

**Developing a Kaupapa Māori science education programme focused  
on microplastics, plastic pollution and sustainability**

A thesis submitted in partial fulfilment for the degree of Master of Science in  
Environmental Science

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*Ko Ruapehu te maunga*

*Ko Whanganui te awa*

*Ko Aotea te waka*

*Ko Te Āti Haunui a Pāpārangi te iwi*

*Tēnā koutou katoa*

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## **Abstract**

This research explores the potential for creating a microplastics education programme which is centered in mātauranga Māori. The project utilizes Participatory Action Research and Kaupapa Māori Research Methods to create a culturally grounded science education initiative.

Through a case study at Te Pā o Rākaihautū, this research found that actively connecting scientific topics to Te Ao Māori (the Māori world) promoted Māori student engagement and understanding of complex topics. This connection must be continually affirmed and made relevant to the local Indigenous context. Connection to Te Ao Māori through te reo Māori (the Māori language), and pūrākau (oral histories) not only creates a positive learning environment but also improves the robustness of environmental science research in Aotearoa.

Research into microplastics and plastics pollution in Aotearoa would benefit greatly from an understanding of Te Ao Māori, and recognition of the responsibilities of Treaty Partners under Te Tiriti o Waitangi. Similarly, policies and government actions on reducing plastics pollution must acknowledge the unique role of Indigenous Peoples and Indigenous Knowledge in solving the plastics pollution crisis.

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## Introduction

### Background – whakapapa of project

This project has been developed as part of the Aotearoa Impacts and Mitigation of Microplastics (AIM2) project, which aims to better understand the effects of microplastics on waterways and ecosystems. This research aims to support the wider goals of the AIM2 project by investigating ways in which mātauranga Māori and Western science knowledge can be integrated to better address the problem of plastic pollution. Mechanisms for integrating mātauranga Māori and Western science can best be investigated and created in a setting in which mātauranga Māori and Te Ao Māori (the Māori worldview) are the norm. This project will create 'bottom-up' initiatives whereby both Indigenous and Western knowledge systems can be brought together to inform the process and the products of this type of education. For these reasons Te Pā o Rākaihautū, a Designated Special Character School located in Ōtautahi (Christchurch), was chosen as a suitable setting to carry out this research. Te Pā o Rākaihautū is a special character school which purposefully approaches education from a culturally grounded perspective based in whānau and wider community relationships.

This research seeks to identify mātauranga Māori-based approaches to understanding the problem of plastic pollution. Mātauranga Māori is a term often used to describe Māori approaches to generating knowledge and understanding, as well as all knowledge generated from within a Māori worldview. In his pioneering work *Tikanga Māori*, Hirini Moko Mead defines mātauranga Māori as a concept which "encompasses all branches of Māori knowledge, past, present and still developing. It is like a super subject because it includes a whole range of subjects that are familiar in our world today, such as philosophy, astronomy, mathematics, language, history, education and so on. And it will also include subjects we have not yet heard about. mātauranga Māori has no ending: it will continue to grow for generations to come." (Mead, 2003, p. 337-8). As a continually evolving body of knowledge, mātauranga Māori utilises many tools including those created since the colonisation of Aotearoa New Zealand. However, and crucially, the use of these tools is carried out from within a Māori worldview and context. Although mātauranga Māori is a Māori-specific term, there are other similar concepts which exist for Indigenous Peoples elsewhere, as well as 'catch-all' terms such as Indigenous Knowledge, Indigenous Science, Native Science, and Traditional Ecological Knowledge. There are nuances within each of these terms which are context specific and will be explored below. Additionally, this research presents opportunities to uphold goals outlined by the Ministry of Education and Māori leaders including Dr Mason Durie with respect to Māori science education (MacFarlane et al., 2019). These goals were proposed at the 2001 Hui Taumata Mātauranga



and expressed that educational institutions should empower Māori to: 1) live as Māori, 2) actively participate as global citizens, and 3) Enjoy good health and a high standard of living (MacFarlane et al., 2019).

### Te Tiriti o Waitangi + WAI262 – mātauranga māori – whakapapa of research

Tina Ngata (2020) discusses the importance of “starting where you are” in any research project. For Māori, starting where we are requires an acknowledgement and understanding of histories stretching back to the times of our tīpuna. This research is underpinned by theoretical frameworks which have a whakapapa relating to Māori knowledge and relationship with the environment. This section will outline this whakapapa and provide the legal and policy frameworks which justify the literature review and overall areas of focus for the research.

