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Teachers' perspectives on

incorporating aspects of Mātauranga Māori

in year 9-10 secondary school science classrooms.

A thesis

submitted in partial fulfilment

of the requirements for the degree

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Abstract

Science classrooms in Aotearoa New Zealand may cause some students to feel marginalised. The inclusion of mātauranga Māori offers a diverse perspective on knowledge which may help inclusion of, and understanding for, these learners. This research examines how science teachers include mātauranga Māori in their junior secondary science learning activities.

I am a Pākehā teacher who was born and raised in Hawaii. I have 17 years of science teaching experience in Aotearoa New Zealand. This interpretive, phenomenographic study involved semi-structured interviews with six teachers, all who taught in North Island schools. Five of the six participants were in schools, and one taught in a Kura Kaupapa Māori. Data were gathered about teachers' understanding of te reo Māori, inclusion of mātauranga Māori in the junior secondary science classroom, and how teachers' own cultural awareness impacted their practice.

The findings indicate that teachers include mātauranga Māori in their science classrooms in a diverse range of ways. From whole course design to more subtle ways that reflect Māori tikanga and Māori pedagogy. Teachers often faced challenges in including mātauranga Māori in their science classroom and they overcame these by learning te reo, embracing Māori tikanga and continuing to learn to fill the gaps in their knowledge. The context of the school and its community was also a factor, as well as teachers' personal philosophies about the nature of knowledge.

The findings have implications for initial teacher education and professional learning for the integration of mātauranga Māori into the secondary science classroom.

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Glossary

Ako- A Māori concept meaning both to teach and to learn, emphasising the reciprocal nature of learning relationships.

Ākonga- student, pupil, learner, protégé**.**

Aronui- Refers to the path of knowledge, understanding, or wisdom.

Ātua- Māori gods or spiritual beings that represent natural elements and ancestors.

Aotearoa- Māori name for New Zealand, meaning "Land of the Long White Cloud."

Haka- A traditional Māori war dance or challenge, performed with rhythmic movements, chanting, and expressions.

Hangi- A traditional Māori method of cooking food using heated rocks buried in a pit oven.

Hapū- A sub-tribe or extended family group within a larger iwi (tribe), often central to Māori social structure.

Harakeke- New Zealand flax, a plant that holds cultural significance for Māori and is used in weaving and other traditional practices.

Hauora- A Māori philosophy of health and well-being encompassing physical, mental, emotional, and spiritual aspects.

He Whakaputanga o te Rangatiratanga o Nu Tireni- The Declaration of Independence of New Zealand, signed in 1835.

Hīkoi- A journey or march; often used to describe a walk for a cause.

Hui- A gathering or meeting, often used for discussions, decision-making, or ceremonies.

Iwi- A tribe or large social unit of Māori, often consisting of multiple hapū (sub-tribes).

Kaitiakitanga- The guardianship and protection of the environment, based on Māori cultural values and practices.

Karanga- A ceremonial call performed by women to welcome visitors onto a marae.

Karakia- Prayers, chants, or incantations used to invoke spiritual guidance, blessings, or protection.

Kaumatua- Elders who are respected leaders within Māori communities, often providing guidance and wisdom.

Kawakawa- A native New Zealand plant used in traditional Māori medicine (rongoā) for its healing properties.

Kōhanga Reo- Māori language immersion preschool.

Kōwhaiwhai- Ornamental patterns used in Māori art, often found in the decoration of meeting houses.

Kura Kaupapa Māori- Māori-language immersion schools that focus on Māori cultural values, knowledge, and language.

Māhāna Māori- Māori knowledge, wisdom, and education.

Mana- A concept referring to authority, prestige, and spiritual power, often linked to leadership and personal integrity.

Manaakitanga- Hospitality, kindness, and the act of caring for others; a key Māori value.

Mana Motuhake- Sovereignty, independence, or self-determination.

Mana ōrite- Equality, equal status or recognition.

Māori- Indigenous people of Aotearoa (New Zealand), or their culture and language.

Māoridom- The culture, identity, and Māori community.

Marae- A communal or sacred place that serves as a venue for meetings, ceremonies, and cultural gatherings.

Maramataka- Māori lunar calendar, used to guide agricultural practices, fishing, and daily life.

Mātauranga Māori- Māori knowledge, wisdom, and understanding, encompassing all aspects of life and the universe.

Matua- A term used to refer to parents or elders, showing respect and affection.

Mihi whakatau- A formal speech of welcome, often delivered during ceremonial occasions to greet and acknowledge guests.

Noa- The state of being free from tapu; common, ordinary, or neutral.

Pākehā- Referring to non-Māori people, typically of European descent.

Papatūānuku- Earth mother, the Māori personification of the earth and nature.

Pōwhiri- A Māori welcoming ceremony involving speeches, singing, and other rituals, typically held on a marae.

Pūrākau- Māori traditional stories or myths that convey cultural knowledge, values, and lessons.

Rongoā- Traditional Māori medicine that incorporates natural remedies and spiritual healing practices.

Tāne Mahuta (Tāne)- the god of forests and birds in Māori mythology.

Tapū- Sacred, restricted, or set apart; a concept of holiness or prohibition.

Te ao hurihuri- The changing world; the world of change.

Te ao Māori- Māori worldview, which encompasses the beliefs, values, and knowledge systems of Māori culture.

Te Kotahitanga- Unity, togetherness, or solidarity.

Te Reo Māori- Māori language, an official language of New Zealand and central to Māori culture and identity.

Te Rōpū o te Matakite- A group of visionaries or seers.

Te Tiriti o Waitangi- Māori version of The Treaty of Waitangi, signed in 1840 between Māori chiefs and the British Crown, foundational to New Zealand's legal and cultural framework.

Tikanga- Customary practices, traditions, and values that guide daily life and interactions within Māori culture.

Tuauri- Refers to sacred knowledge or practices, typically secret or esoteric.

Turangawaewae- A place to stand; a person's place of belonging, often referring to the ancestral land or home.

Waiata- Songs that are an integral part of Māori cultural expression, used in ceremonies, storytelling, and celebrations.

Whakapapa- Genealogy or lineage, an essential concept in Māori culture that connects individuals to their ancestors and the land.

Whakataukī- Proverb or saying, often used to express wisdom or guidance.

Whānau- Extended family or community group, fundamental to Māori social structure and support systems.

Whanaungatanga- The concept of kinship and relationships, emphasising the importance of connections between people and communities.

Whare- A house, building, or structure, especially a meeting house (wharenui) in Māori culture.

Whare wānanga- A place of higher learning or institution for learning.

Chapter One - Introduction

1.1 Introduction

This research seeks to explore how teachers in Aotearoa New Zealand approach the inclusion of mātauranga Māori in their junior secondary science classrooms. It presents the experiences of six secondary school science teachers and their challenges and strategies in bringing mātauranga Māori into the science classroom. Additionally, the research examines the participant perspectives on science education, knowledge systems, and professional learning in mātauranga Māori that they have engaged with throughout their teaching journey.

1.2 Why is this research needed?

Science education has been part of the education system around the world for the last hundred years (Wood & Lewthwaite, 2008). Western science as a body of knowledge has been universally accepted as foundational learning but in recent years, indigenous perspectives and Indigenous knowledge are gaining recognition (Nakata, 2002). The inclusion of mātauranga Māori in the science classroom warrants research for several reasons. Mātauranga Māori contributes to a sense of belonging for ākonga Māori in the science classroom, acknowledges the value of alternative ways of knowing the world, and upholds the Treaty of Waitangi by recognising mātauranga Māori as a legitimate body of knowledge in Aotearoa New Zealand (Stewart, 2017). Finally, this research may provide insight for educators to effectively incorporate mātauranga Māori into their practice in the science classroom.

Indigenous students can feel out of place in the science classroom, and learning science could seem like being in a foreign place (Aikenhead & Ogawa, 2007). This in turn could make it difficult for these students to thrive and achieve. A priority for the Ministry of Education is to "reduce barriers to education for all, including for Māori and Pacific learners/ākonga, disabled learners/ākonga and those with learning support needs" (Ministry of Education, 2020, p. 1). Few ākonga Māori choose to continue studying sciences in their senior years and tend not to choose

careers in the sciences (Stewart, 2017). By continuing with the status quo, presenting Western science in the classroom without acknowledgement of other forms of knowledge, such as mātauranga Māori, we are only prolonging the impact of colonisation and continuing to disadvantage Māori learners (Stewart, 2017). One of the effects of colonisation is the inequity of achievement between Māori and non-Māori leaners, the overrepresentation of ākonga Māori who are leaving school early and Māori learners having low attendance rate when compared with other ethnic groups (Education Counts, n.d.). The education system poorly serves ākonga Māori, by making them conform to Western ideals and ways of learning and these students are opting out of studying sciences beyond mandatory levels (Stewart, 2017).

As education evolves to equip students with the skills to address global challenges, there is a growing need to move beyond conventional Western science knowledge and embrace emerging visions for future knowledge frameworks and alternative ways of knowing (Fazey et al., 2020). In an effort to incorporate mātauranga Māori into science, The New Zealand Curriculum has provided translations of Western science knowledge into te reo Māori and offers teacher resources on their website that intergrate Māori themes into science education (Ministry of Education, n.d.). With the introduction of Te Mātaiaho, the refreshed New Zealand Curriculum (Ministry of Education n.d.), there is also an emphasis on weaving mātauranga Māori and Māori contexts into the science curriculum and valuing the knowledge system itself alongside Western science. The Treaty of Waitangi was signed on the 6th of February 1840 and is a founding document of Aotearoa New Zealand (O'Malley et al., 2013). It is an agreement between the British Crown and the Māori iwi which gave the Queen governance over the land but kept Māori as chieftain over their lands and their resources, in return Māori were assured protection under the Crown (Te Ara, n.d.). The Treaty principles overarch all parts of government and government ministries including the Ministry of Education. Partnership, participation and protection must permeate schools and provide opportunities for ākonga Māori to learn and succeed.

The Treaty of Waitangi and Te Tiriti o Waitangi are two interpretations of the treaty document. I will use the Treaty of Waitangi in this thesis as that is the version that my participants mentioned in their interviews. Te Tiriti o Waitangi is often emphasised as it more closely aligns with the promises made to Māori when the treaty agreement was made (New Zealand State Service Commission, 2004). Honouring the Treaty is something that is sometimes seen as tick box and half-hearted attempts are made without much thought or consultation. Science teachers contend with maintaining authenticity in their efforts to honour the Treaty and by doing so, better serve ākonga Māori.

As a science teacher with 17 years of experience, I find myself wondering how I, as a teacher, 'remove barriers' for learners in my science class. I face the same challenges that many other non-Māori teachers face when introducing Māori context into the lesson. How do I attempt to incorporate mātauranga Māori in my science classroom and avoid it being superficial, or the "window dressing" of science? (McKinley & Stewart, 2009 p. 9). How do I plan my science lessons in a way that allows ākonga Māori to see themselves as science learners and students who are well-equipped to contribute?

1.3 Research questions

This research sought to understand teachers' perspectives when they incorporated mātauranga Māori into their science classrooms, how they did this and what if any impact they felt it had on student engagement in their science classes.

Principal question:

1. What are teachers' perspectives on incorporating aspects of mātauranga Māori in their year 9-10 secondary school science programmes?

Sub-questions:

2 a. How have they incorporated mātauranga Māori in their science classrooms?

2 b. How do they feel this has impacted student engagement and learning outcomes in their science classrooms?

1.4 Outline of the thesis

Chapter two provides a review of the literature associated with Indigenous knowledge, colonisation in Aotearoa New Zealand and its impact on schools and education, science education, government policy initiatives and what is currently known about teachers' perspectives of including mātauranga Māori in their science classrooms.

Chapter three outlines the methodology adopted for this qualitative study, how data were gathered, analysed and themes identified. The approach to selecting participants and ethical considerations is also outlined.

Chapter four presents the findings from the participants. This chapter allows the reader to hear the voices of each participant and the unique insight that they shared. Across the diverse experiences, common themes were identified and these are presented here.

Chapter five provides a discussion of the findings, limitations of the study, a conclusion, and suggested implications of including mātauranga Māori in the science classroom.

Throughout this thesis words in te reo Māori will be used, please refer to the Glossary for translations to English.

Chapter Two - Literature Review

2.1 Introduction

A considerable amount of literature has been published on Indigenous knowledge in the science classroom. However, studies in Aotearoa New Zealand, have been relatively sparse. This review aims to highlight relevant aspects of the existing body of knowledge as well as identify gaps where I have situated my research. I begin by presenting a review of Indigenous knowledge both here in Aotearoa New Zealand as well as in other parts of the world. Next, colonisation in Aotearoa New Zealand and the crucial moments or turning points that have led to the present day are discussed. Modern science education is examined as well as its foundation, evolution and transformation in response to societal pressures. Policy directives of the Ministry of Education here in Aotearoa New Zealand are considered. Finally, the review concludes with perspectives from science teachers on introducing Indigenous knowledge into science and how reflexivity, recognising funds of knowledge and developing their practice contributes to the success of indigenous students in the classroom.

2.2 Indigenous knowledge

2.2.1 Introduction

Indigenous knowledge is a treasure which pre-dates modern civilisations. It has been passed down for generations through storytelling, genealogy, chants, songs and even dance from parents or grandparents to their children (Gibson & Puniwai, 2006). As many indigenous cultures are grounded in an oral tradition, this knowledge may not rely on written documentation and has instead been conserved orally, in contrast to what could be termed Western science knowledge. As Elizabeth Eklund (2017, p. 79) states, “Conventional [Western] science places a strong degree of certainty or permanence in inscribed forms over oral traditions” thus scientists tend to put less trust in knowledge if it is not recorded in text form.

Indigenous or traditional knowledge belongs to indigenous communities and is unique to each place. Indigenous knowledge can sometimes be considered secret, occult, traditional or of dubious origin when viewed through a Western science lens (Kalolo, 2022). However, it is a system of information that has developed over many generations and is specific to a particular place and unique even to a community or region (Osunade, 1994). This knowledge is not static; although based on the experience over millennia, it continues to evolve and be added to today (Wheeler et al., 2020). These systems exist in every continent of the globe, from Australia to Papua New Guinea, the Americas and Africa and more specifically, here in Aotearoa New Zealand. We can see this in Aotearoa New Zealand within Māori culture, and there are differences in the knowledge held within iwi, hapū and even whānau (Lee, 2009). This knowledge exists, provides and contributes to a more diverse understanding of the world.

Observed from a Eurocentric viewpoint, indigenous or traditional knowledge could be seen as 'primitive' or 'inferior' (Nakata, 2002). These labels often diminish the value of knowledge when comparing it with a Western science perspective. Indigenous knowledge and beliefs can be termed 'myths', 'legends' or 'stories' rather than 'facts' or 'history'. In Aotearoa New Zealand, Māori pūrākau are stories which provide explanations for natural phenomena, provide narratives about the gods and how people are descended from them (Ihimaera & Hereaka, 2019). However, in Aotearoa New Zealand society, especially within the schooling system, "mātauranga Māori was systematically dismissed and erased by the English derived education system as being worthless" (Simon et al., 2001). This was seen by Pākehā as being a natural process of 'civilising' Māori, a clear example of ethnocentric thinking, which was concerned with the assimilation of Māori into the European way of life (Waitangi Tribunal, 1999, p. 47). This may have been done without malicious intent, however, once erased, this knowledge can be very difficult to restore due to its oral transmission and thus, this indigenous wisdom can be lost.

Since the 1980s, traditional knowledge has regained prominence and attracted increasing attention. The scientific community has begun to recognise its value, as Myers states:

> This interest has been overwhelmingly driven by research into sustainable development practices in developing countries and the scientific community's concern with loss of biodiversity and of species and ecosystems and the future implication of that for the whole planet (1998, as cited in Nakata, 2002).

Western science in its swift advances over time has also contributed to some of these issues that we are facing, as Fazey et al. (2020, p. 8) mention, "they have yet to develop a means of coherently linking and solving the problems the same systems have also helped to produce."

There are various motivating factors for including Indigenous knowledge in the school curriculum. The application of Indigenous knowledge in schools fulfil two functions: to display the diversity of knowledge and hence to celebrate all people's knowledges and to increase motivation and self-esteem of the indigenous students in the class (McKinley & Stewart, 2009). Another important factor is an indigenous approach to conservation, which would be beneficial to the world population. Consideration of the people who have generated and continue to grow this knowledge is necessary. Understanding that through the experience of many years of assimilation to Western standards, indigenous people have been taught that their knowledge and practices are inferior to Western science and have accepted the delusion that their own cultural practices are inferior (Aikenhead & Ogawa, 2007). Relearning or unlearning is necessary to recuperate this knowledge and allow it to stand alongside Western science as a valid and valuable knowledge system. The next section will introduce Aotearoa New Zealand's own Indigenous knowledge system and provide some insight into te ao Māori and mātauranga Māori.

2.2.2 Mātauranga Māori

Teaching and learning have taken place in Aotearoa New Zealand for generations, as Wharehuia Hemara (2000) reports that pre-contact pedagogy in Aotearoa New Zealand reflected the values of Māori culture. Learning was focused on students and teachers, life-long learning was normal, students began with familiar, and later moved to more unfamiliar, contexts (Hemara, 2000). Parents and grandparents observed their children and recognised their talents, strengths and interests and helped to guide them towards learning that was suited to their strengths, interests, abilities and allowed the learner to flourish (Mead, 2016). Whare wānanga existed and there was an established ritual surrounding the process of learning, which was considered tapu (Mead, 2016). Karakia were said to start and end the sacred time of learning and special robes were worn to denote that the students were in a learning state, which was tapu. Later, when the learning time was finished, the robes were removed and the learners returned to state of noa (Mead, 2016). All learning was carried out without reading or writing, therefore much emphasis was placed on memorisation (Mead, 2016). Although Māori were non-literate, they easily "read in the sky or carry in their heads" what literate cultures relied on texts to remember (Walker, 1990, p. 26). Therefore, in pre-contact Māori culture, listening and recalling were highly valued skills.

Outside of the wānanga, mātauranga Māori exists in every aspect of life. Mātauranga Māori includes every subject from philosophy, astronomy, mathematics, language, history and education (Mead, 2016). Mātauranga Māori is inseparable from tikanga, language, culture and Māori people. It's difficult to extract knowledge from its cultural setting (Mead, 2016). One of the foundational pūrākau tells of the three kete or baskets that Tāne received from the highest level of the heavens. These baskets help to explain Māori understanding of the world (Souness, 2021). The three baskets of knowledge are te kete tuatea, te kete tuauri and te kete aronui (Te Ara, n.d). The baskets represent present knowledge, knowledge from the ancestors or spiritual world, and knowledge of the physical world (Marsden & Henare, 1992). Considering the

baskets of knowledge gives insight into Māori worldview and how Māori made sense of the world around them.

2.2.3 Challenges of including Indigenous knowledge in the curriculum

Deciding what elements are included and what is left out of the science curriculum can be challenging and this presents a hurdle to overcome when introducing Indigenous knowledge in science (Nakata, 2002). The decision often hinges on the established curriculum which is largely viewed through a Western lens and indigenous learners find they are provided with the "acceptable little bits and pieces of their culture that are integrated into educational practice" (Nakata, 2002, p 28). Indigenous knowledge that may seem irrelevant to the established curriculum may be left out and could easily be lost if not passed on in another context (Nakata, 2002).

Within Aotearoa New Zealand, mātauranga Māori is not homogenous. Each place and iwi have their own distinct traditions and practices that have led to the development of knowledge. One iwi's traditions may be completely different to those of another. Indigenous knowledge is specific to place and can vary from area to area within a country or region and even from town to town or within communities. This is one of the unique qualities of this knowledge system, but it can also impede the development of classroom material or resources which may suit one part of the country but may not be applicable in another (Harmsworth & Roskruge 2014).

Indigenous knowledge has typically existed in oral tradition and over the years has evolved and been preserved through storytelling, chants and songs. Some may suggest that documentation is essential in ensuring that this treasured knowledge is preserved and maintained without threat of disappearing. However, Nakata (2002) states that recording and storing the information in a database is a conflict as "Indigenous knowledge is socially and culturally embedded" so recording it removes it from its cultural context and therefore extracts and isolates the knowledge, thereby altering it.

As technological advancement and connectivity increase at a rapid rate, data colonisation is a new threat to Indigenous knowledge. In a similar way that loss of land has meant that indigenous communities can become alienated, so too has the collection of data affected ownership of Indigenous ideas and knowledge (Nakata, 2002). Young (2019, p. 26) states that the principle of land theft can be applied to data commodification and although individuals agree to the term and conditions, they are written in a way that is "deliberately inaccessible and incomprehensible." Therefore, Indigenous knowledge which originally belonged to a group of people is given away by individuals and becomes viewed as a commodity by private technology companies who are benefiting from the collection and dissemination of the knowledge that belongs to a whole community (Young, 2019). Teachers need to be aware of this appropriation of information in the classroom and ensure that they are giving credit to the experts or guardians of the Indigenous knowledge.

