *Cultural Studies of Science Education, 3*(3), 703-730.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. https://doi.org/10.1080/17439760.2016.1262613

Brockie, R. (2007). 'Introduced animal pests - Possums'. In J. Phillips (Ed.), *Te Ara- The Encyclopedia of New Zealand.* Retrieved from https://www.TeAra.govt.nz/en/introduced-animal-pests/page-2

Bryman, A. (2004). *Social research methods* (2nd ed.). Oxford, NY: Oxford University Press.

Bull, A., Gilbert, H., Barwick, H., Hipkins, R., & Baker, R. (2010). *Inspired by science: A paper commissioned by the Royal Society and the Prime Minister's Chief Science Advisor.* Wellington, New Zealand: New Zealand Council for Educational Research Press. Retrieved from https://www.nzcer.org.nz/system/files/inspired-by-science.pdf

Cajete, G. (2000). *Native science: Natural laws of interdependence*. Santa Fe, NM: Clear Light.

Calabrese Barton, A. (1998). Teaching science with homeless children: Pedagogy, representation and identity. *Journal of Research in Science Teaching, 35*(4), 375-394.

Campbell, A., Cooke, P., Earl, S. K., & Otrel-Cass, K. (2004). A New Zealand evolution for teaching online resource. *Teaching Earth Sciences, 29*(3/4), 31-32.

Cahill, F. (2006). Crossing the road from home to secondary school: A conversation with Sāmoan parents. *Waikato Journal of Education, 12*(1).

Carlone, H., Johnson, A., & Eisenhart, M. (2014). Cultural perspectives in science education. In N. G. Lederman & S. K. Abell (Eds.), *Handbook of research on science education: Volume II* (pp. 651-670). New York, NY: Routledge.

Carroll, L., & Oxenbury, H. (2005). *Alice through the looking-glass and what she found there.* London, England: Walker Books.

Carter, L. (2008). Globalization and science education: The implications of science in the new economy. *Journal of Research in Science Teaching, 45*(5), 617-633.

Clark, W. C., & Dickson, N. M. (2003). Sustainability science: the emerging research program. *Proceedings of the National Academy of Sciences*, *100*(14), 8059-8061.

Clarke, V., & Braun, V. (2017). Thematic analysis. *The Journal of Positive Psychology, 12*(3), 297-298.

Cobern, W. W. (1996). Worldview theory and conceptual change in science education. *Science education*, *80*(5), 579-610.

Cobern, W.W. (2000). *Everyday thoughts about nature.* Boston, MA: Kluwer Academic.

Cobern, W.W., & Loving, C. C. (2001). Defining "Science" in a multicultural world: Implications for science education. *Science Education, 85*(1), 50-67.

Cooper, G. (2012). Kaupapa Māori research: Epistemic wilderness as freedom? *New Zealand Journal of Educational Studies, 47*(2), 64-73.

CORE Ten Trends. (2017). *CORE Education.* Tātai Ahu Rau, New Zealand. Retrieved from http://www.core-ed.org

Craig, R., Taonui, R., & Wild, S. (2012). The concept of taonga in Māori culture: insights for accounting. *Accounting, Auditing & Accountability Journal*, *25*(6), 1025-1047.

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory into practice, 39*(3), 124-130. https://doi.org/10.1207/s15430421tip3903_2

Dale, A., Walker, J., & Perrott, J. (2015). Implementation of tikanga Māori in animal euthanasia teaching. *Unitec ePress Occasional & Discussion Paper Series 2015/3, 1*(1), 85-86. Unitec ePress. Retrieved from http://www.unitec.ac.nz/epress

Dencer-Brown, A., Alfaro, A., Milne, S., & Perrott, J. (2018). A review on biodiversity, ecosystem services, and perceptions of New Zealand's mangroves: Can we make informed decisions about their removal? *Resources, 7*(1), 23. https://doi.org/10.3390/resources7010023

Denzin, N. K. (2004). The war on culture, the war on truth. *Cultural Studies, Critical Methodologies, 4*(2), 137-142.

Department of Conservation (2016). New Zealand Biodiversity Action Plan 2016-2020 Retrieved from https://www.doc.govt.nz/globalassets/documents/conservation/new-zealand-biodiversity-action-plan-2016-2020.pdf

Department of Conservation (2019). *Te Koiroa o te Koiora: Our shared vision for living with nature.* Retrieved from https://www.doc.govt.nz/globalassets/documents/conservation/protecting-and-restoring/biodiversity-discussion-document.pdf

Driver, R., & Oldham, V. (1986). A constructivist approach to curriculum development in science. *Studies in Science Education, 13*(1), 105-122.

Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science education*, *84*(3), 287-312.

Durham, W., Sykes, C., Piper, S., & Stokes, P. (2015). Conceptual frameworks and terminology in doctoral nursing research. *Nurse Researcher, 23*(2), 8-12.

Durie, M. (2005). *Ngā tai matatū: Tides of Māori endurance.* Oxford, NY: Oxford University Press.

Durie (2006, 8 October). Whānau, Education and Māori Potential. Paper presented at Hui Taumata Mātauranga V. Taupo, New Zealand. Retrieved from https://www.researchgate.net/profile/Mason_Durie/publication/237204992_WHANAU_EDUCATION_AND_MAORI_POTENTIAL/links/573d838f08aea45ee842959d/WHANAU-EDUCATION-AND-MAORI-POTENTIAL.pdf

Durie, M. (2011). *Ngā tini whetū: Navigating Māori futures*. Auckland, New Zealand: Huia Publishers.