### Tino Rangatiratanga, Waste Colonialism, and Plastic Pollution

Beginning a thesis on microplastics with a discussion of Te Tiriti o Waitangi may seem to some readers to be irrelevant or perhaps a bit far, and I hope that this section will highlight that Te Tiriti o Waitangi is relevant to every environmental science project in Aotearoa New Zealand, regardless of its perceived proximity to Te Ao Māori.

Discussions of Māori knowledge (and Māori science) are necessarily underpinned in the concept of tino rangatiratanga (Broughton & McBreen, 2015; Waitangi Tribunal, 2011), often translated as sovereignty and/or self-determination. Article Two of Te Tiriti o Waitangi affirms the already existing right of Māori to exercise “*tino rangatiratanga o ratou taonga katoa*”. Taonga includes both the tangible and intangible, and taonga which have been found to be protected under Te Tiriti o Waitangi include te reo Māori and mātauranga (Māori language and knowledge). This means that the New Zealand government has a specific obligation to protect Māori knowledge (Broughton & McBreen, 2015). This is affirmed by New Zealand’s international obligations, as the United Nations Declaration on the Rights of Indigenous Peoples (United Nations, 2007) affirms the rights of Indigenous Peoples to “*maintain, control, protect and develop their cultural heritage, traditional **knowledge** and traditional cultural expressions, as well as the manifestations of their **sciences, technologies and cultures***” (United Nations, 2007, *emphasis added*). Despite the clear affirmation of tino rangatiratanga in both historical and recent legislation, there has been a distinct lack of input and decision-making for Māori in all areas of government, including science research and policy. The formation of the Waitangi Tribunal in 1975 aimed to begin addressing this legacy of inequity by investigating claims related to breaching of Te Tiriti o Waitangi. Initially, the Waitangi Tribunal focused only on contemporary claims relating to land, but shifted in 1985 to include breaches of Te Tiriti dating

back to its signing in 1840. WAI262 was a claim brought to the Waitangi Tribunal in 1991 pertaining to the knowledge of Indigenous flora and fauna and the rights of Māori to these genetic resources. This was a historic claim for many reasons including its pan-tribal nature, as it does not restrict itself to one area but discusses the environmental knowledge of Māori from around Aotearoa. The Waitangi Tribunal examined the policies of over twenty government agencies to provide a broad inquiry into biodiversity, genetics, cultural heritage and intellectual property (Te Puni Kōkiri, 2022).

In 2011, the Waitangi Tribunal released the groundbreaking two-part report 'Ko Aotearoa Tēnei' report into the WAI262 claim. The report explores breaches of Te Tiriti relating to Māori knowledge, culture and natural environment. The WAI262 claim relates to the knowledge of Indigenous flora and fauna and argues that the tino rangatiratanga affirmed in Te Tiriti o Waitangi includes the right of decision-making authority over the use of natural resources (including flora and fauna), as well as intellectual property rights over knowledge related to these resources (Wihongi, Murray, Hippolyte, Poata, Rimene, McMath, 1991). The knowledge pertaining to these natural resources is referred to in the WAI262 report as *mātauranga* or *mātauranga Māori* (Waitangi Tribunal, 2011a, 2011b). In fact, the Tribunal asserts that *"the Wai 262 claim is really a claim about mātauranga Māori – that is, the unique Māori way of viewing the world, encompassing both traditional knowledge and culture. The claimants, in other words, are seeking to preserve their culture and identity, and the relationships that culture and identity derive from."* - (Waitangi Tribunal, 2011a, p. xxiii). In particular, the claim is concerned with advances in knowledge and technology relating to breeding, genetic modification, conservation and management of existing flora and fauna, and states that the Crown control of this decision-making does not amount to tino rangatiratanga (Wihongi et al., 1991). The claim outlines the intergenerational and multifaceted relationships Māori have with particular flora and fauna, referred to as *taonga species*. As the WAI262 claim relates to the governance of Aotearoa New Zealand's natural environment, it follows that research relating to the natural environment should, at the very least, consider the findings of the Waitangi Tribunal on this claim.