Cognitive imperialism positions positivism as the sole way to understand the world around us (Martin, 2012). Thus, Western science can be seen as the 'truth' and Indigenous knowledge as 'myth' and 'legend.' This positioning continues to maintain the dominance of Eurocentric knowledge, thus limiting the impact that indigenous researchers can have on the body of academic work (Stewart, 2019). The general belief that progress and development mean turning away from Māori culture and accepting only "proper knowledge" from the Western world still exists today (Mead, 2016, p. 2). A unique aspect of Indigenous knowledge which is sometimes difficult for non-indigenous people to understand is that diverse perspectives and opinions may be held and accepted (Martin, 2012). These seemingly contradictory versions of the same event are all valued as they rely on the collective process of knowledge building which accepts multiple stories and perspectives rather than one 'factual' version (Martin, 2012). In traditional cultures, multiple versions of an event are equally acceptable as knowledge being privileged to certain people and not universally accessible (Martin, 2012). Allowing for knowledge keepers, diverse truths and a communal narrative are all facets of Indigenous knowledge with which science teachers may struggle to come to terms.

Indigenous people may find it difficult to accept the premise that knowledge is for everyone, as some knowledge may be considered sacred or secret and is passed down from parent to child depending on the aptitude or gifts of the learner (Mead, 2016). Knowledge will be shared when one is ready or prepared to learn and with this knowledge comes the responsibility to use it for the benefit of the greater community (McKinley, 2007). This is in striking contrast to the Western worldview which supports the idea that knowledge should be accessible for everyone, and that knowledge does not 'belong' to a specific group of people. This difference in understanding of knowledge and its accessibility is just one of the ways that Indigenous knowledge and Western science differ.

2.2.4 Relationships between Indigenous knowledge and Western science

The Cultural Interface as coined by Nakata (2002, p. 285) is the interaction between traditional and Western ways:

> It is the most complex of intersections and the source of confusion for many. For in this space there are so many interwoven, competing and conflicting discourses, that distinguishing traditional from non-traditional in the day to day is difficult to sustain even if one was in a state of permanent reflection.

This interface between the two knowledge systems is a challenging space to navigate as the two do not always fit seamlessly together. Much has been written about how the two systems interact and academics around the globe have proposed various theories to describe the interaction of the two. George and Glasgow (1999) suggest these four possible relationships:

1. Conventional [Western] science can explain indigenous practice.
2. A conventional [Western] science explanation is unable but likely to be developed.
3. There is a conventional [Western] science link with traditional knowledge.
4. Aspects of Indigenous knowledge that conventional [Western] science cannot accept.

However, it is evident that conventional [Western] science is given the place of dominance in these suggested interactions, and Indigenous knowledge or street science is explained by the principles of science (George & Glasgow, 1999).

There are other suggested relationships that have described the interaction or interface between the two knowledge systems. In Canada, research by Mi'kmaw Elders, Albert and Murdena Marshall, developed the two-eyed seeing theoretical framework (Martin, 2012). This framework proposes that both Indigenous and Western worldviews or "ways of knowing" are useful in understanding complex problems (Martin, 2012, p. 21). According to Martin (2012), it is important that both knowledge systems are viewed as equal to the other and one is not used to validate or disprove the other. Employing more than one perspective to a complex issue is useful and drawing from one or more knowledge systems can provide the most appropriate solution or approach to an issue.

The tension between familiarity with the local environment that is provided by Indigenous knowledge and being able to function in the global community is a complex dynamic. This requires balance between preserving traditional knowledge and the ability to speak the common language of Western science which is needed to take part in the global world. Existing in two worlds is a theme that appears when traditional knowledge and Western science are placed side by side. Stewart (2016) describes this boundary between the cultures as the "intercultural hyphen" when examining two cultures, one being Western and the other a traditional or non-Western culture. This combination of Indigenous knowledge and Western science is a controversial and polarising topic. Recently, in 2021, several Auckland University academics co-signed a letter titled, *In the defence of science*, arguing that although Indigenous knowledge has contributed to global scientific knowledge, it is not in itself science (Clements, et al., 2021). In response to the letter, Dawn Freshwater, Vice-Chancellor of the University of Auckland, responded that mātauranga Māori and Western science are "complementary and have much to learn from each other" (Freshwater 2021 as cited in Griffin, 2021, p. 16). As Western science has established itself as a pillar of academic study for many years, it is not surprising to see that the introduction

of Indigenous knowledge may seem to come as a threat to intellectuals who have based their careers on Western science pre-eminence.

Castagno and Brayboy (2008, p. 961) suggest that when indigenous students can access science curricula and education that is “intimately connected and relevant to tribal communities” they are able to successfully negotiate living in two worlds. The view of living in two worlds mean that a both/and approach is taken, and both traditions are valued. This contrasts with an either/or view where one is chosen and the other discarded (Castagno & Brayboy, 2008). These students develop the ability to codeswitch between Western cultures and languages (Castagno & Brayboy, 2008). Students in Aotearoa New Zealand should also be able to live in two worlds, te ao Māori and te ao hurihuri (the changing world).

Turnbull (1997) suggests that an effort be made to ‘decentre’ Western science by developing a framework where Indigenous knowledge systems and Western science can be equitably compared, their differences recognised but co-existing together. The creation of a “third space” allows Indigenous knowledge to be considered without the fear that it will be absorbed in an imperial fashion into a homogenous global science (Turnbull, 1997). The third space is a complex heterogeneous combination of both knowledge systems and can be most beneficial to overcome problems where modern science has failed (Turnbull, 1997). Considering the example of navigation, traditional knowledge is a type of performative practice or strategy rather than documented rules or plans, as is the case with Western science.

2.2.4.1 Reconciling cultures

Costa (1995) notes that school science can be viewed as a culture unto itself. This may be a difficult place for students depending on how similar or different their personal culture is from school science culture. Costa (1995) suggests four different ‘levels of ease’ for students to negotiate the ‘border crossing’ into the science classroom. They are:

Potential Scientist: who maintains a personal culture like the school science culture and who views science as important and necessary.

Other Smart Kids: whose culture is different but similar enough to allow for manageable transitions. However, they may question the value of science in their personal lives.

I Don't Know Students: whose personal culture is different; border crossing can be hazardous and view science as just another school subject.

Outsiders: whose personal culture is so different that border crossing is likely impossible, and these students typically dislike science.

Teachers play a critical role in supporting students to negotiate this border crossing. Considering the role of teachers in the delivery of mātauranga Māori in the classroom and how the inclusion of this knowledge system could facilitate crossing into the science classroom is vital.

The *Transformations to Sustainability* conference held in Scotland in 2017 explored the need to make significant transformations in knowledge systems to address current global issues that we face (Fazey et al., 2020). This report advocates for shifts from fragmented and disconnected to interconnected and inter-related, from global to local and global knowledge, from competitive to collaborative, from science-for-science to science-for-all, and from knowledge to wisdom focused (Fazey et al., 2020, p. 13). The current formalised systems of knowledge, although successful in knowledge production, struggle to integrate diverse knowledge systems and identify creative solutions that are needed to respond to the challenges of today (Fazey et al., 2020). Reconciling culture and ensuring students feel that their personal values and culture are valued is critical. One approach is Culturally Responsive Schooling, and the merits of respecting students' backgrounds are discussed in the following section.

2.2.5 Culturally Responsive Schooling

Culturally Responsive Schooling (CRS) is education that recognises, respects and uses students' identities and backgrounds as a meaningful source for creating an optimal learning environment. Being culturally responsive is more than being respectful, empathetic, or sensitive (Gay, 2000). Accompanying actions, such as

having high expectations for students and ensuring that these expectations are realised, are key aspects to this approach (Gay, 2000).

Culturally Responsive Schooling is a “highly complex endeavour that requires a systematic change with and across a number of levels in our schooling system” (Castagno & Brayboy, 2008, p. 943). According to Castagno and Brayboy (2008), it is necessary to consider three elements when working with indigenous education. These are: sovereignty and self-determination, acism in schools and indigenous epistemologies. Castagno and Brayboy (2008) identified sovereignty and self-determination of the tribal nations of North America as an area which must be considered and recognised when approaching education through a culturally responsive method and few scholars include this in their writing. Racism in schools is also rarely mentioned in literature on Culturally Responsive Schooling and Castagno and Brayboy (2008) argue that it is necessary to understand the dynamics of racism and how it relates to the need for Culturally Responsive Schooling.

Finally, indigenous epistemologies are the third area that must be considered. This can be a challenging task, and indigenous epistemologies often remain in oral tradition, evolving and dynamic, which make them difficult to define. Castagno and Brayboy (2008, p. 951) note the complexity of Indigenous knowledge and the many elements that go into making the system, such as: focus on community, how it relates to the place and the “responsible use of power.” It may seem obvious, but not all indigenous traditions share the same epistemology, and this can vary between members of the same community as well as from place to place. For example, in Aotearoa New Zealand, there is not one Māori knowledge system, the knowledge may vary from East to West or North to South. The differences are valid, and they can co-exist alongside each other without detracting from or disproving one another.

Funk and Woodroffe (2024), whose work with First Nations people in Australia and Torres Straight Islanders, advocate for teachers to apply the 3Rs to their pedagogy. The 3Rs stand for the principles of respect, relationships and reconciliation. These principles allow teachers to respect the cultural interface,

orient their relationship alongside Indigenous knowledge and engage in pedagogical practice that reconciles colonial education and contributes to the process of decolonisation (Funk & Woodroffe, 2024). The 3Rs principles have a high degree of transferability and are not only applicable in the Australian context, but in most situations where indigenous people are managing with the lasting effects of colonialism.

2.2.6 Section summary

Mātauranga Māori, the Indigenous knowledge of Aotearoa New Zealand, is a rich body of wisdom developed over many generations of lived experience and cultural practice. In Aotearoa New Zealand, mātauranga Māori provides language, practices and traditions that reflect Māori worldviews. There is much to be learnt from this knowledge system and its integration into the classroom aids the preservation of this indigenous way of knowing. Introducing Indigenous knowledge in schools has its challenges and even more so in the science classroom. The relationship between Indigenous knowledge and Western science is an area of contention and has prompted much debate regarding the validity of Indigenous knowledge and how the two systems co-exist in the classroom. The presence of mātauranga Māori not only puts value on Māori culture but also could possibly ease students' entry into learning science by providing a link from their own culture to that of the science classroom.

2.3 Colonisation

2.3.1 Introduction

The impact of European contact has affected every aspect of life in Aotearoa New Zealand and today its ripples continue to be felt in our language, society and educational system. As discussed in the introduction and earlier in this section, failure to honour the Treaty of Waitangi has led to the alienation of iwi from their land, the erosion of community support networks and threats to preserving Māori culture and values (King, 2003). The 1970s marked a renewed resistance to assimilation to colonial culture and has led to the renaissance of Māori language and culture (O’Malley et al., 2013). Immersion Māori language

pre-schools and schools were formed to preserve te reo Māori (O'Malley et al., 2013). This movement continues today and such acts of conscientisation are evidence that Māori are directing their own future outcomes.

2.3.2 Colonisation

The first contacts Māori in Aotearoa New Zealand had with Europeans were with Abel Tasman in 1642 and Captain James Cook in 1769-1779, followed by whalers and sealers in the latter parts of the 18th Century and into the 19th Century (King, 2003). While neither Tasman nor Cook established settlements, their visits increased the European interest in the islands (King, 2003). Samuel Marsden, an Anglican missionary sent to Aotearoa New Zealand, arrived in 1814 and began to seek Māori converts to Christianity (King, 2003). Ever since the first European contact, substantial impact has been felt by Māori.

The impact of the British settlers' arrival to Aotearoa New Zealand has affected Māori and this was the first instance where mātauranga Māori was challenged by western influence. With the arrival of missionaries, Māori chiefs who offered missionaries protection, food and a place to live were compensated with payment in guns (Te Ara, n.d.). Settlers brought with them new methods of agricultural cultivation and Māori entered trade with European ships that landed on their shores. Thomas Kendall, a teacher and missionary, founded a school and wrote the first Māori language dictionary (Belich, 1996). These first missionaries learned Māori language and taught students in their mother tongue and this act of educating tangata whenua (people of the land) in te reo Māori and putting the language into writing marked a transformation from a completely oral tradition to the language being documented in text (Davidson, 1996). European settlers brought with them their Western worldview that contrasted with te ao Māori (Te Ara, n.d.). This began the re-education of Māori to Western ways of thinking (Simon et al., 2001).

Several British immigrants, who understood the Māori language, were involved in drafting two significant documents. First was *He Whakaputanga o te Rangatiratanga o Nu Tireni,* the Declaration of Independence, drafted by James

Busby and Henry Williams with William Colenso in 1835 (O'Malley et al, 2013). The second document the *Treaty of Waitangi,* was drafted by William Hobson, British Consol to Aotearoa New Zealand, and James Busby and the document was translated into te reo Māori by Henry Williams a missionary (Te ara, n.d.). This treaty was sent to Māori for the chiefs to read and sign (New Zealand State Service Commission, 2004). *He Whakaputanga* was acknowledged by the British authorities at this time. However, a few short years later, the *Treaty of Waitangi* was written, and this document still stands today as part of Aotearoa New Zealand's unique history (New Zealand State Service Commission, 2004).

2.3.2.1 Treaty of Waitangi

In 1839 William Hobson was appointed Consul from the New Zealand Company (New Zealand State Service Commission, 2004). He was responsible for gaining the consent of Māori chiefs to agree to ceding sovereignty to Britain (O'Malley, et al., 2013). Assisting Hobson was Henry Williams who translated the *Treaty of Waitangi* into te reo Māori. It is agreed that the two documents, the *Treaty of Waitangi* and the translated *Te Tiriti*, are not identical translations and have some differences in meanings (Orange, 2015). Debate has been ongoing since the inception of the documents and the most significant contrast is in the first article, which in *Te Tiriti* (Māori version) reads "Crown obligations to protect rangatiratanga rights in exchange for Crown rights to occupancy and governance" (Fleras & Spoonley, 1999, p. 9). In the English version, the Crown claims "sovereignty over Aotearoa New Zealand" (Terruhn, n.d.). There are other disparities in the second article, which in *Te Tiriti* ensured Māori chiefs with "tino rangatiratanga" (absolute chieftainship) of the "taonga kātoa" (all treasured things), while the English version says the "full exclusive, and undisturbed possession of the lands, estates, forests, fisheries and other properties" (Te Ara, n.d.). The difference in translation between the two documents may suggest that some coercion was used in gaining Māori chiefs' support for the *Treaty of Waitangi*. This document remains a pillar of government, and its principles guide all people of Aotearoa New Zealand. The Ministry of Education and teachers honour the *Treaty of Waitangi* by including te reo, tikanga and mātauranga Māori in their practice.

2.3.2.2 Land confiscation

Two decades after the *Treaty of Waitangi* was signed, land issues continued to plague Aotearoa New Zealand, and across the country Māori were being alienated from their land as settlers continued to establish themselves (Te Ara, n.d.). To grasp the gravity of the situation, it helps to understand that Māori view the earth as their ancestor, Papatūānuku, the earth mother (Mead, 2016). They see themselves as tangata whenua, the people of the land, and whenua also signifies placenta "symbolising the deep connection between people, their ancestors, and the earth" (Pere, 1994, p. 13). The Māori relationship to the land is better described as the people belonging to the land rather than the land belonging to the people (Durie, 1998). This view contrasts with the Western view of people having ownership of land as personal property (Durie, 1998).

Following the signing of the *Treaty of Waitangi*, conflicts erupted, beginning in the North, then later in Taranaki, Waikato and Bay of Plenty. In 1863, the New Zealand government passed the New Zealand Settlements Act which allowed the confiscation of 1.5 million acres of land in the regions of Taranaki, Waikato, Eastern Bay of Plenty and Mōhaka-Waikare (New Zealand State Service Commission, 2004). The government justified this act as a means of punishment for Māori who rebelled against British authority (Belich, 1986). The land confiscations were a critical moment for Māori, as along with being dispossessed of their land, in efforts to recuperate these lands, which were owned communally, the Native Land Courts only allowed up to 10 owners of a piece of land (New Zealand State Service Commission, 2004). The limit to the number of owners meant that the land was owned by individuals rather than by communal groups, hapū or iwi, and this led to breakdown of these long-established communal structures (Belich, 1986). Confiscation of land has led to Māori alienation from homeland and the deterioration of social structures, and this has negatively impacted iwi and hapū. The next section discusses how education in Aotearoa New Zealand has been affected by colonisation.

2.3.3 Education

Policies of assimilation and cultural adaptation in the 1920s and 1930s were implemented in British colonies from India to the Caribbean and across Aotearoa New Zealand (Simon et al., 2001). The first missionary schools in Aotearoa New Zealand instructed students in te reo Māori and hoped to "Christianise and 'civilise' Māori, but not necessarily assimilate them" (Simon et al., 2001, p. ix). Later in the 1860s, the Native Schools were established and lasted until 1969 (Simon et al., 2001). These schools instructed completely in English, and the main purpose of the schools was to assimilate Māori to European standards (Simon & Smith, 1998). During this time, education has provided Māori with access to global information, yet at the same time eroding Māori language and customs (Simon et al., 2001). Education can be viewed as a tool of control by colonial powers and employed to strip their traditional knowledge (Simon et al., 2001). Mātauranga Māori, the language, customs and practices of Māori have been challenged within education and terms such as 'enlighten' or 'civilise' have been brandished and the not-so-subtle insinuation has been made that colonisation would remedy the ignorance of Māori (Simon et al., 2001). Colonisation, rather than enlightening and lifting up, as Conrad (1988) determines in his novel, can have the opposite effect and be a dehumanising force. Māori have faced numerous challenges to their way of life and education is one area where these challenges persist. The Native Schools Act provides some insight into one of the New Zealand government's previous initiatives for education of Māori.

2.3.3.1 The Native Schools Act

The Native Schools Act of 1867 marked the establishment of Native Schools for Māori in Aotearoa New Zealand (Hutchins & Lee-Morgan, 2016). The schools were supported through partnership between Māori communities and the government through the donation of land and financial support to pay teachers (O'Malley, et al., 2013). Teachers were expected to deliver instruction in English, however in some schools te reo Māori was tolerated, while in others, students ended up being punished and would "get the stick" if they spoke te reo Māori (Simon & Smith, 1998, p. 144). Forbidding students from speaking in their

mother language and instructing them in European practices and culture led to the deprecation of Māori culture and knowledge and subsequent loss of te reo Māori (Penetito, 2010: O'Malley, et al., 2013). Cleanliness and nutrition were promoted in the Native Schools and teachers inspected students' heads for lice and nails for dirt (Simon et al., 2001). Students were fed at school, which educated them about the European diet (Simon & Smith, 1998). By the 1940s, the aim of Māori education was to prepare Māori to be good labourers and homemakers (Edmonds, 2024). There was little opportunity for ākonga Māori to continue their education beyond basic schooling. As Henry Taylor, Inspector of Schools, to the Colonial Secretary stated:

> I do not advocate for the Natives under present circumstances a refined education or high mental culture; it would be inconsistent, if we take into account the positions they are likely to hold for many years to come in the social scale, and inappropriate if we remember that they are better calculated by nature to get their living by manual than by mental labour (O'Malley, 2013, p. 207).

Although the purpose of the Native Schools was for young Māori to assimilate into Western culture, James Belich views the schools from a different perspective, "They [schools] were a set of storm sails under which Māori culture and identity could survive the prevailing winds of socio-economic disadvantage and assimilationist rhetoric" (as cited in Simon et al., 2001, p. xi). These schools were in place for one hundred years before being terminated in 1969 (Simon et al., 2001). In many ways, Māori have shown determination to weather the storm and maintain aspects of their mātauranga Māori even through trying periods. The next section outlines how Māori have done more than survive through the storm, but have initiated the rebuilding of their language, culture and practices.

2.3.4 Resistance, renaissance, and revitalisation

Resistance against colonial influence and assimilation has always been ongoing, however, the 1970s marked the start of a real movement (O'Malley, et al., 2013). Since then, a renaissance of Māori culture and language began to gain

momentum, and this continues to today. Several young, urban Māori, many of whom were tertiary educated, formed a group called Ngā Tamatoa, who strived for "protection of Māori lands, promotion of te reo Māori, and honour of the *Treaty of Waitangi*" (O'Malley, et al., 2013, p. 291). Their protest action at Waitangi led to the ratification of Waitangi Day as an official national holiday in Aotearoa New Zealand (O'Malley, et al., 2013). This group and others began raising awareness of the plight of Māori who continued to be alienated from their land with little government interest or support (O'Malley, et al., 2013).

Whina Cooper, a community leader and founder of Te Rōpū o te Matakite (those with foresight), led a hīkoi or protest march from Northland to Parliament in Wellington to draw attention to loss of Māori land (King, 2003). Cooper and representatives from 18 iwi journeyed to Wellington to confront the government over the continued loss of land (O'Malley, et al., 2013). These protests as well as other acts of resistance led to the establishment of the Treaty of Waitangi Act in 1975 and the formation of the Waitangi Tribunal (O'Malley, et al., 2013). The Tribunal could make recommendations to the government over Māori grievances against the Crown and has provided Māori with a body to address situations that fail to honour the Treaty (O'Malley, et al., 2013).