Durie, M., Hoskins, T. K., & Jones, A. (2012). Interview: Kaupapa Māori: shifting the social. *New Zealand Journal of Educational Studies, 47*(2), 21-29.

Eason, C., Miller, A., Ogilvie, S., & Fairweather, A. (2011). An updated review of the toxicology and ecotoxicology of sodium fluoroacetate (1080) in relation to its use as a pest control tool in New Zealand. *The New Zealand Journal of Ecology, 35*(1), 1-20.

Eason, C. T., Wright, G. R., & Fitzgerald, H. (1992). Sodium monofluoroacetate (1080) water-residue analysis after large-scale possum control. *New Zealand Journal of Ecology, 16*(1), 47-69.

Education Review Office. (n.d.). Various School Reviews. Wellington, New Zealand: author. https://www.ero.govt.nz/review-reports/&Category=3

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

Elliott, G., & Kemp, J. (2016). Large-scale pest control in New Zealand beech forests. *Ecological Management & Restoration, 17*(3), 200-209.

Ferguson, P. B., Gorinski, R., Wendt Samu, T., & Mara, D. (2008). *Literature review on the experiences of Pasifika learners in the classroom: A report prepared for the Ministry of Education.* Wellington, New Zealand: New Zealand Council for Educational Research Press.

Flick, U. (2007). *Designing qualitative research*. London, England: Sage.

Flick, U. (2014). *An introduction to qualitative research* (5th ed.). London, England: Sage.

Flick, L. B., & Lederman, N. G. (2004). Introduction. In L. B. Flick & N. G. Lederman (Eds.), *Scientific inquiry and nature of science* (pp. ix-xviii). Dordrecht, Netherlands: Kluwer Academic.

France, B., & Compton, V. (Eds.). (2012). *Bringing communities together: Connecting learners with scientists or technologists.* Rotterdam, The Netherlands: Sense Publishers.

Gerrard, J. (2018). Making science fly for all: PM's new Chief Science Advisor. *New Zealand Education Gazette 97*(20). Retrieved from https://gazette.education.govt.nz/articles/making-science-fly-for-all-pms-new-chief-science-advisor

Gilbert, J. (2005). *Catching the knowledge wave? The knowledge society and the future of education.* Wellington, New Zealand: NZCER Press

Gilbert, J., & Bull, A. (2013). *Building a Future-Oriented Science Education System in New Zealand: How Are We Doing?* Wellington, New Zealand: New Zealand Council for Educational Research.

Gluckman, P. D. (2011). *Looking ahead: Science education for the twenty-first century: A report from the PMCSA.* Office of the Prime Minister's Advisory Committee. Retrieved from https://www.pmcsa.org.nz/wp-content/uploads/Looking-ahead-Science-education-for-the-twenty-first-century.pdf

Goff, W., & Veresov, N. (2015). Examining teacher-researcher collaboration through the cultural interface. *Cultural Studies of Science Education, 10*, 621-627.

Gondwe, M., & Longnecker, N. (2015). Scientific and cultural knowledge in intercultural science education: Student perceptions of common ground. *Research in Science Education*, *45*(1), 117-147.

Green, W., & Rohan, M. (2012). Opposition to aerial 1080 poisoning for control of invasive mammals in New Zealand: Risk perceptions and agency responses. *Journal of the Royal Society of New Zealand, 42*(3), 185-213.

Gribble, W. L. (1993). *The use of Māori myths and legends as a teaching aid in earth sciences* (Doctoral dissertation). University of Waikato, Hamilton, New Zealand.

Gutierrez, K. D. (2008). Developing a sociocritical literacy in the third space. *Reading Research Quarterly*, *43*(2), 148–164.

Haami, B. (1993). Cultural knowledge and traditions relating to the kiore rat in Aotearoa: Part I: a Māori perspective. *SAMEpapers*, 93: 5-22.

Hacker, P. (2008). *Understanding the nature of language teacher educator learning: Substance, narrative essence and contextual reality.* (Unpublished doctoral thesis). University of Auckland, Auckland, New Zealand.

Handayani, R. D., Wilujeng, I., & Prasetyo, Z. K. (2018). Elaborating indigenous science in the science curriculum for the cultural sustainability. *Journal of Teacher Education for Sustainability 20*(2), 74-78.

Hansford, D. (2016). *Protecting paradise: 1080 and the fight to save New Zealand's wildlife.* Nelson, New Zealand: Potton & Burton.

Harmsworth., G.R. (2004). *The role of Maori values in Low-impact Urban Design and Development (LIUDD): Discussion paper.* Landcare Research NZ Ltd. Retrieved from https://www.landcareresearch.co.nz/publications/researchpubs/harsworth_maori_LIUDD.pdf

Harmsworth, G. R., & Awatere, S. (2013). Indigenous Māori knowledge and perspectives of ecosystems. In J. R. Dymond (Ed.), *Ecosystems services in New Zealand – conditions and trends* (pp. 274-286). Lincoln: Manaaki Whenua Press.

Hawk, K., Cowley, E. T., Hill, J., & Sutherland, S. (2002). The importance of the teacher/student relationship for Māori and Pasifika students. *Set: Research information for teachers, 3*, 44-49.

Heap, R. (2014). *Nature of science in teacher education: rationale, realities, issues and strategies.* (Unpublished doctoral thesis). University of Auckland, Auckland, New Zealand.