Education is another area where the resistance movement has an impact. A movement to Māori medium education began with the opening of the kōhanga reo for preschool learners (Penetito, 2010). The first kōhanga reo was opened in 1982 and was a first step to improve education for Māori by applying culture and values and forming their own kura (schools) (Penetito, 2010). The kohanga reo or language nests are Māori immersion pre-schools established with the aim to strengthen te reo Māori (Te Kohanga Reo, n.d.). In subsequent years, parents whose children attended kōhanga reo became concerned over the loss of language once the children entered English medium schools (O'Malley, et al., 2013). To address these concerns, the Māori Educational Development Conference was held in 1984 at Turangawaewae where worrying statistics were shared that indicated a decrease in Māori language exam pass rates (Walker, 2003). This prompted the inception of Kura Kaupapa Māori with the aim of "the

revitalisation of the Māori language and culture through immersion" (Pentito, 2010, p. 223). These are kura (schools) organised by Māori and for Māori where ākonga Māori spoke te reo Māori and their cultural identities were celebrated (O'Malley, et al., 2013). In 1989, the schools were recognised through the Education Act (1989) and Kura Kaupapa Māori began to receive support from the government and instruction was delivered in te reo Māori.

Sir James Henare said, "Ko te reo te mauri o te mana Māori (language is the core of Māori culture and mana) (as quoted in O'Malley, et al., 2013). Speaking Māori, which once resulted in students being punished in schools, was later recognised as an official language and started to be taught in schools (O'Malley, et al., 2013). Following continued lobbying, in 1987 Māori became an official language of Aotearoa New Zealand with the passing of the Māori Language Act (O'Malley, et al., 2013). Assisting in the acceptance of te reo Māori was a network of regional Māori radio and television stations which provided Māori with "Māori voices," which has positively impacted Māori "self-perception" (Penetito, 2010, p. 123). The revival of the language is ongoing and continues today. Strides have been taken towards reviving te reo as the first kohanga reo babies are now in their 40s and unapologetically speaking te reo Māori as their language of first choice.

2.3.5 Decolonisation and conscientisation

A significant amount of literature has been written about colonisation and its impact on society and education in Aotearoa New Zealand. However, a shift has occurred in the past 40-50 years to conscientisation or *conscientização,* a term first coined by Paulo Freire (2015), which takes the focus off the coloniser and places it on indigenous peoples who are becoming empowered to change their own reality. Freire (2015), who worked with landless, indigenous people in Brazil, believed that developing a critical awareness of the societal features that lead to continued oppression is essential to liberation. Freire asserted that education is fundamental to improving living conditions and overcoming colonial oppression (Vandenbroeck, 2021).

Here in Aotearoa New Zealand, Smith (2003) also prefers the more proactive term `conscientization' and `consciousness-raising' than the reactive "decolonization." Smith (2003) mentions a turning point which took place in the 1980s:

> The 'real' revolution of the 1980's was a shift in mindset of large numbers of Māori people - a shift away from waiting for things to be done to them, to doing things for themselves; a shift away from an emphasis on reactive politics to and an emphasis on being more proactive; a shift from negative motivation to positive motivation.

The establishment of te kohanga reo, kura kaupapa Māori, as well as passing the Māori Language Act are all evidence of decolonisation. In the early 2000s, the formation of a new Māori political party Te Pāti Māori, continued to give Māori a voice and raise awareness of the preservation of te reo Māori, honouring the *Treaty of Waitangi*, valuing Māori knowledge, progress of kohanga reo and kura kaupapa Māori, promoting justice and equity, fostering sustainable economic growth and providing all New Zealanders with a way of life they aspire to (Walker, 2003). These initiatives indicate the ongoing steps Māori are taking to reclaim their culture, language and resist the impact of colonisation.

2.3.6 Section summary

As tangata whenua of Aotearoa New Zealand, Māori have felt the effects of European colonisation for the last four hundred years. Even today, the *Treaty of Waitangi*, the foundational document of this bicultural country, is being questioned and challenged in Parliament. Education, which has undergone various evolutions from assimilation to rejection of Māori language and practices, is now returning to embrace aspects of Māori culture and traditions. From an awakening and revival of language and culture, Māori are increasingly rejecting marginalisation, inequities and Eurocentric norms and standards. The inclusion of mātauranga Māori in the classroom is seen as part of the revitalisation effort and as an act to honour the Treaty of Waitangi.

2.4 Science education

2.4.1 Introduction

Western science education in 2025 includes: inquiry and project-based learning, innovative techniques, STEM (Science, Technology, Engineering, and Maths) and STEAM (Science, Technology, Engineering, Art, and Maths) as well as tech savvy, virtual, and distance learning all in one. Twenty-first century learning is student-centred, collaborative and inquiry based (Next Generation Science Standards, 2013).

Only in the last one hundred years has Western science become available for the general population to access in public education. In 2025, we encounter debates over whether the world is round, and some students are questioning even the most basic tenets of Western science. Teachers and students are co-creating theories, beginning with prior knowledge and including community to contribute to the school curriculum (Sāto et al., 2022). Western science knowledge is dynamic, evolving and must meet the needs of problem-solvers today (Fazey, et al., 2020).

Bull et al. (2010) outlined four broad purposes for school science education in Aotearoa New Zealand. These are: preparing students for a career in science; equipping students with practical knowledge of how things work; building students' science literacy to enable informed participation in science-related debates and issues; and developing students' skills in scientific thinking and their knowledge of science as part of intellectual enculturation (Bull et al., 2010, p. 7). The needs of students vary depending on if they plan to pursue science careers or simply be informed citizens who need to think critically. Regardless of the students' intended pathway, it is essential that science education continues to be engaging and accessible, encouraging students to be curious and understand the world they live in.

However, despite these broad goals, the number of students choosing to pursue senior science is declining. Aikenhead (2001) suggests that one reason science is often perceived as a challenging subject is that school science is a foreign culture separate from students' own realities. On one hand, some students enjoy and thrive in the science class, others may find science difficult and disconnected from their personal life experiences. Aikenhead (2001) postulates that Western science is a culture unto itself, and students experience a 'border-crossing' when they enter the science classroom. The ease with which students navigate this transition plays a crucial role in their academic success. Costa (1995) further highlights that students' worldviews -shaped by their families, communities and personal experiences can either align with or clash with the conventional Western science worldview and impact their engagement and science achievement.

2.4.2. Academies and Royal societies

A considerable amount of literature has been published on science education in the Western world. The Royal Society and Academy of Science which arose following the Counter-Reformation in Europe were reserved only for the most privileged members of society and focussed on scientific thought rather than the practical application of science (Solomon & Aikenhead, 1994). By the start of the 19th century, Solomon and Aikenhead (1994, p.5) relate that the "universal education" included little science in the curriculum. It seemed unnecessary to allow the public to access this formerly exclusive area of learning (Solomon & Aikenhead, 1994). Western science, from its origins in 19th century Britain, therefore, was held to be the most prestigious form of knowledge, and those who dedicated themselves to practical science were seen not as 'real scientists'. One example is Robert Hook, who came from more modest beginnings, and fabricated pumps for Robert Boyle to use in his laboratory demonstrations (Solomon & Aikenhead 1994). Boyle was seen as an authentic scientist and that Hook was more of a handyperson or engineer. From this point forward, we can observe that Western science is often exclusive and has been perceived as an area of study reserved for the semi-aristocratic and a sector that everyday

people should not trouble themselves with (Solomon & Aikenhead, 1994). From its beginnings, Western science has often seemed like a private club where theorists, far removed from the realities of society, meet to discuss lofty scientific ideas. The next section discusses scientific and technological developments that impact the general population.

2.4.3 Science and technology

Scientific and technological development in Britain during the Industrial Revolution helped to advance manufacturing and machinery and had a major impact on the population, especially the working class. The invention of the steam engine facilitated the production and transportation of goods from factories to market (Dickenson, 2022). The power loom and spinning jenny also improved the speed of manufacturing and enabled more efficient production of textiles (National Geographic, n.d.). However, the unexpected and detrimental effect of air pollution decreased the life expectancy of the residents who lived around these industrial centres. By the middle of the 19th century, the life expectancy in Manchester decreased to just 28 years of age due to the pollution from manufacturing (Solomon & Aikenhead, 1994). For much of the population who had limited access to science education, there was little recourse for the poor environmental conditions that negatively impacted their lives. Even towards the end of the 19th century, a basic science education was not afforded to the everyday person. As Europe became more urbanised and the population from rural areas moved to larger towns and cities to seek employment in the newly developing industries, so too did the population of these cities grow and with it a new demand for schools. Yet, science education was largely reserved for academics rather than ordinary citizens (Solomon & Aikenhead, 1994). Today, we often assume that science has always been a fundamental part of the school curriculum, but this has only been the case for the past century, as access to science education in state schools has become more widespread.

2.4.4 How have world events affected science education?

Historical events have affected science education and public awareness. The Black Plague and the Great Fire of London are two disasters which left lasting scars on society and have been remembered in our history books. Both disasters could have potentially been avoided had it been for scientific intervention (Solomon & Aikenhead, 1994). World War Two is another example of an event that "reshaped science more than any other single historical event" (Solomon & Aikenhead, 1994, p. 16). The production of the atomic bomb meant that scientists were no longer dealing with theory and containing their inventions to the laboratory. With this new scientific development there were wide reaching repercussions that affected the whole world. The harm it caused has had significant impact: killing innocent people, affecting the health of survivors and challenging the previously existing 'rules of war.' De Boer (2019) proposes that science education must be socially responsible and relevant, but is there a trade off? A new more balanced social conscience was needed for scientists "on one hand, power and dominion over nature, including economic well-being, and on the other hand, stewardship of the earth and quality of life" (Aikenhead, 1994, p. 17). Since the Second World War, citizen science has seen its inception and science education for the common person has grown and become more prevalent in school curriculums (Vohland et al., 2021). In the end, following nuclear fallout, contamination of waterways and loss of species due to habitat destruction, the world deemed science education for everyone to foster environmental sustainability, informed decision making and an improved future (Vohland et al., 2021).

2.4.5 Science-For-All

Great improvements were made to advance the school science curriculum in the 1960s and 1970s, with a real emphasis placed on specialist science manpower to fill the roles demanded by industry and to keep pace with the global developments in technology. In the 1980s, attention drawn to the school science curriculum was preparing the 20% of the school population who seek to pursue a career in the sciences well (Fensham, 1985). However, the 80% majority who

were not bound for a career in science were not being provided with an "effective science education" (Fensham, 1985, p. 416). Thus, the needs of the few outweighed the needs of the many and the majority of students were not being well served by the science curriculum. Western countries such as Britain and the United States of America, motivated to produce a "scientifically based work force and scientifically literate citizenry", underwent various science educational reforms (Fensham, 1988, p. 3).

Science-for-all was a movement adopted by several countries, including Canada, in an attempt to break the elitist view of science as reserved for the few. Science-for-all called for a social-relevant science education in the 1980s (Fensham, 1988). An initiative, 'Educating Americans for the 21st Century' sought to train workers who had sufficient scientific and technical skills to allow the USA to compete economically with Japan (Fensham, 1988). Science was not just for the privileged class, but also for the working person, and more specifically, to supply skilled workers. Now, 40 years on since the inception of the Science-for-all movement, equipping the public with scientific literacy is more necessary than ever and this is evident in recent years with the COVID-19 pandemic, human impact on the environment and climate change (Landolfi, 2023).

2.4.6 Science education in Aotearoa New Zealand

Science education in New Zealand was a government focus in 1981 as growth of skills in science and technology were viewed as a way for the country to be able to continue to develop and in doing so, compete with other nations of the world (Perris, 1983). The government sought to make gains in science education and specifically, in the areas of "workshop technology, horticulture and computer science" (Perris, 1983, p. 3). In 1993, the New Zealand Curriculum Framework was introduced and brought with it additional detail in certain levels of the curriculum, especially science and maths (Philips, 1993). In response to this increase in content, a programme of extensive teacher development followed to support teachers to develop professionally in their curriculum subjects (Philips, 1993). Since this time, science curriculum in Aotearoa New Zealand continues to

evolve and develop. The New Zealand Curriculum (NZ Ministry of Education, 2007) espoused aims for science learning to enable students to:

- Develop an understanding of the world based on scientific principles.
- Become critical thinkers and informed citizens.
- Engage with socio-scientific issues relevant to New Zealand and the global community.

The science curriculum has four learning strands which are held together by the nature of science (NOS) which overarches the other strands. In the past few decades, a renewed emphasis on Māori context and mātauranga Māori has taken a place in the science classroom. At the time of writing, the intention of the refreshed curriculum, *Te Mātaiaho,* is to see mātauranga Māori woven into all areas of learning, including science (Ministry of Education, n.d.).

2.4.7 Section summary

Science education has adapted and evolved from its early beginning as an exclusive endeavour, solely for the privileged and upper class, to an area of study that permeates all of life and society. As the role of science has become important in technological development, education has responded to these demands to supply a highly trained and cutting edge scientific and technical workforce, as well as preparing all citizens to make sound decisions in their everyday lives. Over time, science education has broadened from focusing on science for the sake of science to Science-for-all. Scientists now consider the ethical effects of their work and science education must ensure that students not only think scientifically but also are accountable to their fellow human beings. In the next section, government policy directives are highlighted and discussed.

2.5 Policy directives

2.5.1 Introduction

Since the Hunn report highlighted the inequality in social, economic and educational success of Māori compared to non-Māori in Aotearoa New Zealand in 1960, the New Zealand government has created policies and undertaken

various initiatives to support the achievement of Māori learners (Biggs, 1961). In the 1960s, Hunn recommended that the government embrace swift movement to integrate Māori into New Zealand European society as a means of bridging the gap between Māori and Pākehā (Biggs, 1961). What Hunn overlooked was the cultural differences that existed between Māori and Pākehā, as he did not value Māori traditions or beliefs but merely considered the quantitative data that was collected in the study (Biggs, 1961). The Hunn report provided extensive data but viewed the situation in Aotearoa New Zealand through a Western lens and compared Māori to the ancient Britons before the expansion of the Roman empire and described them as "primitive" and "backward" (Biggs, 1961, pp. 15-16). Since its formation in 1975, the Waitangi Tribunal hears claims of alleged breaches of the *Treaty* of Waitangi principles. Now 40 years on, Māori still face similar issues of inequality, disparity in educational achievement outcomes and are overrepresented when comparing ethnic groups in early leaving from school (Education Counts).

Since the 1960s, Māori have waged a constant battle against deficit thinking across the wider population. Disparities in educational achievement outcomes have often been blamed on the families or individuals themselves. This deficit thinking has done little to support Māori learners, as they are perceived as the problem (Smith, 1991). The general attitude has now shifted and since the 1970s and 1980s, a critical eye has been turned on the educational system, which appears to be failing Māori (Smith, 1991).

Now in 2025, Aotearoa New Zealand is still working towards eliminating bias and racist attitudes and work continues to support Māori learners to achieve equitable educational outcomes. Since this time, various policies and initiatives, which are discussed in this section, have been written to guide schools to be a positive place for Māori learners. For example, *Ka Hikitia* provides overarching guidance for educators to put in place strategies to support Māori learners to achieve success as Māori (Ministry of Education, n.d.). *Te Kotahitanga* gives an example of what an effective classroom teacher would look like, and teachers create a positive learning environment. *Te Mātaiaho* takes the curriculum in a

new direction with a refresh and reminds educators of their responsibility to Treaty of Waitangi. *Mana Ōrite* gives equal status to mātauranga Māori in assessment alongside Western contexts, knowledge and assessment. Each of these is considered in the context of their aim to eliminate the disparity in achievement outcomes between Māori and non-Māori learners.

2.5.2 Ka Hikitia

In 1999, *Ka Hikitia*, the cross-agency strategy for the education sector, was published with its three main goals: to raise the quality of English-medium education for Māori; to support the growth of high quality kaupapa Māori education; and to support greater Māori involvement and authority in education (Ministry of Education, n.d.). This strategy implores the education sector to 'step up' to support Māori learners to achieve "excellent and equitable educational success" (Ministry of Education, 2024, np). *Ka Hikitia* has had three updates since 2008, *Managing Success, Accelerating Success* and the *Refreshed Ka Hikitia.* Each of these strategies has a set of overarching principles which has guided the work that takes place in education. The most recent principles are: Excellent outcomes, Belonging, Strength-based, Productive-partnership and Te Tiriti o Waitangi (Ministry of Education, 2023). These initiatives have brought attention to the plight of Māori learners; however, the struggle continues. In 2013, the New Zealand Auditor General commented that:

> Although there has been only modest improvement overall in Māori students' academic results since *Ka Hikitia* was launched, schools are increasingly recognising their responsibility to raise the achievement levels of their Māori students. As one principal noted to my team about improving commitment from the school and engaging with whānau and the community, "You have to take a long-term approach. We're working gently and carefully" (New Zealand Auditor General, 2013, p. 8).

This statement raises two important questions. Are schools and teachers simply going through the motions when it comes to government policy implementation? Or do we see the beginnings of a change of trajectory and

improvement of Māori achievement? One would hope the latter is true and that we will see continued improvement achievement over the coming years as outlined in Te Kotahitanga.

2.5.3 Te Kotahitanga

In 2010, Russell Bishop and Mere Berryman produced the Effective Teacher Profile in their project *Te Kotahitanga* (unity), which sought to improve educational achievement of ākonga Māori. As previously mentioned, poor teacher attitude and deficit thinking was seen to contribute to underachievement of Māori learners (Bishop & Berryman, 2010). These authors instead suggested that agentic thinking, positive student-teacher relationships and student acceptance resulted in improved achievement in the classroom (Berryman & Bishop, 2010). This teacher profile provides suggestions that positively impact students' learning. The teacher profile is written with Māori learners in mind and, if implemented, could benefit all learners. The six suggested teacher actions are: Manaakitanga (caring for students), Mana motuhake (caring for the performance of ākonga Māori), Ngā whakapiringatanga (creating a secure, well managed learning environment), Wānanga (engaging in effective learning interactions with ākonga Māori), Ako (using a range of teaching strategies), and Kotahitanga (using student progress to inform future teaching practices) (Berryman & Bishop, 2010). This approach rejects deficit thinking, replacing it with a mana-enhancing approach towards ākonga Māori. The aspirational goal of the teacher profile stands as a guide to support the achievement of Māori and all students.

2.5.4 Te Mātaiaho NCEA Curriculum refresh

Initiated in 2024*, Te Mātaiaho*, the refresh of the New Zealand National Curriculum, which must be fully integrated into schools by 2027, has two aims:

1. To be knowledge-rich and clear about what students need to understand, know and do in each year from Years 0 to 13.

2. Teachers will know what to teach, when, and how, based on the science of learning, which provides them with effective teaching strategies and practices (Ministry of Education, n.d.).

The refreshed curriculum hopes to address the faults of the current *New Zealand Curriculum,* which as Bourke (n.d., p. 13) views are high autonomy, generic, skills-based versus prescriptive, lack of progression, knowledge left to chance and lack of Māori knowledge and content. The refreshed curriculum seeks to "recognise Indigenous knowledge, Māori culture and language in the curricula" (Ormund, 2024, p. 82). One of the key elements of the refreshed curriculum is "Understand, Know, Do" and each of the "Understand" or "Big Ideas" is linked to a whakataukī (Māori proverb) (Ormund, 2024).

In this way, the Ministry of Education is taking steps to include tangata whenua in a partnership to write the new curriculum. Interestingly, the established subject areas remain the same as established by "Western knowledge structures" while an "Indigenous lens" has been applied to these (Ormund, 2024, p. 82). As the refreshed curriculum is in its formative stages, it is yet to be seen how the principles play out in the classroom and is greatly dependent on the school and teachers who are tasked with delivering the curriculum. The Ministry of Education aims to support to teachers by providing guidance on both how and when content should be taught (Ministry of Education, n.d.). As Aotearoa New Zealand progresses through the three phases-preparing for change, implementing change, and finally sustaining and maintaining change-additional resources and materials will become available. Furthermore, the proposed changes will be evaluated to ensure they achieve "equitable and excellent outcomes for all learners" (Ministry of Education, n.d.).

2.5.5 Mana Ōrite

Mana Ōrite gives equal status to mātauranga Māori in the National Certificate of Educational Achievement (National Certificate of Educational Achievement (NCEA), 2025). This initiative proposes that mātauranga Māori along with Western knowledge both be applied as context for NCEA assessments. This

NCEA initiative allows students to access mātauranga Māori and te ao Māori and to see Māori culture and knowledge as a valuable part of their learning journey. A toolkit has been supplied on the NCEA website to support teachers and schools to weave mātauranga Māori through existing subject areas. Mana Ōrite has a vision to not only provide equal status for mātauranga Māori in schools, but to also engage iwi and community in schools and look towards a sustainable future where Māori achieving as Māori is not only acceptable but celebrated. Therefore, providing equal status to mātauranga Māori alongside, not in addition to, conventional science knowledge is absolutely key in realising the vision outlined by Mana Ōrite.

2.5.6 Section summary

The policy initiatives discussed sought to achieve two major outcomes. Firstly, to lift Māori achievement outcomes and secondly provide a roadmap for schools and teachers to guide them towards improved practices more closely aligned with the realities and experiences of ākonga Māori. However, putting this theory into practice can be challenging and one that may require a shift in thinking and practice to master. The aims which were set out by *Ka Hikitia* in 1998 have shown some improvement in Māori achievement. Case studies have been undertaken to find solutions to this situation (Egan, 2022; Virtue, 2021; Rajagopal, 2021). However, applying a formula that is effective in one school does not guarantee its success in another. It is necessary to create a bespoke approach that is tailored to each community, school and group of learners. In the next section, we hear perspectives from teachers on their own experiences in the science classroom.

2.6 Perspectives from teachers

2.6.1. Introduction

Teachers' perspectives on science learning are based on their own experiences in the classroom. Often, these teachers were successful students themselves and went on to enjoy further success studying science in university. They may struggle to relate to students who find science a challenging subject and the science classroom a foreign place (Aikenhead & Jegede 1999). For teachers, contending with a deeply-seated Eurocentric bias may prove challenging, and they may not even recognise that they hold these views and bring with them into the classroom (Tanaka, 2009). For teachers to best serve a diverse student population, confronting the uncomfortable fact they are immersed in their own biases is necessary (Tanaka, 2009). The incorporation of Indigenous knowledge in the science classroom is a relatively recent educational shift and although academics have written about this knowledge system, guidance for how this could be introduced in the classroom is lacking. Teachers, therefore, have their own perspectives based on their lived experience, schooling and their ideas on how to best serve the students in their class.

Teachers' ideas about what constitutes science and science education is explored and discussed in the next section.

2.6.2 Ideas about science

There are differing perspectives on what constitutes science education, with some arguing that school science should place greater emphasis on the nature of science and real-world application of science knowledge, rather than solely focus on facts, theories and content knowledge (Osborne et al., 2003). Achieving this balance between science content knowledge and the science skills necessary for future citizens to make informed decisions for themselves and their communities is a key consideration in curriculum design.
Osborne et al.'s (2003) research, surveyed experts from the science education community to determine the most essential aspects of the nature of science learning. Through a Delphi study, nine essential themes emerged:

- Scientific Method and Critical Testing
- Creativity
- Historical Development of Scientific Knowledge
- Science and Questioning
- Diversity of Scientific Thinking
- Analysis and Interpretation of Data
- Science and Certainty
- Hypothesis and Prediction
- Cooperation and Collaboration (Osborne et al., 2003, pp. 705-706).

These themes demonstrate the importance of fostering both scientific literacy and critical thinking skills, ensuring that students not only understand scientific concepts but are also able to engage and apply their science skills in a meaningful way.

Scientific literacy is a term which is a frequently used term, but it lacks a universally agreed-upon definition. Sjöström (2024) presents three visions for scientific literacy: Vision I- scientific content, Vision II- science-technology societal (STS) issues, and Vision III- scientific engagement with social, cultural, political, and environmental issues. Visions II and III clearly position science in relation to society, emphasising its application in the real world rather than viewing it as an isolated body of knowledge (Osborne et al., 2023).

Vision III extends beyond merely applying science knowledge in society. It focusses on looking beyond oneself, drawing on the expertise of others, incorporating local knowledge and fostering a collective sense of scientific literacy that considers community values and ethics (Osborne et al., 2023). This perspective contrasts with conventional Western notions of science as belonging to each individual (Sjöström, 2024).

Murcia (2009) asserts that "scientific literacy is clearly about KNOWING but it is also about a way of THINKING and ACTING" highlighting the obligation of responsibility to one's community (p. 219). Since 2007, there has been a significant increase in research advocating for Vision III of scientific literacy,

particularly in response to climate change, digital media literacy and life in the Anthropocene (Sjöström, 2024).
The following section explores the important of recognising one's own assumptions and adopting a reflexive approach.

2.6.3 Reflexivity

Introducing mātauranga Māori or another form of Indigenous knowledge into the science classroom can be an unexpected journey into self-awareness. Understanding another culture requires teachers to first understand their own personal culture and biases that they hold as well as their perceptions of science teaching and the role of the science teacher (Naidoo, 2005). Naidoo (2005) cautions us that the experience of including Indigenous knowledge in the science classroom can prompt teachers to run into barriers and dilemmas. Confronting their own beliefs and making sense of including the idea of 'magic or spiritual' elements in the indigenous context alongside Western science concepts can be demanding (Naidoo, 2005). They may be familiar and comfortable with the Western scientific approach to science teaching and view the world through an analytical lens where the whole is broken down and classified by their unique features (Bohm, 2014). This reductionist view is a hallmark of Western science and penetrates the very essence of science, as separating different elements into pieces is evident in all aspects of science, including terminology and language as "fragmentation is built into the very language of science" (Bohm, 2014). However, on the other hand indigenous approaches views the world through a more holistic lens that does not reduce the system into individual units but appreciates the whole as one (Bohm, 2014). This holistic approach surpasses what is typically viewed as science and some may struggle to grasp the lack of separation in Indigenous knowledge where art, science and religion all overlap (Battiste & Youngblood Henderson, 2000). Acknowledging one's own position and views can be confronting and may take time. However, this must be considered when attempting to include two vastly diverse ways of thinking in the classroom.

Conceding deeply-seated colonial notions that a teacher may hold is essential when including Indigenous knowledge in science classrooms. Teachers are compelled to decolonise themselves as well as the curriculum to best serve indigenous students, explains Belczwski (2009). They state, "without personal transformation, the educational process for First Nations students, regardless of the extent of decolonized curriculum used, remains colonial” (Belczewski, 2009). Working towards conscientisation means that the teacher transforms themselves through curriculum transformation. This requires teachers to adopt an attitude of humility and relinquish their position of authority and as Belczewski (2009) suggests, Listen, Ask and Listen. The process of Listen, Ask, Listen advocated for by Belczewski (2009) means that creating opportunity for open dialogue and gathering people together to learn is important and facilitates the growth process.

Amundsen (2020) directs us through the following steps of decolonisation through reconciliation and applies Prochaska’s six steps of change: Pre-contemplation, contemplation, preparation, action, maintenance and relapse. These steps lead a Pākehā teacher through recognising their own identity and experiencing shame and wishing to disown their own culture through carrying out actions that lead to decolonisation and power sharing (Amundsen, 2020). Amundsen (2020) recognises that in all change, these steps are necessary and although we may wish to avoid relapse, it is a natural and essential part of change, but that in making a significant change, reprogramming ourselves and arriving at the ‘third space’, which is a new location that moves us towards decolonisation, are part of the process. Amundsen (2020, p.144) referred to the ‘third space’ as a “new place somewhere between Pākehādom and Māoridom (in betweenness).” Amundsen suggests these steps for researchers working within a Māori context. These could be applied to the science classroom and provide guidelines for teachers who aim to authentically include mātauranga Māori. These steps are:

1. understand self
2. respect cultural identity

3. enter and commit to long term relationships

4. be transparent and humble

5. listen and reconcile

(Amundsen, 2020, pp 149-150).

Taking guidance to move towards appreciating one's own culture and that of the students is necessary to decolonise and reconcile disparities between Māori and Pākehā (Amundsen, 2020).

Finally, Bishop (2005) identifies conversation as a crucial element when welcoming ākonga Māori into the classroom. They suggest that teachers remain mindful of our students' reality and perspectives. When students enter the classroom, they are asked to conform to teachers' expectations and those of the dominant culture within which we live (Bishop, 2005). However, the students are expected to work in this unknown space while teachers operate in their own familiar space, never having to feel the discomfort of being foreign (Bishop,2005). As teachers, it is necessary to ensure our students feel that the experiences that they bring to the classroom are valid and work together to co-create knowledge in the classroom (Bishop, 2005). Recognising that students bring their own prior learning or funds of knowledge to the classroom connect new concepts to existing understandings.

2.6.4 Recognising funds of knowledge

Funds of knowledge was originally developed as a means to counter deficit thinking with students from minority backgrounds in the United States (Gonzalez, et al., 1995). The findings of Gonzalez et al.'s. (1995, p. 457) work requires teachers to relearn a new way of viewing their students and leave behind deficit attitudes that place students and their households in an inferior position of "lacking worthwhile knowledge and experiences." This idea assists teachers to tap into the unique prior knowledge of their students and build learning activities that resonate with them. By taking time to know students,

teachers were able acquaint themselves with the whole child and appreciate their individual challenges and strengths (Gonzalez, et al., 1995).

One method of acknowledging student funds of knowledge is the use of storytelling. Lipe et al. (2023) suggest personal narrative as a means of including Indigenous knowledge and indigenous pedagogy in the science classroom. Through the process of storytelling, students can relate their own culture and previous lived experiences with science learning in the classroom (Lipe et al., 2023). This perpetuates indigenous values and practices as well as connecting and validating students' own background and experiences (Lipe et al., 2023). If students are able to apply their previous knowledge to what they learn in science, they are more likely to be able to negotiate movement between the two worlds (Indigenous knowledge systems and Western science) (Lipe et al., 2023). By existing in these two worlds, they are better prepared for solving future problems by viewing issues through more than one worldview or lens (Lipe et al., 2023). For this to happen, education must shift to be able to accommodate diverse perspectives and adopt a more holistic and bi-cultural approach to learning.

Here in Aotearoa New Zealand, Cowie, et al. (2022) have explored teachers' funds of knowledge and what informal educational experiences teachers have that they could bring into the classroom. The authors assert that both student and teacher funds of knowledge could contribute to making the classroom more authentic and unlock already established funds of knowledge and facilitate the sharing of valuable knowledge between teachers and students. This respect for funds of knowledge averts the assumption that teachers possess all the information and students are little more than empty vessels to be filled. Instead, both teacher and students are seen as having their own unique fund of knowledge to draw from and are able to create knowledge together, which is a more empowering experience.

2.6.5 Learning to teach or teaching to learn?

An implication of including Indigenous knowledge in science is teacher education and preparing teachers to effectively include Indigenous knowledge in the science classroom. We may consider whether teachers are learning to teach or learning through the act of teaching? A combination of the two is most likely the case and often all the preparation in the world will not equip you for what challenges pop up while on the job.

Lemon and Calder (2022) suggest that alternative education has a lot to share with mainstream school about relating to students in a non-judgmental way that helps to rectify education debt. Connection or whanaunatanga is the foundation of relationship building and provides students with a sense of belonging that fosters growth and healthy relationships (Lemon & Calder, 2022). Being able to work in a partnership, teachers and students together, is crucial in providing students with a sense of ownership and agency of their learning.

Photo and McKnight, whose study of science teachers in South Africa sought to produce a "foundation for knowledge that is both culturally and scientifically rich" (Madlela, 2022, cited in Photo & McKnight, 2024). However, they found that there as a lack of explicit guidance on how to include Indigenous knowledge in the science classroom and "exposure to Indigenous knowledge sources for the incorporation into lessons" which proved challenging for teachers (Photo & McKnight, 2024, p. 2). The process of learning to include Indigenous knowledge in science is a cycle and Photo and McKnight (2024) suggest the following guidelines:

1. Applying Indigenous Knowledge Systems as a foundation- In this way, teachers tap into learners' cultural knowledge and experiences to bridge the gap between the familiar and unfamiliar.

2. Use local community culture in the classroom- then integrate community culture into the classroom environment.

3. Teacher experience- acknowledge their own background and diverse experiences.

4. Highlighting Indigenous Knowledge Systems in practical contexts- Provide practical examples of Indigenous Knowledge Systems in students' own lives to highlight Indigenous Knowledge Systems.

5. Professional development- Continue with professional development to grow teachers' understanding of Indigenous Knowledge Systems.

6. Curriculum development- Integrate Indigenous Knowledge Systems into the science curriculum "emphasising its cultural and historical significance"

7. Collaboration- Collaborate with other teachers to share strategies, ideas and resources.

8. Engagement- Engage with community, form partnerships and identify local elders who could act as resources.

9. Evaluation- Carry out evaluation to assess progress, find out impact on students learning and adapt teaching practice (Photo & McKnight, 2024, p. 9).

These guidelines are a framework that could easily be applied to the educational setting in Aotearoa New Zealand. Especially important is guideline six, considering "cultural and historical significance" is mentioned (Photo & McKnight, 2024, p.9). If the significance of the Indigenous knowledge is not recognised, there is the chance of knowledge appropriation and extracting an aspect for the knowledge from its cultural context making it artificial.

2.6.6 Section summary

Teachers hold their own perspectives on science education. Integrating Indigenous knowledge requires teachers to first understand and possibly confront their own personal culture biases. They may need to consider how they view the world and model using both indigenous and Western science lenses. The ability to understand new perspectives and place themselves in the shoes of the student helps to provide insight to challenges and obstacles that learners may experience. Learning is an ongoing process, and teachers as well as

students are learning and adapting. Accessing and applying suggested guidelines to inform their practice and carry out self-evaluation is advantageous.

2.7 Chapter summary

Previous studies have focussed on including Indigenous knowledge and how teachers respond to the needs of their indigenous students by being a "cultural broker" with some familiarity in the science classroom (McKinley & Stewart, 2008). The impact of colonisation in Aotearoa New Zealand and how this has adversely impacted Māori education and resulted in disparity between Māori and non-Māori especially in science remains a real concern. Revitalisation of Māori culture and language has in recent years led to the awareness of the absence of mātauranga Māori from classrooms. The development of modern science education and criticism of its long-established biases towards Western worldviews and ways of knowing provide motivation to review conventional school science and how it is taught. The Ministry of Education in Aotearoa New Zealand has attempted to introduce policies and initiatives to provide equity in the classroom and better cater for Māori learners to address disparities in educational outcomes. These policies have had limited success and persistent inequity among students in science classrooms has motivated me to explore potential solutions to this ongoing issue. Finally, perspectives of science teachers working in this space can offer valuable insights into the current efforts to foreground mātauranga Māori as a visible and dynamic part of their classroom curriculum as well as beliefs on what constitutes science. In the next chapter, the methodology and methods used in this research are outlined.

Chapter Three - Methodology

3.1 Introduction

The purpose of this research project was to investigate how teachers approached the incorporation of mātauranga Māori in their junior science classrooms. The area of mātauranga Māori and Indigenous knowledge is gaining more attention in Aotearoa New Zealand and around the world. These previously disregarded worldviews, once seen as 'primitive,' are now being increasingly included alongside Western science as valid and valuable way of viewing the world, knowing and doing. The present study examines how this knowledge is incorporated with science in junior secondary school classes and the different ways teachers have approached this.

This chapter presents the methodology and methods as well as the overarching questions that drove the research. The ontology, epistemology and axiology that impacted my approach and research design are described. Participant selection, methods used to generate and collect data and the ways data were analysed is outlined. Potential ethical issues, the steps taken to ensure participant identity was protected are outlined. Finally, the main steps taken to establish trustworthiness of the data are discussed.

3.1.1 Research questions

This research sought to understand teachers' perspectives when they incorporated mātauranga Māori into their science classrooms, how they did this and what, if any, impact they felt that doing so had on student engagement in their science classes.

Principal question:

1. What are teachers' perspectives on incorporating aspects of mātauranga Māori in their year 9-10 secondary school science programmes?

Sub-questions:

2 a. How have they incorporated mātauranga Māori in their science classrooms?

2 b. How do they feel this has impacted student engagement and learning outcomes in their science classrooms?

3.2 Paradigm of this study

This research adopts the ontological understanding of relativism and accepts that there is no single reality, but rather that individuals have their own truth and that this may vary depending on their lived experience, perspective and context (Denzin & Lincoln, 2005). This aligns with epistemological constructivism that knowledge is co-constructed between the researcher and participants (Denzin & Lincoln, 2005). The participants contributed to this by sharing their own perceptions and insights, which were rooted in their individual realities. The axiological stance embraces interpretivist paradigm which rather than seek a neutral positivist outcome, recognises that the preferred goal is deep, personal understanding of the phenomena. This signifies that perceptions of reality are not fixed and that actions can be understood on a deeper level if the researcher is able to position these within the different realities of the participants. As Schwandt (1994, p. 222) mentions:

> That is, particular actions, in particular places, at particular times, fashion meaning out of events and phenomena through prolonged, complex processes of social interaction involving history, language and action.

Focus on meaning is the primary goal of this approach and data were gathered through the qualitative method of semi-structured interviews through which participants were able to share their lived, classroom experiences. During this process, participants spoke about their teaching and interactions with students in the classroom. However, we cannot look solely at the act of including two knowledge systems in the classroom but must consider the intentions of the participants and what motivated them to include mātauranga Māori in their science classrooms.

3.2.1 Position as a researcher

As a researcher, my background, life experiences and worldview affect the lens through which I have viewed this study. One may expect research to be scientifically objective; however, this is nearly impossible and fails to recognise what the researcher brings to their research. Court and Abba (2022) discuss the position of the researcher as “insider-outsider” in relation to research. In the present study, I as a researcher am both an insider and an outsider. As I was born and grew up in Hawaii, in the United States, I am as a foreigner and an outsider in New Zealand. However, after arriving to here in Aotearoa New Zealand with a bachelor's degree in biology and Spanish, I completed my graduate diploma in secondary teaching through the University of Waikato in 2006. I have taught secondary science for more than 17 years. This positions me as an ‘insider’ as I have experience and knowledge of the realities of being a science teacher in Aotearoa New Zealand. I endeavour to make science engaging for young learners and plan learning activities which relate science to students’ lives while at the same time preparing them with a foundation for senior science. I am non-Māori but have a profound respect for indigenous peoples and their knowledge having grown up on a Pacific island. As a science teacher, I have grappled with ways to authentically incorporate mātauranga Māori in science while honouring both Western science as well as mātauranga Māori.

3.3 Timeline

The following was the timeline that guided this thesis.

Table 3.1:

Table 3.1 Outlines the task study such as through: gaining research and ethics approval, carrying out the research. Gathering, analysing, and processing the data as well as writing, editing and formatting the thesis.

Month	Task
March	Thesis Proposal and application
	Thesis proposal accepted on the 25th of March 2024
April	Submit Ethics application
May	Ethics application approved on the 13th of May 2024,
	Pilot interviews, participant selection
June	Interviews, transcription
July	Interviews, transcription, member checking, code, analysis
Aug	Code, analysis, write findings
Sept	Write findings
October	Write literature review, methodology
November	Write literature review
December	Write discussion
January	Write discussion
February	Editing and formatting
March	Proofreading and submission

3.4 Participant selection

I selected a group of participants who represented as much as possible a cross section of New Zealand science teachers. I used purposeful sampling to select my participants as I sought to gain information-rich cases. Although this approach is not random, in a qualitative study, purposeful sampling is one of the accepted methods of selection (Patton, 2002). Purposive sampling allows the researcher:

> Insights and in-depth understanding by creatively solving puzzles with convincing evidence. Purposive sampling demands that the researcher exercise their best judgement by intentionally inviting those people or selecting locations, documents, or artifacts that can help accomplish these tasks (Staller, 2021, p. 898).

I chose not to seek participants from the school where I am currently employed as I felt that although we do have an established rapport, it could blur the lines of colleague and researcher. As all the participants worked in schools other than my own, this allowed me to maintain a level of objectivity in the research.

The participants were secondary school teachers who taught junior secondary science classes. They each took part in an individual semi-structured interview to find what their perspectives are on incorporating mātauranga Māori in science classes. I hoped that five to seven participants would provide an acceptable range of experience and different types of schools: single-sex, co-ed, rural, urban, state schools, state integrated school as well as a kura Māori. The participants selected were from a range of schools as well as one Kura Kaupapa Māori. They have a range of experience; however, three of the six were very experienced with more than 20 years of teaching (see Table 3.2).

Participants were identified and recruited through a combination of word of mouth, connections with my University of Waikato supervisors, New Zealand Association of Science Educators newsletters and science teacher Facebook groups. Participants were teachers who were either currently implementing or planning to incorporate elements of mātauranga Māori in their science classrooms. This criterion was met when participants opted into the study after receiving the invitation to participate and the information letter.

Table 3.2:

Table 3.2 Participants' outlining pseudonyms chosen, year of teaching experience, type of school and self-identified level of te reo Māori ability.