Heap, R., & France, B. (2012). Realising the potential of an authentic context to understand the characteristics of NOS and NOT: You, Me and UV. *International Journal of Science Education, 35* (2). https://doi.org/10.1080/09500693.2011.653417

Hikuroa, D. (2017). Mātauranga Māori – the ūkaipō of knowledge in New Zealand. *Journal of the Royal Society of New Zealand, 47*(1), 5-10.

Hikuroa, D., Slade, A., & Gravley, D. (2011). Implementing Māori indigenous knowledge (mātauranga) in a scientific paradigm: restoring the mauri to te kete poutama. *MAI review (Online),* (3), 1-9.

Hynds, A., Averill, R., Hindle, R., & Meyer, L. (2017). School expectations and student aspirations: The influence of schools and teachers on Indigenous secondary students. *Ethnicities, 17*(4), 546-573.

Hynds, A., Webber, M., Irving, E., Cockle, V., Wilson, A., Bendikson, L., … Kiro, A. (2015). The Starpath Project for Tertiary Participation and Success: What have we learnt about equity and excellence in low-mid decile secondary schools? *Te Toroa Titiro Tawhiti: Emancipation through Education*.

Irwin, G., & Walrond, C. (2012). When was New Zealand first settled? The date debate. In J. Phillips (Ed.), *Te Ara- The Encyclopedia of New Zealand*. Retrieved from https://teara.govt.nz/en/when-was-new-zealand-first-settled/page-1

Irzik, G. (2001). Universalism, multiculturalism, and science education. *Science Education, 85*(1), 71-73.

Irzik, G., & Nola, R. (2011). A family resemblance approach to the nature of science for science education. *Science and Education, 20*(7), 591-607.

Jelemenská, P., & Kattmann, U. (2008). Understanding the units of nature: From reification to reflection. A contribution to educational reconstruction in the field of ecology. In M. Hammann., M. Reiss., C Boulter., & S. Dale Tunnicliffe. *Biology in context. Learning and teaching for the twenty-first century.* (pp. 29-39), London, England: Institute of Education, University of London.

Jegede, O. (1995). Collateral learning and the ecocultural paradigm in science and mathematics education in Africa. *Studies in Science Education, 25*, 97-137.

Jegede, O. (1997). Collateral learning: A theory to explain learning from an anthropomorphic worldview. *Journal of Science Education Japan, 21*(3), 145-153.

Jenkins, E. W. (2013). The 'nature of science' in the school curriculum: The great survivor. *Journal of Curriculum Studies, 45*(2), 132-151. https://doi.org/10.1080/00220272.2012.741264

Johnson, M. (1992). Research on traditional environmental knowledge: its development and its role. In M. Johnson, (Ed.), *Lore: capturing traditional environmental knowledge* (pp. 3-22). Ottawa, ON: IDRC.

Johnston, M., Hipkins, R., & Sheehan, M. (2017). Building epistemic thinking through disciplinary inquiry: Contrasting lessons from history and biology. *Curriculum Matters, 13*, 80-102.

Jones, A., & Baker, R. (2005). Curriculum, learning and effective pedagogy in science education for New Zealand: Introduction to special issue. *International Journal of Science Education, 27*(2), 131-143. https://doi.org/10.1080/0950069042000276686

Jordan, R., Gray, S., Demeter, M., Lui, L., & Hmelo-Silver, C. E. (2009). An assessment of students' understanding of ecosystem concepts: conflating ecological systems and cycles. *Applied Environmental Education and Communication, 8*(1), 40-48.

Kahu, E., & Nelson, K. (2018). Student engagement in the educational interface: understanding the mechanisms of student success. *Higher Education Research & Development, 37*(1), 58-71.

Kawharu, M. (2000). Kaitiakitanga: a Māori anthropological perspective of the Māori socio-environmental ethic of resource management. *Journal of the Polynesian Society, 109*(4), 349-370.

Kearney, E., McIntosh, L., Perry, B., Dockett, S., & Clayton, K. (2014). Building positive relationships with indigenous children, families and communities: Learning at the cultural interface. *Critical Studies in Education, 55*(3), 338-352. https://doi.org/10.1080/17508487.2014.914963

Kennedy, N. (2008). *Viewing the world through a wider lens: Māori and council planning documents*. Hamilton, New Zealand: IGCI, The University of Waikato.

Kim, M. (2017). Indigenous knowledge in Canadian science curricula: Cases from Western Canada. *Cultural Studies of Science Education, 12,* 605-613.

Kirch, S., & Ma, J. (2016). The relationship between passibility, agency and social interaction and its relevance for research and pedagogy. *Cultural Studies of Science Education, 2016, 11*(4), 1103-1113. https://doi.org/10.1007/s11422-015-9683-7

Klenowski, V. (2009). Australian Indigenous students: Addressing equity issues in assessment. *Teaching Education, 20*(1), 77-93.

Kolstø, S., D. (2000). Consensus projects: Teaching science for citizenship. *International Journal of Science education. 22*(6), 645-664.

Kukla, A. (2000). *Social constructivism and the philosophy of science.* New York, NY: Routledge.

Lederman, N. G. (1992). Students' and teachers' conceptions of the nature of science: A review of the research. *Journal of research in science teaching*, *29*(4), 331-359.