Pseudonym	Years teaching	School	te reo Māori
Noah	30	State integrated	Unknown
Anne	6	Kura Kaupapa Māori	Fluent
Rachel	30	State	Level 4
Ted	3	State	Unknown
Meredith	20	State	Immersion
Francis	6	State	Level 2

3.5 Research design

3.5.1 Methodology

The methodology employed in this research was phenomenographic (Seidman, 2013). Phenomenography aims to capture the lived experience of the participants. Each of whom have their own understanding and reality and through interviewing and conversation, can convey their own unique insight and experience. I adopted a phenomenographic approach for this project as I was interested in understanding how experiences of including mātauranga Māori in science classes varied among the set of participants (Denzin et al., 2024). I sought to explore how the participants incorporated mātauranga Māori into their classroom science programmes, what challenges they faced and how they overcame these.

3.5.2 Data generation

Semi-structured interviews are recognised as an important qualitative data collection method, and they are a way of finding out participants' stories (Seidman, 2013). The semi-structured interview allows some flexibility to follow the participants' unique lived experience, while at the same time maintaining focus on the process (Adeoye-Olatunde & Olenik, 2021). Semi-structured interview questions are designed to be open ended to allow the participant the opportunity to expound on their experience. The interviewer can use follow up

questions to seek more profound understanding or to clarify any responses that the participant may make.

I developed the interview questions after undertaking an initial review of the literature. After familiarising myself with Aikenhead, Castango and Brayboy, Wood and Lewthwaite and others, I began to formulate the interview questions. I also had my own questions based on my own personal experiences in the science classroom and areas where I felt there were gaps in my own understanding of including mātauranga Māori in the science classroom. In consultation with my supervisors and cultural advisor, I adapted the list and used these in my pilot interviews.

To conduct pilot interviews, I requested the assistance of my colleagues in the Science Department at Francis Douglas Memorial College who agreed to support me by engaging in pilot interviews. This step in the process was beneficial, as it allowed me to identify a few pitfalls that I was able to remedy before the actual interviews. For example, one of these was that the free version of the voice recording and transcribing app that I chose to use would not transcribe recordings longer than 30 minutes in length. This would have proved problematic and could have created more work for me in transcribing should I have used it in the participant interviews. One of the pilot interviews took place during an after-school robotics activity and students were in the room discussing their projects while I was interviewing my colleague. When I listened to the recording and viewed the transcript, the background voices were not recorded, nor did they appear in the transcript. This indicated that should I need to interview a participant while they were in a noisy space, it would be possible to have a record of the interview. I was encouraged to know this as often teachers do not always have their own labs or offices.

A few of the questions that I had initially written needed further clarification. One of the pilot participants made an interesting comment about Western science being viewed as a tool of colonisation. I thought this was an interesting comment and wanted to include a question along this line. As a non-Māori, I wondered how cultural knowledge and familiarity with Māori culture or one's

own culture impacted the delivery of mātauranga Māori in the science classroom.

3.5.3 Context

Interviews took place within the participants' schools, either in the teacher's lab, classroom or office. One of the teachers, who was unable to go to school on the day we had planned to meet for the interview, invited me to their home to conduct the interview. Another teacher arranged for to me interview them on a weekend day at their home as this was more convenient than meeting in their classroom outside of school hours.

To gather data, I organised a time that suited the participant and visited their school and teaching space. I conducted a semi-structured interview using the interview questions (Appendix A). Each interview lasted between 45-60 min, during which time I heard about their science teaching experience, understanding of mātauranga Māori and how they included elements of this mātauranga Māori in their year 9 and 10 science classrooms.

Being present, in-person in the participants' teaching space during the interviews upheld their mana, for as stated by Opai (2021, p. 85), "In the Māori world, there is great mana in being there in person and expressing thoughts face to face." By travelling and visiting the participants in their own school environment, I hoped to gain a rich understanding of their school context and bring an immersive element to the interview experience that would be difficult to replicate by virtual meeting or phone call. Adeoye-Olatunde and Olenik (2021) agree that in-person interviews can provide valuable non-verbal reactions to questions, which would not be possible to observe with a phone interview. I found it most valuable and enriching to visit teachers in-person and get a sense of their classrooms and schools firsthand.

3.6 Data Analysis

The data from the interview transcripts were coded using an inductive method and codes were grouped into themes which emerged from the data (Braun &

Clarke, 2021). The steps taken to analyse the data were familiarisation in which the recording was listened to without any attempt to analyse or notes being taken. The next step was to listen to the recordings while taking notes and noticing main points of the interviews. Codes were generated mostly through an inductive approach. However, while developing research questions some ideas for codes came up and were considered during analysis. These were identified by carefully listening and reading over each participant's transcript and allocating a word or phrase that captured the meaning of the various responses. These passages were then grouped with similar codes, during this process some of the codes merged while others were divided. Establishing definitions to help distinguish between similar codes was needed in some cases to ensure that the data were maintained in each code. The codes were then combined into themes and the themes were arranged into maps. Seidman (2013, p. 130), reminds us that the final step in the process of analysis is to find "connective threads among the experiences of the participants interviewed" and to "understand and explain these connections." Thus, after sharing my maps with my supervisors and receiving their input into the organisation of codes into themes, I reviewed the data for the underlying themes and patterns that emerged and how they formed a connection between the teachers who participated.

3.7 Trustworthiness

Trustworthiness of data in research is important and as my method of data collection was by interviews, I needed to enhance the rigour of the qualitative data gathered (Gunawan, 2015). I took several steps to ensure this. Voice recordings and automatic transcriptions were made with the use of the Otter.ai app for each of the semi-structured interviews. Once the interviews were transcribed, I re-listened to them, read the transcriptions to check for accuracy and corrected any errors that were identified. I followed the process of member checking by sending each participant the transcript of their interviews, to add or remove what they wished and accept if they agreed that it was an accurate account of their interview comments. The scripts were all returned by the participants unchanged. I chose one of the interviews for my supervisors to peer

review and confirm the coding process and explore if codes should be added or removed from the set.

3.8 Ethical considerations

Ethical considerations were attended to during the research process, to ensure the respectful treatment of participants, protection from harm, as well as the maintenance of privacy and confidentiality (Morrison & Cowie, 2024). I received ethical approval from the University of Waikato Ethics Committee on the 13th of May 2024 (Appendix D). Cullen et al. (2011) provide a user-friendly framework which I found quite helpful in considering possible ethical issues and a list of questions to consider when carrying out research in an educational setting.

3.8.1 Informed consent

All participants were asked for their informed consent when asked to take part in the study. In the initial email all participants received an information letter (Appendix B) outlining the purpose of the study, requesting their contribution in the form of an interview as well as specifically stating how their responses would be kept confidential and their identity protected. The participants who replied with interest were then sent a consent form (Appendix C) to sign to indicate that they agreed to be included in the study. The form also requested that they inform their school principal of their involvement and confirm their support as well.

3.8.2 Protection of identity and confidentiality

During the interview, I asked participants to select a pseudonym to protect their identity I kept confidentiality and privacy by using the pseudonyms and blurring details in data reporting that could make teachers or schools identifiable. I have tried to describe the teachers in a way that represents them in a respectful and dignified manner to avoid possible harm. I anticipated my research being of benefit to secondary school science teachers in Aotearoa New Zealand and other places where Indigenous knowledge systems exist alongside non-indigenous systems.

3.8.3 Cultural advisor

My cultural advisor, Rory Maxwell, and I met to discuss my interview questions and the interview process. His suggestion was to include more questions with reference to te ao Māori and mātauranga Māori. Whakataka te hau, an appropriate karakia for starting and finishing a meeting or interview was suggested for use to begin and end the interview process. My supervisors also provided feedback and helped me to craft other interview questions about how one's cultural knowledge may impact the delivery of mātauranga Māori in science.

3.8.4 Voluntary participation

Participants agreed to take part in the study voluntarily. No offer of compensation was made as a means of coercion. Participants were free to withdraw from the study at any point and without needing to give a reason for their withdrawal. The participants owned the data until it had been processed at which point, the data becomes the property of the researcher.

3.9 Chapter summary

The interpretivist epistemology was the paradigm employed in this study and the data that were generated from semi-structured interviews contributed to inform this phenomenographic qualitative research about teachers' perspectives on including aspects of mātauranga Māori in their year 9 and 10 science classrooms. The process and research design have been outlined as well as the approach to participant selection. The research design was described, including data gathering and analysis. Trustworthiness and ethical issues were considered and steps taken to meet these requirements discussed. In the next chapter, Findings, participants' responses are shared through common themes that emerged from the data.

Chapter Four - Findings

4.1 Introduction

This chapter reports on the findings from the six interviews conducted with teachers of junior secondary science. Three themes emerged that provide insight into teachers' perspectives on including mātauranga Māori in the junior science classroom. Organising these themes was not without its challenges as many of the themes overlap and extracting one from another as well as defining limitations of each was difficult. However, they have been grouped into broad themes of society, two knowledge systems and schools.

The first theme focusses on the society where the research is situated, Aotearoa New Zealand and considers the *Treaty of Waitangi* as a guiding principle. It also examines iwi and their relationships with the schools. Secondly, the two knowledge systems are considered beginning with teachers' views on the purpose of science in education followed by the relationship between Western science and mātauranga Māori. Finally, the largest section is schools and addresses the key players: teachers and students. In this section, participants share how they developed confidence to include mātauranga Māori in the science classroom, and discuss students' attitudes, the unique school environment, their approaches, and examples of incorporating mātauranga Māori in their classrooms.

4.2 Society

4.2.1 Introduction

This section considers the society of Aotearoa New Zealand, in which the study is situated. Unique to Aotearoa New Zealand is the *Treaty of Waitangi* and its principles of partnership, protection and participation. The findings indicate that participants felt that their role in the science classroom was to honour the *Treaty* through the inclusion of mātauranga Māori. The participants also described how iwi were consulted to support this work, that these relationships took various

forms, and that there were challenges that exist when schools and iwi work together.

4.2.2 Treaty of Waitangi

The inclusion of mātauranga Māori in science was seen by five of the six participants as fulfilling their obligation or duty to the *Treaty of Waitangi* by providing opportunities for partnership between Māori and Pākehā. Francis commented on how they have incorporated te reo Māori and mātauranga Māori in their classroom and attempted to normalise it through their actions. This can be challenging, as it may not be included in all schools. Francis said:

> [I try to] normalise it, to make it so that it's just part of every learning. [I respond] to people when they say, "Oh, but I didn't grow up with this." I [say], "Yes, but if we had respected the Treaty right from the start, you would have."

Francis' perspective of what the reality could have been had the *Treaty of Waitangi* been honoured from the start indicates their view of the challenge that can exist in incorporating mātauranga Māori into their teaching now. Rachel, however, was concerned that some attempts to acknowledge the *Treaty* could be perceived as superficial:

> Māori are the indigenous people of this country, and you have an obligation to them. It is because of the *Treaty of Waitangi* that we immigrants are here. But that obligation, you should really feel it rather than [it being] superficial.

Too often honouring the *Treaty* was seen as a 'box ticking' exercise rather than a step in the journey towards a bicultural partnership. Noah gave an example of their experience:

> The [schools] see things as a tick box. So, they will call on the local iwi to help us with the pōwhiri at the beginning of the year, but then we won't see them till next year. So that's why now iwi and kaumatua [elders] are charging $1,000 because they've had enough. And I don't blame them.

It is easy to see that this sort of one-sided relationship could become more of a business transaction than a reciprocal and lasting relationship. However, the commercialisation of cultural support by iwi is a response to this seemingly disingenuous relationship. The lack of an enduring reciprocal relationship between the schools and iwi means iwi visits to the school may be more of a transactional relationship.

4.2.3 Iwi

Relationships with local iwi varied from school to school. Some participants had no idea how to get in touch with iwi, while others had members of the iwi teaching in the classroom next door, and still others held whānau hui. Relationships with iwi were not always straightforward, as Francis recalls, there was just one iwi in their community and the principal had "basically alienated [them]." This could put a strain on the relationship and make it challenging to attempt to collaborate with each other. Other schools had good working relationships with the local iwi or a representative who they could consult and from whom they could seek advice.

An ideal situation that Noah spoke of was having regular contact with kaumatua and iwi local to their school area. This is what they sought:

> I want them to turn up at lunchtime, have a cup of tea and walk around with the students. I want that type of relationship. So, it's normalised. Not something special.

They also said that forming a relationship with the iwi meant calling in to have cups of tea or informal visits to the iwi offices, consulting with iwi and giving them a say in the direction of the school as well as aligning the school's strategic plan with the iwi's educational plan.

Participants commented that iwi were stretched. Rachel mentioned that there are many demands on local iwi and with one or two iwi in a region and many schools making requests, it is difficult to rely on them for assistance:

> They [iwi] are so stretched. Every school wants them. Then at the same time, the Ministry wants them. Luckily, one of our teachers is Māori. So, it is easier for me to talk to him and develop what I can change within my classroom.

Francis mentioned that as they had just started teaching at a new school, they wouldn't know how to contact the local iwi, saying "I haven't, because I've not been at the school long enough. I really have no knowledge of what they do." The expectation of schools to consult with local iwi may not match the availability of iwi representatives to provide support. This could prove challenging when schools wish to contact local iwi and iwi are unable to meet these requests.

Four participants mentioned seeking help from fellow teachers within their schools who had knowledge of mātauranga Māori. In two cases the participants knew that these teachers belonged to the local iwi. As one said:

> I have colleagues who I work with who are experts in te ao Māori and I will call on them for anything that I need to know because they know. I call on colleagues [rather than] iwi because the colleagues that I work with are from that local [iwi]. (Anne)

However, just as iwi are stretched, so too are Māori teachers, as they can often be asked to carry out extra duties and sometimes without compensation for this additional work. Although teachers may wish to add to their knowledge and familiarity with their local context, they may also not know the right person to ask. This could hinder the progress of including mātauranga Māori in the classroom.

Meredith found a solution to the challenge of finding mātauranga Māori expertise for their science classes. A call was put out for any whānau with local knowledge at the start of the course and the response was pleasing as several whānau members offered help with resources, guest speakers and making connections to experts in the field. For this participant, seeking community support had its advantages as they were able to contact experts and their

request for assistance was answered by the whānau and community. Meredith said:

> I'm not an expert in this, [does] anybody want to come in and help [or] speak to the class? I've got good buy in. [A parent said,] "Someone I work with is an expert on rongoā and, maramataka, I can bring her into the class."

Sometimes all that is needed is to ask for help and this can lead to a good response from the community.

4.2.4 Section summary

Connecting and maintaining contact with iwi can be challenging and take time, however, the participants felt it was worth the effort and beneficial. They saw the incorporation of mātauranga Māori in science as a way of fulfilling their obligation to the *Treaty of Waitangi*. They were clear that this was not to be done in a superficial way, but with genuine intent and as a means of achieving a bicultural partnership in Aotearoa New Zealand. In some schools an overlap between iwi and staff meant that local knowledge was already present.

4.3 Two knowledge systems

4.3.1 Introduction

This section examines the importance of science education and participants' insights on the benefits of learning science. The two knowledge systems, Western science and mātauranga Māori, are also discussed as well as participants' different views on these two systems. Three suggested perspectives are mentioned here: everything is science, mātauranga Māori is science and mātauranga Māori is more than science.

4.3.2 Science is important

Participants thought that science was a necessary part of the curriculum for a number of reasons. Francis said, “Science is how we live our lives. [It’s] how things work in our everyday lives. You can kind of spike that curiosity into the why, and science does that.” This participant sees science as an all-encompassing and curiosity-prompting area of learning. Meredith said they enjoys teaching science and said, “[I] like the connections to other subjects and the connections to the real world and the environment.” The link between the science classroom and other classes, as well as the real world and environment, prompts students to realise that science does not exist solely in the vacuum of the laboratory but has its real-life applications outside of the school walls. Finally, Noah stated that, “I think everyone should be doing science, [at least] to level one, because that preparation and knowledge [is] general science knowledge for life.” It is evident that these participants view their role as teachers as more than delivering the science curriculum. They want to spark curiosity, link their students to the world and environment and give them the preparation they need for life.

4.3.2.1. Preparing students for future careers

All of the six participants agreed that science education prepares students for future careers. Anne said that science “helps shape the future generations and leads to pathways into future careers.” Ted had this perspective on considering and responding to the range of student motivation for taking science:

> [There are] students who want to know some science and have a general knowledge of science that makes their lives better. And then [there are] students that really have a very specific pathway in science because they need it to go on to do what they're doing next, whether that's some kind of tertiary education or some kind of vocational education.

Students’ diverse needs may be a consideration when designing courses and lessons. On the one hand, the content knowledge is necessary for those hoping to pursue a career in science, while on the other hand, students who have a general interest in science but are not planning to follow a science career pathway may rather know about how science applies to everyday life.

Ted saw benefit in linking community members with careers in the science sector with students in the classroom. For students to see a real-life scientist and form that connection between what happens in the classroom and a potential future career can be important. Some students may lack awareness of the range of career options in the sciences. This connection with the community and exposing students to people who have science careers can begin the conversation about career options and plant the seed for further exploration into careers in science. Ted said, “I think that was really beneficial for the community and linking up students to what happens, what their career paths could be, and what other people are doing.” This could enable students to make the link between what they are learning and how it could apply to a career or life in the future.

Meredith mentioned that although students may not choose to follow a science-related career pathway, having a good foundation of science knowledge would benefit students in their chosen career pathway: Students need science to succeed in our economy, and the better they perform in science, statistically, the more likely they are to have careers that are going to help them. Although students may not be driven to pursue a career in science, they could benefit from being exposed to different possible science career options.

4.3.2.2 Healthy living

Four of the six participants mentioned learning about leading a healthy lifestyle as a purpose of science education. They saw their science instruction as directly impacting students’ lives in this way. The participants believed that students with basic scientific understanding could apply that knowledge to improve their lives. Noah commented that students could take an active role in their lives:

> Rather than just going about their lives, day after day, and not really understanding why things are happening around them or why things change. Understanding things like health care and medication.

Being able to understand aspects of our lives and think critically about them rather than just accepting without question what is occurring or the choices that we make for ourselves seemed important to these teachers. Rachel asserted

that being able to use the available resources to keep healthy and protect your whānau were advantages of having a science education, saying "you have good veggies coming in winter like broccoli, cauliflower and cabbages and they are high in vitamin B. You can grow that. So, you don't need to go to the market to shop for processed foods every time." The teachers also believed children could transfer that knowledge gained in the classroom home to their parents and help them make wise choices in nutrition and choosing a healthy diet, as Rachel stated, "And if you teach our kids how to read the energy, the calorie value on the back of the process food, our kids can teach their parents." In this way, as students share what they have learnt, the whole family benefits.

The participants felt that being able to understand your own personal health and development is an important aspect to living a healthy life. As students gain greater independence and have money to spend, choosing healthy options is important and sets them up to establish good habits that will benefit them in the future. Ted mentioned:

> [It's about] your own personal health... what's going on in your body, how your body works, but [that] drinking V every morning for breakfast is not the best thing in the world. Or what's going on with your body changes as you go through the path of life.

Understanding your body, what is needed to stay healthy, and choosing a balanced diet is important. Applying science knowledge learned can empower students to live healthier lives.

4.3.2.3 Decision making.

Participants were concerned about the information that students are being bombarded with today. How do teachers prepare students to determine for themselves whether information is reputable or not? Ted felt that arming students with the tools to think like scientists and make good decisions now and later in life was a valuable outcome of science education. Ted said, "[science is] being connected to the whole world that surrounds you, and things that are new, being able to make scientific decisions or decisions based on scientific rationale."

Being able to sift through news and media hype and apply some understanding of science is an important skill. Francis recalled:

> When you saw the misinformation that came out through COVID, just having even a little bit of understanding of what science is about, so you can have that understanding when things like that happen, you don't have to have that [much] in-depth knowledge, but just the understanding of how science works.

Francis felt that providing this basic understanding was vital to ensuring that students were not going to be persuaded by misinformation.

4.3.2.4 Making science accessible for all.

Making science accessible for all students is important. Ideally, the science classroom is a place where all people, regardless of their gender or ethnicity, feel welcome. Four participants felt that providing contexts where students could see themselves in science was important and helped foster inclusivity. Anne said, "It's more meaningful to them, because they can see the context, see themselves in that context and people before them, such as their ancestors."

The New Zealand Curriculum (NZC) positions science as a fundamental learning area and therefore all students are entitled to learn science through their schooling until at least the age of 14 years. Meredith spoke about how at their school the applied health science course did not lead on to further senior science courses. They considered that this course narrowed student career options and therefore was putting students at a disadvantage:

> The majority of the health science course was Māori and Pasifika students, and this is not equitable. If we've got a course that is limiting in terms of its career options, that's not okay.

Accommodating students with their varying degrees of interest in science is challenging, however it also ensures that students are not disadvantaged or limited by a course. Meredith said, "We created a Māori and Pasifika science course that gives mana to Māori and Pacific science knowledge as well as

teaching the three main sciences and the material needed for [students] to continue."

In summary, science education appeared to be essential to prepare students for life for the participants in this study. Science content knowledge may be necessary for a future career in science for those who choose to pursue one. Although students who go on to work in science are in the minority, all students need to live a healthy life, and the participants suggested that science education helps prepare them to be aware of how diet and exercise can lead to a healthy lifestyle. Apart from living well, the skills to evaluate information and think critically about choices is another way that science prepares students for life. All students need to feel that they can access science without feeling marginalised.

In the next section, the perceptions of knowledge systems are examined as well as teachers' understanding of the relationship between Western science and mātauranga Māori.

4.3.3 Perspectives on knowledge systems in science

When interviewing participants, responses differed on what science meant to each one and how they negotiated mātauranga Māori and science. There were three main beliefs: everything is science, mātauranga Māori is science and mātauranga Māori is more than science.

4.3.3.1 Everything is science

Participants who believed that everything is science thought that science encompassed all parts of the world and especially what happens in students' lives. They used these everyday situations to tap into students' prior knowledge and help students to realise that they already do science. As stated by Rachel:

> My kids are born into it. I'm only highlighting it when I retell them. They know it. I'm not teaching them. I'm just reviving their knowledge. I don't have to teach my kids; my kids know it.

This response offered an interesting insight into the participant's view of knowledge and teaching. It exemplified the belief that students bring their own

life experiences into the classroom and that the teacher’s role is to unlock what the students already know. Ted agreed that science was in every part of life:

> [Science is] everything that's around you. So, the clothes you wear, the food you eat, the air you breathe, the country you live in, it is everything. So, you'll have students that will say, “I can't do science or chemistry,” and I [say], “well, but you've just baked these amazing cookies or cakes, you've just done some science.”

Rachel believed that there was nothing to distinguish Western science and other knowledge. They said, “So, when people talk of Western science and ... there is no western; there is no eastern. Science is science, but the way you project it is different.” Noah maintained that mātauranga Māori, although not always scientifically proven, does have value:

> I believe science is science, science is truth. The perspectives from a Māori point of view or from a Pasifika point of view, they are perspectives. Built upon thousands of years of accumulated knowledge, but whether that knowledge is proven through the scientific method, is debatable. But is it without value? No, because it allows you to see through someone else's eyes. So, when you look through someone else's eyes, you can have empathy.

This opinion may be perceived as placing Western science as the superior of the two knowledge systems and in this participant’s view, Western science validates mātauranga Māori, thus validating some parts of mātauranga Māori as scientifically valuable and others less so. This participant did, however, agree that mātauranga Māori was valuable in the regard that it helped students to view the world through a different lens and develop empathy.

4.3.3.2 Mātauranga Māori is science

Some participants who believed that everything is science also believed that part of mātauranga Māori is science. Māori have developed scientific understanding through their many years of observing nature, as Rachel commented:

> Because when you look at the how Māori gathered their knowledge, which is mātauranga, [they did this] by observation. And what is key in science? What are the scientists doing? Aren't they observing? And their observation, they put it under the word of scientific fair testing. Isn't that what our ancestors did? So, what is the difference?

Rachel saw mātauranga Māori as science as it is based on observation. There are some areas of mātauranga Māori which could be viewed as superior to Western science. Francis mentioned this in their interview: “Reading about kawakawa balm, if you try to extract it in a Western way, it doesn't actually work.” For these participants, there is no debate about whether mātauranga Māori belongs in the science classroom, they believe it does.

4.3.3.3 Mātauranga Māori is more than science

One participant recognised mātauranga Māori as more than science. Meredith stated, “[mātauranga Māori is] any knowledge from the ancestors, regardless of what it's about. And that's so varied. It might be about language, tikanga, the environment, arts, or about law. And then those aren't siloed, they're all interconnected.” Mātauranga Māori includes other areas such as culture, language and spirituality. Some aspects of mātauranga Māori are easily incorporated into the science classroom, however, other areas may be difficult to negotiate. Mātauranga Māori is dynamic and evolving, not static or fixed. Meredith described it as:

> It's an understanding of how the world works from a cultural perspective. And it looks different to different iwi to different hapū, even within whānau. And it's something that's alive today. And it's not just something that is studied as an artifact of history.

It is not just limited to knowledge of the ancestors; it continues to be added to today and will continue to develop in the future. It is difficult to dissect one element of mātauranga Māori from another, which may be why accepting mātauranga Māori can be difficult and viewing the world from a Māori perspective can take some getting used to.

The interaction between the two knowledge systems is an area that is stimulating much research and argument. Meredith was especially interested in how the two systems work together and said:

> The interface between Western science and mātauranga Māori is really my area of interest and for students to understand that there are multiple ways of seeing the world, that there are multiple sciences is important, because then they understand both knowledge systems better. So, they can understand that Western science is a cultural knowledge system, just as mātauranga Māori is, and that [each has its own] rules and features. We don't use one system to criticise the other.

Negotiating the interaction, relationship, overlap between Indigenous knowledge (mātauranga) and Western science does bring up more questions than answers and is not straightforward. There are also many considerations when navigating these knowledge systems which may be why some participants prefer to view everything as science.

4.3.4 Section summary

Participants saw the benefits of science education as preparing students for later life and possibly careers in science, ensuring that all students could make choices that lead to a healthy life and think like a scientist to make good decisions for themselves. Choosing a good diet, thinking critically about information in the media and science learning is fundamental in preparing all students to live a good life. They believed mātauranga Māori brought valuable elements that could provide engaging context for learning science, a way for students to apply Māori concepts such as kaitiakitanga and whanaunatanga to science learning as well as acknowledge mātauranga Māori such as rongoā or celestial navigation as a contribution to the body of scientific knowledge. That mātauranga Māori is a knowledge system of equal value to Western science.

Participants' perspectives on the interaction between the two knowledge systems ranged from considering some aspects of mātauranga Māori valuable and including these in the science classroom, that there was no difference

between mātauranga Māori and science, everything is science and finally, science and mātauranga Māori are two knowledge systems and could be used to give different perspectives and offer different explanations or even solutions to real world problems. The participants' views impacted how they included mātauranga Māori in their science classrooms.

4.4 Schools

4.4.1 Introduction

In this section, the focus is on findings related to the schools and how they impact the inclusion of mātauranga Māori in science classrooms. These primarily focus on the teachers, how they build confidence to incorporate mātauranga Māori in their classrooms, how they balance science content with Māori contexts, and areas of professional development that they have accessed. The school environment and how this provides opportunities for education outside of the classroom and mātauranga Māori projects is mentioned as well as participants' impressions of how their students have responded to mātauranga Māori in the classroom. Finally, the range of approaches that participants have adopted and examples of mātauranga Māori that were included in their science classrooms is also highlighted.

4.4.2 Confidence

Confidence is fundamental to the success of including mātauranga Māori in the science classroom effectively. For teachers to be able to incorporate mātauranga Māori in their science classrooms, they need to be familiar with te ao Māori [the Māori world]. This is a unique way of teaching that one may gain over years of experience. However, it may be difficult to understand and define what a teacher needs to include mātauranga Māori in their science classroom while balancing it with teaching science content successfully and being sensitive to valuable cultural elements.

Four of the six participants interviewed said that they were confident to deliver mātauranga Māori in their science classrooms. For example, Rachel said, "My

understanding of the culture and my subject is strong. It is not superficial, and that's why I can create innovative ways of teaching." In addition to having a firm scientific knowledge, it is not surprising that three out of these four participants were experienced teachers and had time to develop their knowledge of science and te ao Māori, over a period of more than 20 years. Their commitment to learn and adapt was a key element in the implementation of mātauranga Māori in the science classroom. Ted described how their school encourages staff to begin teaching by engaging with the students and following their interests rather than a set unit plan:

> We don't actually have unit plans, particularly in the junior level. We'll have a rough idea of what we want to do. At the beginning of each class, we'll ask the students what their interests are. What do they like doing, and why did they choose that class? What is it they're thinking that's going to happen? And you try and incorporate that into your class.

Meredith explained how her department 'plays' with the curriculum: "In terms of the combined curriculum, we've been doing that as well. So, it's a little bit of us just playing based on research and Ministry guidelines." Meredith's choice of words may indicate how the department feels about breaking the mold and experimenting with a new course design. Being open to play could demonstrate a level of confidence, openness and flexibility to apply new teaching approaches.

Rachel said, "If we don't use the culture, the mātauranga Māori or the Pasifika culture, if we don't relate to their experience, what are we doing? We're doing a superficial [job and] bombarding them. That's not learning." This statement reflects the way they believe they are always continuing to learn and adapt their practice to engage the students. This learning is ongoing, as Meredith stated, "it's just all about continuing to learn." It is evident that teaching is a process of learning, and as they apply new methods of teaching, their confidence grows.

4.4.2.1 Te reo

One of the areas that participants focused on in their learning journey was the acquisition of te reo Māori. Participants relayed that a combination of scientific knowledge along with Māori language knowledge provided teachers with confidence to include mātauranga Māori in their science classrooms. Rachel enrolled in te reo Māori and tikanga Māori courses for several years and had this to say regarding using te reo in the classroom:

> I take pride in learning and doing it correctly. And the kids also reciprocate that, because they know it is not superficial; when people say a karakia [and] they can't even read it. Don't do that. If you really mean it, learn how it is pronounced and then do it. If I can't say it properly, I would rather not say it and not disrespect the language.

Achieving confidence to include te reo Māori is not always straightforward and everyone's experience can play a part. Although Noah is Māori, their upbringing was in a "European world." When Noah recounted the story of their childhood and the absence of reo Māori from their homelife, there was a real sense of regret and sorrow of what could have been. Although Noah was confident to include aspects of mātauranga Māori in science, had designed units of work, organised a revitalisation of a nearby stream, the strain in their voice was clear when they shared that, "One of the things I regret the most is that I can't speak te reo, I can't speak my own language, and to me, that's heartbreaking." Francis related that ākonga Māori were most pleased to hear te reo Māori being used in the classroom that they offered corrections to help them improve their pronunciation. Francis welcomed the correction, and the students felt that they had the mana to be able to correct the teacher without fear of retribution, as Francis said:

> I had students that when I started to try to use it [Māori language] normally, they were amazing, because they would correct me. I had a few students that were on my case if I didn't, which was great.

The underlying message here is that Francis, in their attempt to use te reo Māori, has demonstrated respect for Māori tikanga by allowing ako to take place. This

interaction showed how receptive Francis was toward the students' correction of their attempts to use of te reo. Confidence among teachers varied depending on several factors: their ability to use te reo Māori and pronounce the words well, understanding of Māori culture, traditions and practices and support from school, colleagues and students.

Three participants made the comment that they felt comfortable making mistakes, failing and trying again. As Meredith said, "So, I am just a learner, continuing to learn. And people say, are you fluent? But I think with any second language, fluency is a bit of a myth. And it's just all about continuing to learn." Noah echoed this sentiment and felt encouraged to continue learning te reo Māori, "I am deeply heartened when I hear the message from different circles, what makes you Māori? Well, your heart is what makes you Māori, right? It doesn't matter where you are in your journey, but as long as you're positive and you want to be part of it." Their attitudes and willingness to put themselves in the place of the learner meant that wherever they were on their learning journey, they were their authentic selves. They indicated that they were not trying to be something that they were not, and did not assume authority on Māori language or tikanga, and that they were comfortable with that.

4.4.2.2 Tikanga Māori

Te reo Māori is one important aspect of te ao Māori, however, tikanga Māori [Māori customs] is also important and an effective way of including mātauranga Māori in the classroom. Ted said, "Languages are not my thing. I find them difficult to work out." However, they did mention that although pronunciation and vocabulary were challenging, nevertheless, they resonated with Māori values and preferred to include these as an aspect of mātauranga Māori rather than focus on te reo Māori. As said by Francis, "I try to learn the respect of the concepts, and that's what I take on board and incorporate that respect into what I do...then bring those concepts of whanaungatanga and kaitiakitanga [in my classes]."

Participants who had not been born in Aotearoa New Zealand were able to find similarities between Māori culture and their own culture. Two participants were

born outside of Aotearoa New Zealand and came to Aotearoa New Zealand as adults. This did not deter them from learning about tikanga Māori. Rachel was able to relate tikanga Māori to their own culture:

> In Māori [culture], they do not touch the head, but in [my] culture, when you touch the head of a child, you're blessing them. That [is similar to] Māori tikanga when you're blessing things you hold it with your hand. In [my] culture, you're passing on your strength, your energy into it.

Ted, who was also born overseas said, "Well, I tend to feel I'm completely rubbish at it because I am not from New Zealand." It is evident that Ted felt that they could be more confident and that not having grown up in Aotearoa New Zealand impacted on their level of confidence. However, they were open to learning and interested in finding out more.

Anne reflected on how they felt it would feel to be a non-Māori incorporating mātauranga Māori in the science classroom:

> For me, it comes naturally, but you know, if I wasn't Māori, and I didn't grow up in my te ao Māori, it would be even tougher. Just learning to make those connections and learning about te ao Māori at the same time would be very hard. I'm very fortunate to have grown up and to learn about my te ao Māori, because if I didn't have it, I feel I would be lost [when] teaching mātauranga Māori.

This statement shows the depth of te ao Māori and how it could take a lifetime to thoroughly immerse oneself in.

4.4.2.3 Journey

Often the most difficult part of a journey is taking the first step. Four participants feared being tokenistic in their approach to including mātauranga Māori in science. They felt that "ticking boxes" as Francis said, or "making it cliche," as Meredith mentioned, dishonoured Māori culture. However, participants were willing to make their first attempts and start with what they knew. Later, as they progressed, they felt they were able to begin to fill in the gaps where their lack of te reo Māori, good pronunciation or understanding of tikanga Māori have left them feeling inadequate. Francis said:

> You have to incorporate an aspect [of mātauranga Māori], and at the moment, it is just ticking a box. I think, as we go, as we learn how to look at it and incorporate it better [and] it will become more authentic. But at the moment, I didn't really feel it was terribly authentic.

Anne, a teacher of Māori descent, who was brought up in te ao Māori and speaks te reo Māori, also felt that they could learn more and improve. Anne felt that learning the stories of the local iwi was of supreme importance and said:

> I find it's my duty as a Māori and as someone in that district, that it's my duty to teach that area's history, because they've allowed me to be here. I would not feel good if I was teaching something not relevant to the area.

This comment exemplified the diversity that exists between iwi in different regions of Aotearoa New Zealand. It would be incorrect to assume that a teacher of Māori descent will have knowledge of all iwi narratives and traditions.

Half of the participants described how their perspectives have changed since starting their learning journey into mātauranga Māori. As they learned more, their ideas evolved, and they gained confidence in their approach to including mātauranga Māori. They also mentioned how, even though they may have been learning for many years, they continued to see themselves as learners. As Meredith described their learning journey:

> I started, learning te reo [Māori] and when I first started learning te reo, I thought that that was it and then I started learning about the different areas of mātauranga Māori. I did the course with Ocean Mercier at [University of Victoria], the Pūtaiao course. That was a real eye-opener, at a high academic level of understanding of the interface between Western science and mātauranga Māori. It's probably just made me more confident.

As participants continued their journey, they accepted that it was difficult to learn everything overnight, and that it was acceptable to fail and try again. They

also acknowledged that their initial views sometimes changed and evolved as they continued their journey.

4.4.2.4 Balancing content and context

Participants said it was often difficult to maintain a balance between including the contexts that were interesting and ensuring that students have the basic content knowledge that they need to succeed in higher science levels. Meredith’s school embraces innovation and they stated:

> Everything is a pendulum. And we've swung quite far into teaching cross curricular [and] doing projects. But I think actually, we've gotten a little bit too far away from having structure, routine, good literacy and numeracy practices, all of those things. So, we're kind of on the swing back.

Francis has observed the range of different approaches, having taught in three schools and this is their opinion on why they think that students can sometimes be put off science when it is mostly focused on content:

> Even though you’ve got the curriculum there, it is quite broad, and it depends on each [schools’] science leadership. You definitely have to keep current and make it relatable to them. So sometimes science struggles to do that if you haven't got the right programme in place, I think that's what turns a lot of kids off science.

Anne mentioned how the context can make science real for the students in their school:

> They're engaged, it's more meaningful to them, because they can see the context, see themselves in that context and people before them, such as their ancestors. They can make those connections. Sometimes when we just teach them acids and bases, there's no connection for them.

Anne and Francis commented on how the context for learning could make the difference between a student engaging with science or feeling that it was boring

and irrelevant to them. Finding this balance of content and context is one of the most challenging parts of including mātauranga Māori in science.

4.4.2.5 Getting better

All participants interviewed were committed to continuing their professional development to get better at including mātauranga Māori in their science classrooms. Although the ways each person carried out this learning differed. Participants found support from colleagues, other science teachers and staff with knowledge of te ao Māori within their schools. Quite often assistance was available in their own schools. Colleagues as well as whānau and even students were willing to provide ideas and share expertise. Rachel described the process of initiating new teachers to the school:

> The first step is we do a pōwhiri or a mihi whakatau for them. Every Monday, we have the karakia [and] we have a school whakapapa. [We sing the] school song every Wednesday [and] we practice our school haka. If they're new [and] have not learned it, our students teach them.

This is a lovely example of embedding regular professional development and making it normal and routine. These practices of karakia, whakapapa, waiata, and haka are regular occurrences at Rachel's school. Teachers will continue to grow as they take part in these activities.

Not all participants were able to access assistance in their own schools. However, they were able to source information needed to include mātauranga Māori in their science classes. Anne said, "I read some of Ocean Mercier's [work on] mātauranga Māori, and she's got a [Project Mātauranga] on Māori Television," where mātauranga Māori is showcased and reported alongside Western science knowledge. Francis studied to improve her te reo Māori and said, "I did the level two [te reo Māori course] last year, Te Rekamauroa." Noah commented, "Through Enviroschools, I worked with [the facilitator] who made contacts for me and brought in people who were experts in the areas of, like rongoā garden, Māori medicine." Online resources were also useful, especially the Science Learning Hub, as Ted said, "Science [Learning] Hub, they've got some great resources, and great stories and articles there." In summary, teachers

learned through a variety of avenues: In–school professional learning and development (PLD), te reo and tikanga courses, university papers, Enviroschools, the Science Learning Hub, as well as others.

4.4.3. School environment

The school environment was mentioned by all but one participant and is a factor that could impact the implementation of mātauranga Māori in the science classroom. This element may need to be considered when planning for education outside of the classroom. Several participants discussed how their surroundings, school gardens, the proximity to a stream, coastline or forest, were a resource to make mātauranga Māori real to their students.

Rachel's school backs on to a swamp and the school has begun to revitalise the ecosystem:

> The entire swamp revitalization [was] done from the basis of mātauranga Māori. You are doing climate change, you are looking at the way the migration of the species happened, the flora and fauna of the land. What are [the] exotic plants?

A school stream is an asset and could be a great place for hands-on learning and engagement with mātauranga Māori outside of the classroom. It is a location familiar to the students, where science theories can be applied outside of the classroom.

Francis' school has access to farmland, and they intend to make use of the paddock. They said: "My idea [is to] create a [rongoā] garden [in] that paddock where they can see, by doing these plantings, you can increase [the] biodiversity." These kinds of activities would be difficult to carry out in other schools where the grounds do not include any natural spaces. Outdoor spaces are just one aspect of the school environment that affects how mātauranga Māori may be incorporated into science learning.

Teaching context should relate to the students' reality and the place where the school is situated. As Anne mentioned: "It's just learning about the local context.

What is an important context in this area? Aside from the streams, [we're] not close to the sea. So, doing ocean acidification, how relevant [is this to the students]?" Making the context relevant and relatable to the students is necessary to make the learning context authentic.

What may be effective in one school may not be easily applied to another. This plays out in the classroom and will impact on science teaching, as Meredith observed:

> For some schools, there is still a large focus on science knowledge, content knowledge as a pathway to succeeding in senior science, science rather than science as a way of understanding how the world works and participating in society. And you'd have a really broad spectrum in New Zealand.

The school location and its surrounding areas and the school's approach to including mātauranga Māori in classes were seen to be important by the participants. Just as schools vary in their environment, so too do students in their levels of engagement with mātauranga Māori in science, and this is explored in the next section.

4.4.4 Students

The participants reported that they had experienced a mixture of student feedback when including mātauranga Māori in their science classrooms. Three of the six said they received negative feedback from students when including mātauranga Māori in science class. They reported students made comments that led them to believe that the students did not see the value in learning mātauranga Māori in science. Francis mentioned students' attitudes as one of the biggest challenges to overcome when incorporating mātauranga Māori:

> [The] attitude of the students. That's the biggest one. Definitely. The non-Māori students often have a very interesting view of incorporating Māori [in classes] and it's along the lines of, I don't need to know that. Why do I need to know that? (Francis)

Anne who has experience teaching in both a mainstream English medium school and a Kura Kaupapa Māori mentioned that “I find that I used to get backlash at mainstream schools about learning about mātauranga Māori and why is it important.” Valuing Māori knowledge and making it part of science learning is not always accepted in all schools and participants reported that students readily expressed these opinions in class.