Lederman N. G., & Lederman, J. S., (2014). Research on Teaching and Learning of Nature of Science. In N. G. Lederman & S. K. Abell (Eds.), *Handbook of research on science education: Volume II* (pp. 600-620). New York, NY: Routledge.

Lederman, N. G., Schwartz, R. S., Khishfe, R., Lederman, J. S., Matthews, L., & Liu, S. (2002). Project ICAN: A professional development program for teachers' knowledge and pedagogy of nature of science and scientific inquiry. In *Annual Meeting of the Association for the Education of Teachers of Science, Charlotte, NC.*

Lee, O., & Buxton, C. (2011). Engaging culturally and linguistically diverse students in learning science. *Theory into Practice*, *50*(4), 277-284.

Lee, O., & Luykx, A. (2006). *Science education and student diversity: Synthesis and research agenda.* New York, NY: Cambridge University Press.

Lewis, B. F., & Aikenhead, G. S. (2001). Introduction: Shifting perspectives from universalism to cross-culturalism. *Science Education*, *85*(1), 3-5.

Lewis, J., & Leach, J. (2006). Discussion of socio-scientific issues: The role of science knowledge. *International Journal of Science Education*, *28*(11), 1267-1287.

Lincoln, Y., & Guba, E. (1985). *Naturalistic enquiry.* Beverly Hills, CA: Sage

Lindahl, M. G., & Linder, C. (2013). Students' ontological security and agency in science education—an example from reasoning about the use of gene technology. *International Journal of Science Education*, *35*(14), 2299-2330.

Linklater, W. (2016, July 28). Its' a people problem, not a pest problem. *The Dominion Post*. Retrieved from https://www.victoria.ac.nz/news/2016/07/predator-free-2050-mainly-a-people-problem

Loughland, T., Reid, A., Walker, K., & Petocz, P. (2003). Factors influencing young people's conceptions of environment. *Environmental Education Research*, *9*(1), 3-19.

Lyver, P. O. B., Timoti, P., Gormley, A. M., Jones, C. J., Richardson, S. J., Tahi, B. L., & Greenhalgh, S. (2017). Key Māori values strengthen the mapping of forest ecosystem services. *Ecosystem services*, *27*(Part A), 92-102.

Macfarlane, A. H. (2004). *Kia Hiwa Ra! Listen to culture: Māori students' plea to educators.* Wellington, New Zealand: NCER.

Macfarlane, A., Glynn, T., Grace, W., Penetito, W., & Bateman, S. (2008). Indigenous epistemology in a national curriculum framework? *Ethnicities*, *8*(1), 102-126.

Macfarlane, A. H., Macfarlane, S., & Webber, M. (Eds.). (2015). *Sociocultural realities: Exploring new horizons*. Christchurch, New Zealand: Canterbury University Press.

Mackay, D. (1990). 'Cook, James', Dictionary of New Zealand Biography, (updated November, 2007). In J. Phillips (Ed.), *Te Ara- The Encyclopedia of New Zealand.* Retrieved from https://teara.govt.nz/en/biographies/1c25/cook-james

Madjar, I., & McKinley, E. (2013). *Understanding NCEA: A relatively short and very useful guide for secondary school students and their parents* (2nd ed.). Wellington, New Zealand: NCER Press.

Mahuika, R., Berryman, M., & Bishop, R. (2011). Issues of culture and assessment in New Zealand education pertaining to Māori students. *Assessment Matters*, *3*, 183+. Retrieved from https://link-gale-com/apps/doc/A307413792/AONE?u=learn&sid=AONE&xid=f655b536

Marsden, M., & Royal, Te Ahukaramū C. (Eds.). (2003). *The woven universe: Selected writings of Rev. Māori Marsden.* Otaki, New Zealand: Estate of Rev. Māori Marsden.

Marsden. M., & Henare; T. A. (1992). *Kaitiakitanga: a definitive introduction to the holistic world view of the Māori.* Wellington, New Zealand: Ministry for the Environment.

Matthews, P (2019). Tuia 250: The return of the death ship. *Stuff NZ News*. Retrieved from https://www.stuff.co.nz/national/politics/116374482/tuia-250-the-return-of-the-death-ship

Mazzocchi, F. (2018). Why "integrating" western science and indigenous knowledge is not an easy task: What lessons could be learned for the future of knowledge? *Journal of Futures Studies*, *22*(3), 19-34. https://doi.org/10.6531/JFS.2018.22(3).00A19

McCain, K. (2016). *The Nature of Scientific Knowledge: An exploratory approach.* Switzerland: Springer International Publishing. https://doi.org/10.1007/978-3-319-33405_1

McComas, W. F., & Olson, J. K. (1998). The nature of science in international science education standards documents. In W. F. McComas (Ed.), *The nature of science in science education: Rationales and strategies.* (pp. 41-52). Dordrecht, Netherlands: Kluwer Academic.

McGlone, M. (2007). Evolution of plants and animals: Distinctive qualities. In J. Phillips (Ed.), *Te Ara- The Encyclopedia of New Zealand.* Retrieved from http://www.TeAra.govt.nz/en/evolution-of-plants-and-animals/page-4

McKinley, E. A. (2003). *Brown Bodies, White Coats: Postcolonialism, Māori Women and Science.* (Unpublished Doctoral thesis). University of Waikato, Hamilton, New Zealand. Retrieved from https://hdl.handle.net/10289/13238

McKinley, E. (2005). Locating the global: Culture, language and science education for indigenous students. *International journal of science Education*, *27*(2), 227-241.