Finally, Ted suggested that the incorporation of mātauranga Māori be more understated saying “You need to be subtler with it [mātauranga], and just do it as a way of life. Rather than saying, this is mātauranga Māori, you know, because they don't like that.” The incorporation of mātauranga Māori can take many forms and infusing the classes with subtle elements of tikanga could be an effective method of doing this. Francis incorporated the Māori concepts of hauora into their science unit, stating “[We did] the body systems: the lungs and the heart and things and then looking at the hauora, aspect of breathing and [the] heart.” Francis presented the body systems and their physical parts but also went on to describe how hauora is more than solely the physical but encompasses other aspects of wellbeing.

Not all the feedback from students was negative. Half of the participants reported that their students enjoyed learning about mātauranga Māori in science classes. These teachers mentioned how student engagement increased with the incorporation of mātauranga Māori. As Francis stated:

> I certainly did see the increased engagement from my Māori students with some concepts. [One student] lived on the river, and just learning about how the local people used the river, she got really into it. And it's just so amazing to watch.

Being able to see themselves in context within the science learning made a difference to these students. Noah, who had planned units of work that included elements of mātauranga Māori, said, “Where there were links back to [mātauranga], the rongoā garden, dyeing or navigation, the kids loved it.”

The other half of the participants mentioned that they received mixed responses from the students. Some enjoyed it, as Meredith commented: "Make it interesting for the students. In the past, we have had students [that say], this isn't science, what are we doing? If you make it engaging, they're more likely to believe it." Each teacher reported including mātauranga Māori in a way that meets their school and students' needs.

4.4.5 Approach

All participants interviewed believed that mātauranga Māori had a place in the science classroom. However, approaches varied from school to school. In some schools, there was collaboration with local iwi and the wider community outside the school gates. In others, a school-wide approach existed and in others, the science department had its own goals and suggested approach to incorporating mātauranga Māori in the classroom. Still, in other schools, although there was an understanding that mātauranga Māori should be included in all subject areas, participants reported that there was no official plan or guidelines for implementing this.

4.4.5.1 School-wide approach

A school-wide approach was in place for half of the participants interviewed. Three participants had clear directions from their senior leadership team of the school's approach for including mātauranga Māori in the classroom. There was a school plan that incorporated iwi goals, school-wide contexts and a unit planning document to help teachers authentically incorporate mātauranga Māori in their subject classes. These schools had their own way of implementing the inclusion of mātauranga Māori in their classes. Each approach was unique and had been chosen by the school for themselves. The teachers from each school referred to this plan, which meant they were given guidance and a known direction outlined by the leadership of the school.

A school-wide plan was developed in a school where the leadership team worked together with local iwi. Noah said, "this plan is our college vision, goal and our commitment to the Treaty. [It includes] the critical outcomes, the college

projects and alignment with [the iwi's] educational plan." This is a good example of cooperation between school and iwi and combining the school vision with the established iwi educational plan. Noah went on to say:

> [The] school design, architecture, our logo, [the] kowhaiwhai, [the] long panels that are built into the school, that's all done in conjunction with [local iwi]. So, all of this is not random. All of this has been done by the local iwi from the beginning.

This school had only recently been founded and was just beginning the process of establishing school values and traditions. As it was still in the process of laying down its foundations as a school, developing a relationship and connection with the local iwi was critical. Noah affirmed that the school was investing time in forming a relationship with the local iwi and said, "We're going down and we're having cups of tea and doing nothing else, we're [just] having a cuppa." Noah's regular visits are a way of establishing a relationship with iwi.

Anne explained that their school adopted four school-wide contexts for the course of the year. Each term, the whole school would focus on a different context and the teachers were asked to include that theme in their classroom teaching. As stated by Anne, "[We] have school wide contexts that we have to teach to. They ask us to incorporate mātauranga Māori into these four contexts." Teachers have the freedom to choose how to incorporate these contexts in their own classrooms. This approach allows the whole school to be able to integrate learning across the curriculum and tie into a common topic or context, which related to tea o Māori.

Another school has developed a unit planning document that provides guidance to assist teachers with planning of lessons and units. This document, Meredith said, "helps guide you through your planning in terms of mātauranga Māori." It also asks teachers to consider what their context is, how this relates to the subject content, "to not get trapped by some of those easy things, like making it a cliche, or not presenting who your expert is" (Meredith). Finally, the unit planning guide seeks to relate the learning to ātua, pūrākau or whakapapa to situate the learning in te ao Māori. By providing this framework, staff can avoid

the pitfall of being superficial in their approach and learn the process of seamlessly including mātauranga Māori in their classrooms.

4.4.5.2 Departmental approach

A departmental approach was taken by other schools. Meredith commented:

> We've made it part of our goal. That every course has [a] meaningful mātauranga Māori component. It doesn't need to be in every topic. We try and make [sure] every course has got [it].

This science department has developed their own matrices including mātauranga Māori alongside the nature of science components. The school also provides a unit plan template to facilitate and guide teachers in their inclusion of mātauranga Māori in their units. They have not forced mātauranga Māori into every lesson as sometimes it just does not fit.

In Anne's school, where there are just two science teachers in the department, they collaborate and discuss methods for tailoring science to meet students' interests, meaning they "just bounce off each other." The benefit of consulting with colleagues is that they are readily accessible, familiar with the school context and are teachers themselves. Therefore, departmental collaboration can be an effective method to implement mātauranga Māori in science classrooms.

4.4.5.3 Individual approach

Three participants reported that in their schools the unofficial expectation was to include mātauranga Māori in the classrooms. However, little guidance from the school was provided on how to achieve this. In which case, different teachers incorporated mātauranga Māori as they saw fit. On the one hand, this allows teachers autonomy and freedom to use their own creativity and initiative in their classrooms. However, it may inhibit others who need guidance to begin the journey and would prefer to work within an established framework to avoid guesswork.

Ted recognised the variance between how elements of mātauranga Māori are implemented depending on individuals' strengths, saying, "Each teacher incorporates it in the way that seems right to their class and the subject that

they're teaching and the year level that they're teaching." Ted viewed the diversity within the teaching staff as a resource that added richness to the students' learning experience. For Ted, they saw the variety in teaching styles as a benefit of each person's unique qualities.

Francis, who had just started a new role in their current school less than a year ago, made this comment regarding a school plan: "I've not seen anything." Ted reported that, "The official, broad sweeping line is that every class should be incorporating [mātauranga Māori]. But how that happens is left entirely up to us as individuals to try and make that work." Finally, Rachel commented, "Yes, we all do it naturally." When the school does not have a procedure or method of incorporating mātauranga Māori into classrooms, variations may exist. There may be a great variance between teachers in the method and approach adopted in integrating mātauranga Māori in the classroom.

4.4.6 Examples of mātauranga Māori in science

An exciting part of this study was hearing about how mātauranga Māori is currently being incorporated in science classrooms. A variety of different approaches were taken, and participants often learnt through trial and error to discover what works for the students. Reflecting on their practice, changes were made, adjustments on how information was presented or expertise accessed. These changes made for improvements in subsequent lessons or units.

4.4.6.1 Cross-curricular learning with a thematic approach

Rachel described a cross-curricular approach of including mātauranga Māori. The hangi was the chosen context of this cross-curricular learning activity. Each department selected subject content related to the thematic topic. Rachel described how students learn about the Māori process of preparing food in a hangi:

> The hangi and umu, which we do for our heat transfer, we teach them the conduction, convection and radiation. And we have our matua here [and] the kids would be involved in digging of the pit, they would measure the pit, how much soil was removed. And then they cut the

> veggies and the meat, and they know what goes first. And then they use a thermal camera with Callaghan Innovation [science organisation] to measure the temperature of the fire.

They learn about heat transfer, said Rachel, “We used to teach them the conduction, convection and radiation” in science, they test the specific heat of different rocks or how they retain or transfer heat energy, thus cooking the food. In maths, students learned to calculate the volume of earth removed from a hangi pit. In technology, Rachel said, “[they] designed an invitation for their parents. And so that was part of their technology.” The students, Rachel went on to say, “Performed a pōwhiri for their parents for the evening. So that came under Māori performance and in the marae, the speeches were [said] by our boys and the karanga by the girls.” Following Māori tikanga, Rachel shared that students contributed ingredients for the hangi: bread or vegetables or other ingredients. The learning culminated in a day when the whole year group spent the day outside the classroom: the students prepared food, dug the hangi and finally, served the meal to their parents. This Māori practice of cooking using the hangi allowed the whānau to see their children achieving the learning outcomes while celebrating their culture.

4.4.6.2 Common topics included in science classes

Common topics used to include mātauranga Māori in the science classrooms were flax dyeing, celestial navigation, rongoā, and maramataka. These topics were included in various ways. Maramataka was a topic which was included by three of the six participants interviewed. In Ted’s school, the students compared how well their plants grew depending on the calendar with which they planned the planting times. Ted said, “We were growing some [plants], and we used different calendars to try and do that to see whether they’re growing or not.”

Harakeke and the dyeing of flax leaves was another topic commonly used in science classrooms. In Anne’s school, this included learning the karakia that is performed before harakeke is harvested and learning about Hine-rehia, the Māori ancestor, who wove and plaited the flax. Anne noticed that the students responded well to this context for learning chemistry and how it related to the

dyeing process. The lesson was not only put into a Māori context, but the tikanga or traditions surrounding the practice were shared and the students could see themselves in the lesson. Anne said:

> It shows the students the process of acids and bases and chemistry. So, they go and learn how to cut the harakeke, that comes with all those traditional practices, which the students learn.

4.4.6.3 Special course design

Meredith's school did a complete redesign of the junior science course to include mātauranga Māori in science. The course combines te ao Māori and junior science. Meredith described the class:

> [It is] called Maramataka and we're building a year long, seasonal Maramataka for our region, [specifically] for our school. [We will be] observing the same species, the same plants and animals over a year and then saying, what's happening at what time? What food needs to be gathered? How does [the garden] need to be looked after? And then learning about the Western science and the mātauranga Māori of those.

The class takes advantage of the school's location and access to natural spaces as well as longer class periods which allow for deeper learning and hands-on activities, "It's also quite generous in its time allowance. I get three 75-minute sessions with them a week. [Which] is quite a lot. We do all sorts: gardening, cooking, [field] trips. Last week, we foraged seaweed" (Meredith). This approach allows mātauranga Māori to be combined with in science, provides flexibility with timetabling, and crossover between subject areas.

4.4.7 Section summary

Teacher confidence is fundamental to the success of including mātauranga Māori effectively in the science classroom and can be fostered through professional learning. Participants said that learning was a journey and as they learned more, their views often changed and evolved. The unique school environment allows for different approaches to be taken depending on the resources that are accessible to each school. Participants reported that students' attitudes ranged

from rejecting mātauranga Māori as not part of science to increased engagement being able to see themselves in science. How each of these teachers implements mātauranga Māori in their classroom is varied. Schools appear to choose their own approach which suits them.

4.5 Chapter summary

Participants in this study saw the incorporation of mātauranga Māori in science classes as a step towards achieving a bicultural partnership in Aotearoa New Zealand and acknowledging the *Treaty of Waitangi*. Connections with iwi, hapū and whānau were key and in some schools an overlap between iwi and staff meant that local knowledge was present. Although iwi can often be stretched in their time available, participants felt that making these connections was important.

Participants viewed science as a beneficial part of a student's education that prepares them not only for life but also for possible future careers. They shared their perceptions of science as a knowledge system and how they reconciled mātauranga Māori and Western science. Some teachers felt that elements of mātauranga Māori provided a context that was scientifically valuable while others approached mātauranga Māori and Western science as separate knowledge systesm and both equally valuable.

Teacher confidence is fundamental to the success of including mātauranga Māori effectively in the science classroom. An understanding of te ao Māori was seen to be necessary and teachers reported developing their understanding through various avenues. While they felt they were on a learning journey, they indicated it was not uncommon for their views to shift and evolve.

The unique school environment appeared to allow for different approaches to be taken depending on the location and resources that are accessible to each school. Participants reported that students' attitudes towards mātauranga Māori varied. Some students rejected mātauranga Māori as not part of science whereas participants also observed improved student engagement as they were able to connect with the content and see themselves in science

Chapter Five - Discussion

5.1 Introduction:

In this chapter, I respond to the three research questions that I chose at the outset of this research:

Principal question:

1. What are teachers' perspectives on incorporating aspects of mātauranga Māori in their year 9-10 secondary school science programmes?

Sub-questions:

2 a. How have they incorporated mātauranga Māori in their science classrooms?

2 b. How do they feel this has impacted student engagement and learning outcomes in their science classrooms?

The themes are organised in responses to the research questions, and I discuss how they align with previous research. I begin with teachers' perspectives and then move on to how mātauranga Māori was incorporated into the classroom and what effect participant teachers felt that this had on students' engagement. Finally, I present my conclusions, recommendations and implications of the research findings.

5.2 What are teachers' perspectives on incorporating aspects of mātauranga Māori in their year 9-10 secondary school science classrooms?

There are three themes that arose regarding teacher perspectives of incorporating Mātauranga Māori in their classes: knowledge systems, teacher confidence and journey. Each is explored within its section and provides insight into how teachers make sense of mātauranga Māori and Western science, grow their confidence to include mātauranga Māori in the classroom, and accept that although they may never be 'mātauranga Māori experts' they are on a learning

journey alongside their students and recognise that their own biases and preconceived ideas are part of learning and growing.

5.2.1 Knowledge systems

The responses from the participants indicated that teachers embraced the inclusion of mātauranga Māori in the science classroom and some even saw it as their duty to honour the *Treaty of Waitangi* “in order to honour the Treaty, we need to make sure that we give mana to mātauranga Māori in all of our curriculum areas” (Meredith). This motivation to embrace mātauranga Māori and weave it through all parts of the curriculum aligns with the development of refreshed curriculum, Te Mataiaho, and the Ministry’s current policy (Ministry, n.d.). As participants were purposefully selected on the basis of their attempts to include mātauranga Māori, this may account for their positive responses to the inclusion of mātauranga Māori in science classes. It is possible that another group of the teaching population could reject the inclusion of mātauranga Māori in the science classroom. However, that discussion is for another time.
Participants held diverse perspectives on knowledge systems, and some felt that science and mātauranga Māori were both forms of science. Rachel’s statement, “There is no Western [science] there is no eastern [science]. Science is science” indicates that they believe that all knowledge, as well as Indigenous knowledge is science. Other participants viewed the two as separate knowledge systems, such as Meredith’s statement, “Western science is a cultural knowledge system in itself, just as mātauranga Māori and there are rules and features of both.” Still other participants used the analogy of viewing the world through different lenses the Western lens and a mātauranga Māori lens as different ways of understanding phenomena and providing students with the opportunity to learn empathy by using different lenses.

The integration of Indigenous knowledge into the science classroom has been the topic of research and has been implemented in different fashions and to varying degrees in classrooms over the last 30 years (Stewart, 2019). This combination of Indigenous knowledge and Western science is a controversial and polarising topic. As shown by the recent events at the University of Auckland (see Chapter

2, p. 8), there continues to be a debate surrounding these two systems and how they interact. On one hand, including mātauranga Māori gives mana to ākonga Māori, as some participants noted, but on the other, some may assert that it threatens the foundations of science. Rationalising two knowledge systems, therefore, is not straightforward and if handled indelicately can cause harm. Failing to acknowledge the source of knowledge, experts, or keepers of wisdom could be seen as theft or cultural appropriation (Tynan, 2024). Stewart (2019) encourages us to view Indigenous knowledge in the science classroom as an educational opportunity. As teachers, we can start by embracing humility and respect while ensuring that mātauranga Māori is included in a way that acknowledges Māori as its rightful guardians.

5.2.2 Confidence

Teachers expressed varying degrees of confidence to include mātauranga Māori in the science classroom. Although teachers mentioned that learning opportunities and professional development helped them to feel more confident, most of these learnings happened on the job. None of the teachers stated that they left pre-service teacher education well-equipped to understand and incorporate mātauranga Māori in their science classrooms. Participants also reported that as they developed their practice, they often changed their approaches, views of education, science learning and understanding of mātauranga Māori. The participants indicated that teachers should have a go and accept that failure and mistakes are part of learning and enacting change. As Francis stated, "Being authentic is one of those things that you always question yourself about" but they said, "I've done it honestly."

Participants reported seeking professional development opportunities in the form of learning te reo Māori, tikanga Māori as well as mātauranga Māori. They also mentioned āko as a Māori pedagogical approach that they found beneficial in the classroom. Rachel mentioned tapping into students' funds of knowledge and did this by inviting students to share their knowledge of iwi practices in science class. Funk and Woodroffe (2024) addressed the gap in Indigenous knowledge that teachers working in indigenous communities in the Northern

Territory of Australia have and they concluded that applying the principles of the 3Rs Framework: respect, relationships, and reconciliation were vital and could be applied as guiding principles. However, choosing a pedagogy or approach without considering the 3Rs can be problematic and artificial. Francis indicated that they felt incorporating mātauranga when it was seen as a “tick box” was not very authentic, but with further teacher development, that it could become authentic. Nakata (2007) concurs and cautions against simply “plonk[ing] in” Indigenous knowledge to the curriculum without first considering factors about the knowledge system, as Indigenous knowledge and Western science have many epistemological differences. Assuming that knowledge is simply information can be a mistake that is easily made and result in unintended harm rather than benefit (Nakata, 2007). This is specifically what Meredith attempts to avoid in their science class, as she said, “Accidentally causing harm or making students feel dumb about what they know or don't know.” Establishing a level of teacher confidence, therefore is complex, multilayered and ongoing. Being petrified into inaction or avoiding any inclusion of mātauranga Māori so as not to find oneself being tokenistic could be a response that some teachers who lack confidence could make. Instead, teachers should boldly embrace the role of cultural broker and assist students in navigating the border-crossing from their own reality into the science classroom (McKinley & Stewart, 2008).

5.2.3 Journey

Teachers are all on a learning journey. As Francis describes the journey of learning te reo Māori, “Like to grow the kumara, [we are] growing our knowledge.” Participants all expressed their own challenges they faced. Learning te reo Māori can be challenging and as Noah said, “At this point in my life, it's very difficult now to learn a new language.” Sometimes it is not learning something new, but reflecting on what we know and do as Meredith stated, “We need to look at our practice in a different way.” Teachers must contend with and in some cases overcome their own ideas of knowledge, deeply seated beliefs about science and preconceived notions of what the role of a science teacher

entails (Naidoo, 2005). These possible stumbling blocks can make the teacher's journey towards including mātauranga Māori most challenging.
The journey is transformative, as Belczewski (2009, p. 198) proposes, teachers are not only learning as they journey but undergoing a "personal transformation." Transformation is not an easy process and involves questioning yourself and grappling with where you are and the range of feelings you experience. This transformation is something that takes place though the process of "engagement and dialog" as stated by Howard (2006, p. 6). Therefore, the act of responding to students' needs is indeed an interaction which is done *with* not *to* the learner. Ted starts with gathering student input in their science class and is flexible with unit planning, considering what students' interests are to improve engagement. Wondering, contemplation and changing one's mind is common when on a journey. One essential part of a journey is recognising where you begin and what baggage you carry with you. Meredith mentioned how their own perspective has changed with continued learning and greater understanding of the knowledge systems. Confronting challenges is all part of learning and growing and can be an uncomfortable feeling but appears to be a necessary part of the journey.

5.3 How have teachers incorporated mātauranga Māori in their science classrooms?

How teachers introduce mātauranga Māori in their classrooms varied depending on several factors including their knowledge of Māori culture and language, the school environment and availability to outdoor spaces, the receptiveness of the school population and access to resources and expertise. There were three main approaches: School-wide, departmental and teacher-by-teacher, which all had their strengths and weaknesses. There were some participants who included mātauranga Māori contexts and embedded science learning into these, while others embraced Māori values and finally others examined phenomena through a Western science or mātauranga Māori lens. Teachers adopted the method that was most authentic to them.

5.3.1 Every classroom is unique

Every classroom, teacher and school is unique and different. Therefore, there is not one single approach to introducing mātauranga Māori in the science classroom. Depending on what teachers' background and expertise were, this too impacted the form mātauranga Māori had in the classroom. As Ted noticed, teachers do things differently depending on their students and class, "each teacher incorporates it in the way that seems right to their class." Meredith observed that "Te ao Māori looks different, for lots of our students and there's different ways of participating in [it]" this may depend on the local iwi or the students' connection to their marae. Making the learning relevant to the students was another idea that participants discussed. Anne said, "They're engaged, it's more meaningful to them, because they can see the context." Schools all have different relationships with iwi and access to different resources outside of the school. Anne mentioned that the location of their school near a forest and river meant that studying stream ecology was a more familiar context for the students.

Belczewski stated that "Indeed, no two classes are the same because required curricula content is adapted continuously to different contexts using a variety of methods" (Belczewski, 2009, p. 200). For Naidoo (2005, p.12) in South Africa, the tension between local versus global science means that the 'one-size-fits-all' Western science curriculum may not meet the needs of indigenous learners. Equally, the specific local context may resonate more and be more familiar to the learners in Aotearoa New Zealand. Balancing local with global is a challenge and preparing students well to participate in science on the global stage can sometimes seem more important than ensuring that they are familiar with their unique local context. As Merdith observed, some schools "Focus on science content knowledge as a pathway to succeeding in senior science. [Other school teach] science as a way of understanding how the world works and participating in society." Naidoo (2005) mentions this 'catch-22' situation in South Africa and it is indeed a challenge which all educators face when they endeavour to include Indigenous knowledge in the science classroom in an effort to support indigenous learners. Keeping students grounded in their own place in the world

while at the same time allowing them to access and compete on a global level can be difficult.