McKinley, E. A. (2007). Postcolonialism, indigenous students and science education. In S. K. Abell., & N. G. Lederman (Eds.), *Handbook of research in science education* (pp. 199-226). Mahwah and London: Lawrence Erlbaum Associates.

McKinley, E., & Stewart, G. (2009). Falling into place: Indigenous science education research in the Pacific. In S. Ritchie (Ed.), *World of science education: Handbook of Research in Australasia* (Vol. 2, pp. 49-66), Handbook of research in Australasia. Rotterdam, The Netherlands: Sense Publishers.

McKinley, E., Stewart, G. M., & Richards, P. (2005). *Māori knowledge, language and participation in mathematics and science education*. University of Waikato.

McLaughlin, C. (2018). Schools, psychosocial well-being and agency: From fragmentation to coherence. *European Journal of Education, 53*, 281-292.

Mead, H. M. (2006). *Tikanga Māori – Living by Māori values.* Wellington, New Zealand: Huia Publishers.

Mercier, O. (2007). Indigenous knowledge and science: A new representation of the interface between indigenous and eurocentric ways of knowing. *He Pukenga Kōrero: A Journal of Māori Studies, 8*(2), 20-28.

Mercier, O., Stevens, N., & Toia, A. (2012). Mātauranga Māori and the data-information-knowledge-wisdom hierarchy *MAI Journal (Online), 1*(2), 103-116. Retrieved from: https://ndhadeliver.natlib.govt.nz/delivery/DeliveryManagerServlet?dps_pid=FL15030125

Meredith, P. (1999). Hybridity in the third space: Rethinking bi-cultural politics in Aotearoa/New Zealand. *He Pukenga Kōrero 4*(2), 1999, 12-16.

Merriam, S. B. (1998*). Qualitative research and case study applications in education* (2nd ed.). San Francisco, CA: Jossey-Bass.

Meyer, X., & Crawford, B. A. (2011). Teaching science as a cultural way of knowing: Merging authentic inquiry, nature of science, and multicultural strategies. *Cultural Studies of Science Education, 6*(3), 525-547.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage.

Millar, R. (2004). The role of practical work in the teaching and learning of science. *High school science laboratories: Role and vision*, 1-24. Retrieved from http://www.informalscience.org/images/research/Robin_Millar_Final_Paper.pdf

Miller, C. J., & Anderson, S. (1992). Impacts of aerial 1080 poisoning on the birds of Rangitoto Island, Hauraki Gulf, New Zealand. *New Zealand Journal of Ecology, 16*(2), 103–107.

Millner, J., & Sciascia, P. (1997, October). Māori and biological diversity. In *Proceedings of BioLive, the Second Biennial Biology Teachers' Conference.* Wellington, New Zealand.

Milton, K. (1996). *Environmentalism and cultural theory: exploring the role of anthropology in environmental discourse*. New York, NY: Routledge.

Ministry for the Environment. (2000). *The New Zealand Biodiversity Strategy*. Wellington, New Zealand: Department of Conservation.

Ministry of Education. (2001). *Pacific education research guidelines – report.* Wellington, New Zealand: Learning Media.

Ministry of Education. (2007a). *Pūtaiao i roto i te Marautanga o Aotearoa. Wellington: Learning Media.* Wellington, New Zealand: Learning Media.

Ministry of Education. (2007b). *The New Zealand Curriculum.* Wellington, New Zealand: Learning Media.

Ministry of Education. (2008). *Te Marautanga o Aotearoa: Te Pou Taki Kōrero Whāiti*. Wellington, New Zealand: Author.

Ministry of Education. (2016). *Ambitious for New Zealand: The Ministry of Education Four Year Plan 2016-2020.* Wellington, New Zealand: Author. Retrieved from https://www.education.govt.nz/assets/Uploads/4-Year-Plan-2016-WEB.pdf

Minniecon, D., Franks, N., & Heffernan, M. (2007). Indigenous research: Three researchers reflect on their experiences at the interface. *The Australian Journal of Indigenous Education, 36* (Supplementary), 23-31.

Moeed, A., & Anderson, D. (2018). *Learning through school science investigation: Teachers putting research into practice*. Singapore: Springer Nature.

Morin, O., Simonneaux, L., Simonneaux, J., & Tytler, R. (2013). Digital technology to support students' socioscientific reasoning about environmental issues. *Journal of biological education 47*(3), 157-165.

Morris, M. C., & Weaver, S. A. (2002). Re: Advances in animal welfare in New Zealand. *New Zealand Veterinary Journal 50*(5), p. 211.

Muru-Lanning, M. (2016). *Tupuna Awa: People and politics of the Waikato river.* Auckland, New Zealand: Auckland University Press.

Nakata, M. (2002). *Some thoughts on the literacy issues in indigenous contexts*. Melbourne: Language Australia.

Nakata, M. (2007). The cultural interface. *The Australian Journal of Indigenous Education, 36* (Supplementary), 7-14.

Nathan, E. T. (2013). *Determining the spatial extent of the biodiversity outcomes of mammalian predator pest management.* (Unpublished master's thesis). University of Auckland, Auckland, New Zealand.

New Zealand Government. (1991). *Resource Management Act.* Wellington, New Zealand: Author.

New Zealand Office of the Parliamentary Commissioner for the Environment. (2000). *Caught in the headlights: New Zealanders' reflections on Possums, control options and genetic engineering*. Wellington, New Zealand: Author.

O'Donnell, C. F., & Hoare, J. M. (2012). Quantifying the benefits of long-term integrated pest control for forest bird populations in a New Zealand temperate rainforest. *New Zealand Journal of Ecology, 36*(2), p. 131.

Odum, E. P. (1971). *Fundamentals of Ecology* (3rd. ed.). Philadelphia, PA: W. B. Saunders Co.

Ogawa, M. (1995). Science education in a multiscience perspective. *Science Education, 79*(5), 583-593.

Organisation for Economic Co-operation and Development (OECD). (2000). *PISA 2000: Sample tasks from the PISA 2000 assessment of reading, mathematical and scientific literacy.* Paris: OECD. Retrieved from http://www.oecd.org/dataoecd/44/62/33692744.pdf

Organisation for Economic Co-operation and Development (OECD). (2003). *The PISA 2003 assessment framework – mathematics, reading, science and problem-solving knowledge and skills.* Paris: OECD. Retrieved from www.oecd.org/education/school/programmeforinternationalstudentassessmentpisa/33694881.pdf

Organisation for Economic Co-operation and Development (OECD). (2007). *Environmental performance reviews: New Zealand*. Paris: OECD. Retrieved from https://www.oecd.org/env/country-reviews/environmentalperformancereviewsnewzealand2007.htm

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International journal of science education, 25*(9), 1049-1079.

Otrel-Cass, K., Cowie, B., & Glynn, T. (2009). Connecting science teachers with their Māori students: Linking one school's tuata with forest ecology. Set *2*, pp. 35-41.

Ottander, C., & Ekborg, M. (2012). Students' experiences of working with socioscientific issues: A quantitative study in secondary school. *Research in Science Education, 42*(6), 1147-1163.

Paradis, C., Hudson, J., & Magnusson, U. (Eds.), (2013). *The construal of spatial meaning: Windows into conceptual space.* Oxford, England: Oxford University Press.

Parkes, J., & Murphy, E. (2003). Management of introduced mammals in New Zealand. *New Zealand Journal of Zoology, 30*(4), 335-359.

Partasi, E. (2013). Narrative inquiry in a divided island: Dealing with sensitive and complex methodological issues in Cyprus. In S. Trahar. (Ed.), *Contextualising Narrative Inquiry: Developing methodological approaches for local contexts.* (pp. 108-121). Oxford, England: Routledge.

Patterson, J. (1992). *Exploring Māori values.* Palmerston North, New Zealand: Dunmore

Peden, R. (2008). Rabbits. In J. Phillips (Ed.), *Te Ara- The Encyclopedia of New Zealand.* Retrieved from http://www.TeAra.govt.nz/en/rabbits

Penetito, W. (2015). Choosing to be both provincial and cosmopolitan: Straddling two worlds. In A. H. Macfarlane., S. Macfarlane., & M. Webber. (Eds.), *Sociocultural realities: Exploring new horizons* (pp. 36-51). Christchurch, New Zealand: Canterbury University Press.

Phelan, P., Davidson, A., & Cao, H. (1990). Students' multiple worlds: Negotiating the boundaries of family, peer and school cultures. *Anthropology and Education Quarterly*, *22*(3), 224-250.

Phillips, J. (2014). 'Ideas in New Zealand - Enlightenment science'. In J. Phillips (Ed.), *Te Ara- The Encyclopedia of New Zealand.* Retrieved from http://www.TeAra.govt.nz/en/ideas-in-new-zealand/page-2

Pierotti, R. (2010). *Indigenous knowledge, ecology, and evolutionary biology*. NY, New York: Routledge.

Potts, A. (2009). Kiwis against possums: A critical analysis of anti-possum rhetoric in and document the unknown natural world Aotearoa New Zealand. *Society and Animals*, *17*(1), 1-20. https://doi.org/10.1163/156853009X393738

Pretty, J., Adams, B., Berkes, F., De Athayde, S. F., Dudley, N., Hunn, E., ... Sterling, E. (2009). The intersections of biological diversity and cultural diversity: towards integration. *Conservation and Society*, *7*(2), 100-112.

Punch, K. F. (2014). *Introduction to social research: Quantitative and qualitative approaches* (3rd ed.). Los Angeles, CA: Sage.

Rackin, D. (1991). *Alice's adventures in wonderland and through the looking glass: Nonsense, sense, and meaning*. New York, NY: Twayne Publishers.

Relph, D. H., & Black, M. (1995). *The living world: Teacher's help book.* Auckland, New Zealand: New House.

Relph, D. H., & Black, M., & Jamieson, J. (1994). *The living world.* Auckland, New Zealand: New House.

Remler, D. K., & Van Ryzin, G. G. (2015). *Research methods in practice: Strategies for description and causation* (2nd ed.). Los Angeles, CA: Sage.

Richards, L., & Morse J. M. (2013). *Readme first for a user's guide to qualitative methods* (3rd. ed.). Los Angeles, CA: Sage.

Richardson, (2018). Why aerial 1080 is more than a science debate. *Stuff NZ News*. Retrieved from https://www.stuff.co.nz/environment/107722463/why-aerial-1080-is-more-than-a-science-debate

Ritchie, J., Spencer, L., & O'Connor, W. (2003). Carrying out qualitative analysis. In J. Ritchie., & J. Lewis (Eds.), *Qualitative research practice: A guide for social science students and researchers* (pp. 219-62). London, UK: Sage.