5.3.2 Incorporating mātauranga Māori gives mana to Māori knowledge

Teachers discussed how they integrated mātauranga Māori in the science classroom and they felt that it should be more than just a tick box. Rather, they felt that it was a way to give mana to Māori knowledge, as Rachel said, "You should really feel it rather than [it being] superficial." The subtle weaving of Māori values into science learning was another technique that teachers employed to acknowledge mātauranga Māori. Ted suggested that "You need to be subtler with it [mātauranga], and just do it as a way of life." Francis says they try to "Normalise it, to make it so that it's just part of every learning." Teachers agreed that students were able to see through attempts that were sanctimonious rather than genuine, honest and authentic. The sincerity and thoughtfulness that teachers demonstrated when integrating mātauranga Māori in their science classrooms upholds the mana of both ākonga Māori and their cultural values. Expert teachers have an intuitive way of knowing how to best cater for their students (Hattie, 2012). The findings indicate that teachers trusted their own intuition and knowledge of their students and school to best introduce mātauranga Māori in science. The Children's Commissioner (2022) found that ākonga Māori in mainstream schools lacked the opportunity to see themselves and their culture reflected in their learning. The presence of mātauranga Māori in science provides mana for Māori ways of knowing that would allow students to see themselves in science.

5.4 How do teachers feel this has affected student engagement?

At the outset of this research, I hoped to find that the inclusion of mātauranga Māori in the science classroom would result in overwhelming student engagement, especially for Māori and Pasifika learners. This was not what participants reported and although evidence did support that some student engagement improved, in some instances, it was far from resounding. What I had not expected was that some feedback from students was negative and

senior science students in some schools rejected and questioned the relevance of mātauranga Māori in science classrooms at all. The rejection of mātauranga Māori by some senior science students may indicate that Māori culture in certain areas, such as language and the arts is expected, however, is less welcomed in science classrooms.

In response to the research question which asked, 'How has the inclusion of mātauranga Māori affected student engagement?' I examine this in the following three sections: stories matter, mātauranga Māori allows students to see themselves and their ancestors in science and finally, mātauranga Māori is not a magic bullet. These topics provide insight into student engagement and provide motivations for incorporating mātauranga Māori in the science classroom.

5.4.1 The power of stories in science education

The use of pūrākau or storytelling can be an effective method of integrating mātauranga Māori into the science classroom. Mātauranga Māori is grounded in oral traditions, and has been preserved, expanded on, and passed down through generations this way (Mead, 2016). In te ao Māori, storytelling is significant and connecting learning to narratives of a specific place can be an impactful way to include mātauranga Māori in science education. However, participants noted that stories are specific to each region and often treasured and protected as a taonga. This means that learning them can often prove challenging. Acknowledging the stories of a place may require a sensitive and respectful approach, as engaging with local iwi and their histories can sometimes be a complex or even painful process. Participants shared their own experiences with storytelling in science education. They observed that when students could see their own stories and culture reflected in science, their connection to the subject improved. As one participant commented, their students' enthusiasm was most evident when discussing how science related to their lives.

5.4.1.1 Each place has its own story

While the term 'Māori' encompasses all iwi of Aotearoa New Zealand, each iwi has its own distinct traditions, narratives and knowledge systems unique to their

region. Pākehā teachers or those working outside of their own iwi often grapple with teaching local stories that are not their own. As Anne, shared:

> I'm actually not from here. So, the stories that I'm teaching and learning, they're not my own. [However,] I find it's my duty as a Māori and as someone in that district, to teach the area's histories.

Anne actively sought to learn and understand local iwi knowledge of te ao Māori and took advantage of working alongside a colleague from the iwi and willing to share these stories. However, accessing such knowledge is not always straightforward. Noah remarked: "Their stories are not the story that you [read] written down in a book, because they share what they want to share. And they'll only share with people that they trust." This emphasises the importance of building relationships with local iwi and acting as a cultural broker in the science classroom (McKinley & Stewart, 2008). By basing science education in local knowledge and narratives, teachers help students make meaningful connection between science concepts and their own lives.

5.4.1.2 Stories make a difference

While participants did not report overwhelming improvements in student engagement, anecdotal evidence suggests that introducing science within a familiar cultural context sparks interest and motivation. Francis shared their experience of teaching about rongoā, "It's so amazing to watch students who really, up to that point, don't put any effort into anything. You've just hit them with [a topic] where they can see themselves in science." One student, who previously showed little interest in science, found her passion for rongoā, highlighting the impact of culturally relevant learning. Similarly, Rachel reported that students took pride in sharing their learning through a cross-curricular hangi activity, "I think it is telling them, you need to take pride in what you're doing, and once you show pride, they take pride." Belczewski (2009) identifies three key elements for making science education meaningful for indigenous students:

1. Relationally linking place and learning
2. Reciprocal community involvement

3. Respectful attitudes

These principles align with Nakata's (2002) 3 Rs and could serve as a foundation for culturally responsive science education in Aotearoa New Zealand. Narrative pedagogy (Bishop, 2005) is an effective way to validate students' own stories, ensuring they feel heard and respected. This approach requires teachers to refine their listening skills, shifting from a model of transmitting knowledge to one of facilitating and co-creating knowledge through storytelling.

5.4.2 Mātauranga Māori allows students to 'see themselves and their ancestors' in science

"It's more meaningful to them, because they can see themselves in that context and [the] people before them, their ancestors" (Anne). Including mātauranga Māori allows students to see themselves in science and gives mana to mātauranga Māori. Seeing oneself in science or as a scientist may seem like the ideal outcome of making mātauranga Māori part of science learning and it could lead to more ākonga Māori choosing to continue to study senior secondary science and in turn increase the number of Māori science teachers.

Negotiating the border crossing and allowing students to develop their own identities in the process may be challenging. As mentioned by Aikenhead (2001), there is often a distinct contrast between students' own home culture and that of the school science classroom. Remembering that teachers play an important role in facilitating the border crossing for students between their own cultural reality and the cultural reality of the school science classroom is critical (Aikenhead & Jegede, 1999). The inclusion of mātauranga Māori in the classroom provides students with Māori context to learn science, which in turn can improve the motivation and self-esteem of students and lead to better results (McKinley & Stewart, 2009).

More than just seeing themselves in the science classroom, ākonga Māori should be able to be themselves. An element that supports ākonga Māori to succeed as Māori is the Ministry of Education policy, Mana ōrite mō te mātauranga, which gives equal status to Māori knowledge in NCEA. This policy is developing and

aims to provide teachers with toolkits to be able to effectively provide opportunities for ākonga Māori to achieve as Māori. Another policy initiative, Te Mātaiaho, the NCEA curriculum refresh ,also advocates for mātauranga Māori to be part of all subject areas. Both policies are in their initial phases and as teachers learn to transform their practice, these provide equal opportunity for assessment using Māori contexts thereby valuing mātauranga Māori. However, as Howard (2006, p. 132) states, "We must know our students well, for the purpose of building relationships that work, and also for the purpose of designing curriculum and pedagogical strategies that are responsive to, and honouring of, our students actual lived experiences. There is no work more complex and no work more important than this." From the ideals introduced in these two policy initiatives, with further practice, inclusivity in the science classroom continues to be the aim.

5.4.3 Mātauranga Māori is not a magic bullet

Participants reported that students' responses to the inclusion of mātauranga Māori in the science classroom were mixed. Some embraced it while others questioned what it had to do with science. Meredith summed it up well by stating, when working with teenagers, "It's not a magic bullet." Mātauranga Māori may capture and engage the interests of many students, but it is not fail-proof nor a quick fix to levelling the playing field for ākonga Māori. However, although mātauranga Māori may raise more questions than answers, Stewart (2019) views Māori knowledge as a "gift or educational opportunity." Mātauranga Māori in the science classroom helps connect science to our unique place, Aotearoa New Zealand. Mātauranga Māori is a gift that must be handled with care and consideration.

5.5 Limitations

Limitations arise in every study and affect the scope of the study, findings and some of the conclusions which may be drawn (Simon and Goes, 2013). A limitation of this research is the small number of participants who were involved in the research. Although only six participants were interviewed, I believe that

they provide a good representative sampling of the population of secondary school science teachers as they teach at a variety of different schools and in different locations in the North Island, ranging from urban to rural. This research could be extended to the South Island of Aotearoa New Zealand to gather data from teachers who teach in secondary schools there. This has potential to widen the responses to those of South Island teachers and confirm if their experience aligns with that of their North Island colleagues. Four of the six participants had over 20 years of teaching experience, therefore the data reflects their extensive experience as secondary school science teachers. Involving new or beginning teachers in future research could provide insight into the experience of early-career teachers and may contribute to understanding the implications of pre-service teacher education and induction.

To provide boundaries to my research, the study was limited to year 9 and 10 science classes. There is scope for further research in the senior science area, however, I felt that general science at years 9 and 10 is vital as it informs students' next steps in science and can be a turning point in a student's education, before they choose to opt into more specialised senior subjects.

Finally, my research focusses on mātauranga Māori in Aotearoa New Zealand. Although there are Indigenous knowledge systems in all parts of the world and there are some commonalities between these, I chose to focus on mātauranga Māori and New Zealand science teachers as this is my own reality and the findings will be applicable to Aotearoa New Zealand. Educators in other parts of the world such as Canada, Australia or the United States may find that some of the findings reported could be transferred to their classrooms, especially if they serve students from an indigenous or minority background who could relate to the experience of learners in Aotearoa New Zealand.

A further limitation of this research is that the area of mātauranga Māori in science is a relatively new and emerging area of study that has come to the forefront in the last 30 years. Although there is ongoing research in Aotearoa New Zealand as well as other parts of the world where indigenous people are navigating their post-colonial world, Indigenous knowledge is unique to its place

and research findings are not always easily transferable. Indigenous knowledge and understanding are also closely aligned to language and even if well translated, grasping the subtle nuances may be difficult without a good command of the language. The base of research is growing, and as more teachers gain experience, this will contribute to a richer body of knowledge and a wider range of effective examples of mātauranga Māori in science.
At this point, the findings are based on the limited number of participants and are tentative and specific to these teachers' realities and experiences. The findings have value, however, as there were common themes which emerged, and participant responses were echoed from one interview to another.

5.6 Conclusion

The following conclusions can be drawn from this study**:**

- Mātauranga Māori has a place in the science classroom and provides ākonga Māori with a connection to science.
    - Teachers have a duty to uphold and honour the *Treaty of Waitangi.* Including mātauranga Māori in the science classroom is fundamental to fulfilling this obligation.
    - The inclusion of mātauranga Māori provides ākonga Māori with a way to 'see themselves and their ancestors' in science.
- Teachers include mātauranga Māori in the science classroom in ways that are authentic to them (contexts, Māori values, te reo Māori, karakia, waiata, pūrākau, restoration projects, etc.) depending on their cultural knowledge and experience.
- Learning about mātauranga Māori can trigger a teacher's self-awareness and lead to them acknowledging their own beliefs about knowledge, science and the role of the science teacher.
- There is no 'one-size-fits-all' approach for including mātauranga Māori in the science classroom. The local context of the school, available resources and establishing lasting relationships with local iwi and hapū are vital.

- Opportunities to learn te reo Māori and tikanga Māori are part of the journey and benefit teachers to build their confidence to incorporate mātauranga Māori in the science classroom.

5.7 Implications and recommendations

Having finalised this research and gathered the data from participants, I suggest the following implications and recommendations in regard to policy, practice and further research.

5.7.1 Policy

As educators in Aotearoa New Zealand take the next step towards a refreshed curriculum, Te Mātaiaho, the inclusion of mātauranga Māori is an important element to consider. Making mātauranga Māori part of every lesson in every classroom may be an unrealistic goal and lead to a tokenistic rather than a more authentic and sustainable approach. Although there is no standardised method to provide opportunities for mātauranga Māori in science, suggested topics from Te Kete Ipurangi (TKI) and guidelines for culturally responsive approaches may be helpful for teachers as a starting point. Expecting an element of mātauranga Māori to be present in each unit would be a realistic goal for some schools which are beginning their journey. On the other hand, schools which have already further along, may aim for the goal of employing multiple knowledge system or worldviews when studying a topic. Ministry of Education policy to guide schools towards an authentic and meaningful inclusion is essential and schools and teachers with adaptation could put this into practice.

5.7.2 Practice

The findings of this study suggest that science teachers in Aotearoa New Zealand are responding to the call to include mātauranga Māori in the science classroom. Some are learning te reo and embracing it in every-day classroom activities in an effort to normalise its use alongside English in the classrooms. Others are incorporating Māori contexts as a way of integrating mātauranga Māori into the classroom and viewing science through a mātauranga Māori lens. In other

instances, Māori values and concepts are the focus, and ako, manaaki, kaitiakitanga and whanaunatanga allow teachers the opportunity to situate mātauranga Māori in the classroom in a subtle way that is more authentic to them. Providing an opportunity for teachers to share their best practice and exchange ideas about possible ways to introduce mātauranga Māori in the science classroom could spark collaborative professional development in this space.

Applying the 3Rs suggested by Nakata (2005) is a valuable starting point for teachers who are seeking guidance for implementing mātauranga Māori in the classroom. There may be scope for adjusting the 3Rs to better respond to our schools here in Aotearoa New Zealand. The Ministry of Education along with schools could seek to develop an approach or guidelines for teachers to incorporate mātauranga Māori in the classroom as Meredith's school did. It would help to increase teacher confidence if there was some guidance provided and examples available for teachers to draw from. The Science Learning Hub and Project Mātauranga on Māori Television were useful resources that were mentioned by participants in this study. There is still more work to be done and scope for further research.

5.7.3 Future research

Further research is required to fully explore the fascinating and complex area of mātauranga Māori and science. At the outset of this study, the direction and research questions seemed straightforward, however, as I progressed further into the research, many more questions arose. There are several other considerations that surround mātauranga Māori, and indeed other Indigenous knowledge systems, such as data sovereignty, the lack of Māori science teachers, education as colonisation, conscientisation, cultural border crossings, funds of knowledge, storytelling as pedagogy and assessment just to name a few. A comparison of how Indigenous knowledge in science is incorporated in different areas of the world would offer insight and possible ideas and approaches that could be trialled in Aotearoa New Zealand. Experiential learning and education outside of the classroom with a focus on mātauranga Māori in science is an

exciting area with enormous scope for further exploration. A more comprehensive survey of what teachers are doing throughout the length and breadth of New Zealand may help to provide insight and share ways of including mātauranga Māori in the science classroom.

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Appendices

Appendix A

Interview Questions

How long have you been teaching?

Have you taught in other schools?

What do you love the most about teaching science?

What year levels have you taught?

Which sciences have you taught?

Do you/have you teach other subjects outside of the sciences?

Why do you think science should be part of the curriculum?

What are your thoughts on science education and its purpose?

What do you think of current science education in Aotearoa New Zealand?

What influences your decisions about what to teach in your science classes?

What is your understanding of te ao Māori?

What is your understanding of te reo Māori?

What is your understanding of mātauranga Māori?

Do you believe mātauranga Māori has a place in the science curriculum? Why/why not?

Do you incorporate any mātauranga Māori in your science classes?

Do you involve local iwi, hapū, and whānau input in curriculum development?

What professional development have you undertaken to help you to include mātauranga Māori in your science lessons?

What challenges have you faced including mātauranga Māori in science?

How have you overcome these challenges?

How has your cultural knowledge impacted your delivery of mātauranga Māori in your science classroom?

Would you share with me an example where you felt you authentically included mātauranga Māori in your science classroom?

Why do you feel that this worked well?

How have your students responded/reacted to the inclusion of mātauranga Māori in science lessons?

Has the inclusion of mātauranga Māori impacted students' engagement in science?

Does your science department or school have their own approach for incorporating mātauranga Māori in classes/throughout the school?

Is there anything else you would like to add?

Do you have a preferred pseudonym for me to use in my report?

Appendix B

Information Letter

13 May 2024

Tēnā Koe _______________

My name is Christina Hermanns, I am a student at the University of Waikato. I am currently completing my research project towards a thesis for a Master of Education. The focus of my research is on teachers' perspectives on the inclusion of Mātuaranga Māori in year 9 and 10 science classrooms. I hope that the findings will help teachers to achieve a better understanding of how Māori knowledge and contexts can be included in science learning and examples of ways that teachers have acknowledged Mātauranga Māori in their science classrooms.

I would like to invite you to be part of this study. Your involvement would include me visiting your school to observe your teaching space and conducting a face-to-face or online interview lasting up to an hour with you to find out more about your perspective on Mātauranga Māori in year 9 and 10 science. I may also ask to photograph your classroom (without students present) and view and copy (with your permission) your lesson or unit plans. You would also receive a transcript of our interview to check for accuracy. The total time of interviews and transcript checking would be 2-3 hrs.

Data collected during the study may be used in writing my Master's thesis, publications or in presentations that may arise from it. I will make sure that I store all the information gathered securely. You have the right to withdraw from the study at any time for whatever reason, up until two weeks after you have received your transcript. If there is a withdrawal, I will destroy any data gathered from that participant.

Every effort will be made to protect confidentiality, identifying details will be blurred and pseudonyms will be used instead of your name, the name of your school or organisation in any publications or presentations. Photographs of the classroom learning space will be taken (without students present) so that no

identifying details are included. I will not photograph teachers or students at the school. While every effort will be made to protect the anonymity of all participants, this cannot be guaranteed.

I would appreciate your consent to be involved as described above. If you need any more details about the project, or issues arise for you during the project, please contact me 021 277 1833 or by email che@fdmc.school.nz. If I am unable to resolve your concerns, you may contact my Project Supervisor, Dr. Brent Wagner, 07 838 4576 or by email brent.wagner@waikato.ac.nz

Ngā mihi,

Christina Hermanns

This research has been approved by the University of Waikato Faculty of Education Ethics Committee on [13 May 2024]. Approval number: FEDU018/24

Appendix C

Research Consent Form

I have read the attached letter of information.

I understand that:

1. My participation in the project is voluntary.
2. A voice recording will be taken during the face-to-face or online interview.
3. Photographs may be taken of my classroom (without students present).
4. I may be requested to access lesson or unit plans and for them to be copied (with my permission) for analysis.
5. I have the right to withdraw until 2 weeks after my transcript is received.
6. Data collected from school visit or interview will be kept confidential and securely stored.
7. Data obtained from me during the research project may be used in the writing of the Master's thesis and any presentations or publications that arise
8. Every effort will be made to ensure confidentiality and anonymity.

I give my consent to the following for the study to proceed.

Please don't hesitate to contact me with any questions you may have. Christina Hermanns 021 277 1833 or by email che@fdmc.school.nz.

For any unresolved issues, you may contact my Project Supervisor Dr. Brent Wagner 07 838 4576 or by email brent.wagner@waikato.ac.nz

Teacher (participant)

I give consent to be involved in the project under the conditions outlined above.

Name:___________________________

Signed:__________________________

Date:____________________________

Principal (support)

I support the above-mentioned teacher to be involved in the project under the conditions outlined above.

Name:___________________________

Signed:__________________________

Date:____________________________

Please return this form to the researcher by scanning and emailing a copy to che@fdmc.school.nz or post to Christina Hermanns 695 Carrington Rd, RD1 Hurworth, New Plymouth 4371.

This research has been approved by the University of Waikato Faculty of Education Ethics Committee on [13 May 2024]. Approval number: FEDU018/24

Appendix D

Ethics Approval

Te Wānanga Toi Tangata
Division of Education
The University of Waikato
Private Bag 3105
Hamilton,
New Zealand, 3240

Division of Education Research
Ethics
fedu.ethics@waikato.ac.nz
www.waikato.ac.nz

TE WĀNANGA
TOI TANGATA
DIVISION OF EDUCATION

13/5/2024

Christina Hermanns

Division of Education Research Ethics Committee Application Approved FEDU018/24

I am pleased to advise you that your ethics application for the project entitled "Teachers' perspectives on incorporative aspects of Mātauranga Māori in the year 9-10 science classroom." was approved by Te Wānanga Toi Tangata Division of Education Research Ethics Committee on May 13th, 2024.

Please be aware that the Te Wānanga Toi Tangata Division of Education Research Ethics Committee must be advised (by memo) of any changes to the details recorded in your approved ethics application. This process is outlined in the application portal, under the heading 'Amendments for an approved application'. Send your memo to fedu.ethics@waikato.ac.nz. You will receive a memo of approval once the change(s) has been considered.

Kind regards

Dr Dianne Forbes
Acting Chairperson

Te Wānanga Toi Tangata Division of Education Research Ethics Committee