Roberts, D. A. (2007). Scientific literacy/science literacy. In S. K. Abell., & N. G. Lederman (Eds.), *Handbook of research in science education* (pp. 729-780). Mahwah and London: Lawrence Erlbaum Associates.

Roberts, M. (1998). Indigenous knowledges and Western science: Perspectives from the Pacific. In D. Hodson (Ed.), *Science, Technology Education, and Ethnicity: An Aotearoa/New Zealand Perspective* (pp. 59-75). Wellington: Royal Society of New Zealand Miscellaneous series #50

Roberts, M. (2012). Mind maps of the Māori. *GeoJournal*, *77*(6), 741-751.

Roberts, M. (2013). Ways of seeing: Whakapapa. *Sites: A Journal of Social Anthropology and Cultural Studies*, *10*(1), 93-120.

Roberts, M., Haami, B., Benton, R., Satterfield, T., Finucane, M. L., Henare, M., & Henare, M. (2004). Whakapapa as a Māori mental construct: Some implications for the debate over genetic modification of organisms. *The Contemporary Pacific*, *16*(1), 1-28.

Roberts, M., Norman, W., Minhinnick, N., Wihongi, D., & Kirkwood, C. (1995). Kaitiakitanga: Māori perspectives on conservation. *Pacific Conservation Biology*, *2*(1), 7-20.

Royal Forest and Bird Protection Society of New Zealand. (2019). *Native plants and animals*. Retrieved from https://www.forestandbird.org.nz/native-plants-and-animals

Royal Society of New Zealand (Education Committee). (2012). *The future of science education in New Zealand.* Retrieved from https://www.royalsociety.org.nz/assets/documents/Future-Science-Education-Oct-2012.pdf

Royal, Te Ahukaramū C. (2004). An organic arising: an interpretation of tikanga based upon the Māori creation traditions. In Ngā Pae o te Maramatanga, *Tikanga Rangahau Mātauranga Tuku Iho: Traditional knowledge and research ethics conference proceedings* (pp. 217-242). Auckland, New Zealand: The National Institute for Research Excellence for Māori Development and Advancement.

Royal, Te Ahukaramū C. (2009). *Let the world speak: Towards indigenous epistemology*. Porirua: Mauriora-ki-te-Ao/Living Universe Ltd.

Russell, J. C. (2014). A comparison of attitudes towards introduced wildlife in New Zealand in 1994 and 2012. *Journal of the Royal Society of New Zealand*, *44*(4), 136-151. https://doi.org/10.1080/03036758.2014.944192

Sadler, T. D. (Ed.), (2011). *Socio-scientific issues in the classroom: Teaching, learning and research, 39*. Springer Science & Business Media.

Sadler, T. D., & Zeidler, D. L. (2004). The morality of socioscientific issues: Construal and resolution of genetic engineering dilemmas. *Science education*, *88*(1), 4-27.

Saldaña, J. (2015). *Thinking qualitatively: Methods of mind.* Thousand Oaks, CA: Sage.

Salmond, A. (1991). Tipuna – ancestors: Aspects of Māori cognatic descent. *Man and a Half: Essays in Pacific Anthropology and Ethnobiology in Honour of Ralph Bulmer. Auckland: Polynesian Society*, 343–56.

Salmond, A. (2000). Māori and modernity: Ruatara's dying. In A. P. Cohen (Ed.), *Signifying identities: Anthropological perspectives on boundaries and contested values* (pp. 37-58). London, England: Routledge.

Sarantakos, S. (2013*). Social research* (4th ed.). Basingstoke, England: Palgrave Macmillan.

Saunders, K. J., & Rennie, L. J. (2013). A pedagogical model for ethical inquiry into socioscientific issues in science. *Research in Science Education*, *43*(1), 253-274.

Schwandt (1998). Constructivist, interpretivist approaches to human inquiry. In N. K. Denzin & Y. S. Lincoln (Eds.), *The landscape of qualitative research: theories and issues* (pp. 221-259). Thousand Oaks, CA: Sage.

Schwartz, R., & Lederman, N. G. (2008). What scientists say: Scientists' views of nature of science and relation to science context. *International Journal of Science Education*, *30*(6), 727-771.

Scott, G., & Garner, R. (2013). *Doing qualitative research: Designs methods and techniques.* Boston, MA: Pearson.

Shamos, M. H. (1995). *The myth of scientific literacy*. New Brunswick, NJ: Rutgers University Press.

Sillitoe, P. (2017). Indigenous knowledge and natural resources management: An introduction featuring wildlife. In P. Sillitoe, (Ed.), *Indigenous Knowledge: Enhancing Its Contribution to Natural Resources Management* (pp. 1-14). Oxfordshire, England: CAB International.

Simonneaux, L., Panissal, N., & Brossais, E. (2013). Students' perception of risk about nanotechnology after an SAQ teaching strategy. *International Journal of Science Education*, *35*(14), 2376-2406.

Simonneaux, J., & Simonneaux, L. (2012). Educational configurations for teaching environmental socioscientific issues within the perspective of sustainability. *Research in Science Education*, *42*(1), 75-94.

Snively, G., & Corsiglia, J. (2001). Discovering indigenous science: Implications for science education. *Science education*, *85*(1), 6-34.

Stake, R. E. (2010). *Qualitative research: Studying how things work.* New York: Guilford Press.

Stanley, W. B., & Brickhouse, N. W. (1994). Multiculturalism, universalism, and science education. *Science education*, *78*(4), 387-398.

Starpath Project. (2014). *Annual Report 2014.* Auckland, New Zealand: Author.

Stephens, S. (2001). *Handbook for culturally responsive science curriculum.* Fairbanks, AK: Alaska Native Knowledge Network.

Sutherland, D. (2005). Resiliency and collateral learning in science in some students of Cree ancestry. *Science Education*, *89*, 595-613.

Tang, K.-S., & Yang, X. (2017). Student agency in negotiating the relationship between science and religion. *Research in Science Education*, *47*(August, 2017), 1-17. https://doi.org/10.1007/s11165-017-9655-x

Teymur, N. (2002). Space between disciplines. In S. Herbrechter (Ed.), *Cultural studies: Interdisciplinary and translation*, *20*(pp. 97-111). New York, NY: Rodopi.

Thorne, S. E. (2008). *Interpretive description.* Walnut Creek, CA: Left Coast Press, Inc.

Tipa, G., & Nelson, K. (2008). Introducing cultural opportunities: A framework for incorporating cultural perspectives in contemporary resource management. *Journal of Environmental Policy & Planning*, *10*(4), 313-337.

Turner, N., & Spalding, P. (2013). "We might go back to this"; drawing on the past to meet the future in north western North American Indigenous communities. *Ecology and Society*, *18*(4), 1002-1012.

Van Eijck, M., & Roth, W.-M. (2007). Keeping the local, local: Recalibrating the status of science and traditional ecological knowledge (TEK) in education. *Science Education*, *91*(6), 926-947.

Varelas, M., Settlage, J., & Mensah, F. M. (2015). Explorations of the structure–agency dialectic as a tool for framing equity in science education. *Journal of Research in Science Teaching*, *52*(4), 439-447.

Waitangi Tribunal (2011). *Ko Aotearoa tēnei Te Taumata Tuatahi: A report into claims concerning New Zealand law and policy affecting Māori culture and identity. WAI 262.* Wellington, New Zealand: Author.

Waiti, P., & Hipkins, R. (2002). Cultural issues that challenge traditional science teaching. Paper presented at the Third Annual New Zealand Science Education Symposium, Massey University, Wellington; 22-23 November 2002. Retrieved from https://www.nzcer.org.nz/system/files/12618.pdf

Wallace, C. S. (2004). Framing new research in science literacy and language use: Authenticity, multiple discourses, and the "third space". *Science Education*, *88*(6), 901-914.

Walliman, N. (2005). *Your research project: a step-by-step guide for the first-time researcher* (2nd ed.). London: Sage.

Warren, B., Ballenger, C., Ogonowski, M., Rosebery, A. S., & Hudicourt-Barnes, J. (2001). Rethinking diversity in learning science: The logic of everyday sense-making. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *38*(5), 529-552.

Warren, T. R., Webster, J., & Kiriona, D. (2006). Thru the looking glass – rangatahi research traditions. In *Mātauranga Taketake: Traditional Knowledge Conference* (pp. 191-198). Nga Pae o te Maramatanga. Auckland, New Zealand: The National Institute for Research Excellence for Māori Development and Advancement.

Willis, J. W. (2007). *Foundations of qualitative research: Interpretive and critical approaches.* London, England: Sage.

Willis, R. (2017). Exploring the ethics of agency through the lens of Bildung. *International Journal of Children's Spirituality, 22*(3-4), 317-328.

Wilson, K. -J. (2004). *Flight of the Huia: Ecology and conservation of New Zealand's frogs, reptiles, birds and mammals*. Christchurch, New Zealand: Canterbury University Press.

Winiata, P (2006). The role of tikanga Māori institutions in the protecting, sustaining and nurturing of traditional knowledge. (pp.199-209). In *Mātauranga Taketake: Traditional Knowledge Conference*. Nga Pae o te Maramatanga. Auckland, New Zealand: The National Institute for Research Excellence for Māori Development and Advancement.

Woods-McConney, A., Oliver, M. C., McConney, A., Maor, D., & Schibeci, R. (2013). Science engagement and literacy: A retrospective analysis for Indigenous and non-Indigenous students in Aotearoa New Zealand and Australia. *Research in Science Education*, *43*(1), 233-252. https://doi.org/10.1007/s11165-011-9265-y

Zeidler, D. L. (2014). Socioscientific issues as a curriculum emphasis: Theory, research, and practice. In S. K. Abell., & N. G. Lederman (Eds.), *Handbook of research in science education Volume II* (2nd ed., pp. 697-726). New York, NY: Routledge.

Zeidler, D. L., & Sadler, T. D. (2010). An Inclusive View of Scientific Literacy. In C. Linder, L. Östman, D. Roberts, P. Wickman, G. Ericksen, & A. MacKinnon (Eds.), *Exploring the landscape of scientific literacy* (pp. 176-192). New York, NY: Routledge.

Zeidler, D. L., Walker, K. A., & Ackett, W. A., & Simmons, M. L. (2002). Tangled up in views: Beliefs in the nature of science and responses to socioscientific dilemmas. *Science Education*, *86*(3), 343-367.

Zieleniec, A. J. L. (2007). *Space and social theory.* London, England: Sage.

Zimmerman, H. T., & Weible, J. L. (2018). Epistemic agency in an environmental sciences watershed investigation fostered by digital photography. *International Journal of Science Education*, *40*(8), 894-918.