In their two reports on WAI262, the Waitangi Tribunal concluded that, among other findings, the Crown had failed in its responsibility to adequately protect Māori rights to tino rangatiratanga over mātauranga Māori and taonga species. The intention of the WAI262 claim was for the findings to be used as a basis for developing policies and frameworks to address the Crown's failure to guarantee tino rangatiratanga over mātauranga Māori (Houghton, 2021). However, the first formal response from the New Zealand government came from the Labour-led government in 2019, with the Te Pae Tawhiti report (ibid.). Te Pae

Tawhiti sets out the Crown's approach to engaging with Māori on issues relating to the recommendations of WAI262.

As well as having broader implications for New Zealand's environmental policies, the findings of WAI262 also have important implications for the future of Aotearoa New Zealand environmental science research. The Waitangi Tribunal (2011) asserts that while scientists work well with tangata whenua when the knowledge being presented aligns well with their own scientific interest, academic interest in mātauranga itself is limited. In other words, mātauranga Māori is not valued for its potential for Māori or its inherent value, but for its contribution to Western academia and its potential value in supporting scientific findings. This is an important distinction to understand. The implication is that it is important to approach research from a standpoint which is culturally responsive and prioritises the values of Māori in the first instance, and secondarily consideration of the value to te Ao Pākehā. This is consistent with the goals of Kaupapa Māori research (Smith, 1999).

The importance of tino rangatiratanga and the findings of the WAI262 claim and subsequent reports to this research manifest on multiple levels. Firstly, the development of a Māori-focused science education programme gives mana to the need for self-determination for Māori in the education system. Secondly, and more broadly, this research speaks to the need for mana whenua voices to be prioritised in the creation of policy to address microplastic pollution and its potential to cause harm to taonga species.

## AIM2

Aotearoa Impacts and Mitigation of Microplastics (AIM2) is a five-year Endeavour programme funded by the Ministry of Business Innovation (MBIE). It is the first comprehensive research programme investigating the impact of microplastics on New Zealand's ecosystems, animals and people. The project aims to bring together biophysical, cultural, and community engagement to improve understandings of the distribution and effects of microplastics on the unique ecosystems and taonga of Aotearoa. Microplastics are an emerging area of study linked to the well-known problem of macroplastic pollution. Microplastics are defined as plastic particles less than 5 mm in size and can be produced either intentionally (primary microplastics) or as a result of environmental degradation (secondary microplastics). Sources of microplastics pollution include physico-chemical fragmentation of larger plastic products, littering, and municipal wastewater treatment plants. The effects of microplastics are still widely unknown.

## Te Pā - a grounded site for science education

Te Pā o Rākaihautū (Te Pā) is a special character kura (school) which opened in 2015 in Ōtautahi (Christchurch), New Zealand. Te Pā is strongly based within Te Ao Māori and aims to uphold tikanga Māori and mātauranga Māori through a wānanga-style learning environment (Ataria & ParataTakurua, 2012). The school's vision has been described through the metaphor of a waka hourua/double-hulled waka (Ataria et al. 2021) which has strong identity and leadership as the hull to provide a foundation for learning. The three foundational pillars or pou (Matatū, Matatau, Mataora) that are represented as sails that in turn are anchored in the values of Tika, Pono and Aroha, which move the waka to its destination. The destination encompasses the goals of Te Pā, including graduates who are culturally grounded and confident, and able to excel in both Te Ao Māori and Te Ao Pākehā. Traditional narratives of Rākaihautū provide the foundation through which the school's values are recognised. Rākaihautū was the earliest ancestor of the iwi of Waitaha, the first iwi to set foot in Te Wai Pounamu (the South Island). Waitaha and Ngāi Tahu histories recount that geographical features of Te Wai Pounamu were fashioned using Tūwhakarōria, the kō or digging stick of Rākaihautū (MacFarlane et al., 2019). The classrooms at Te Pā are named for these features including lakes, rivers and mountains. Rākaihautū is described as a leader explorer, and knowledge holder, thus providing a positive model for Te Pā learning outcomes.

Te Pā formed from dissatisfaction with mainstream education which is largely disconnected from Māoritanga (Ataria & Parata-Takurua 2012; MacFarlane et al., 2019). The learning village encompasses education from early childhood through secondary and treats learning as a long-term process. Science education at Te Pā focuses on reconnecting whānau with ancestral places and traditional narratives, meaning that learning is place-based and creates local solutions to global problems.

Te Pā was identified as an ideal community in which to develop a science education programme grounded in Te Ao Māori. Previous projects carried out at Te Pā (Ataria et al. 2021 unpublished), MacFarlane et al., 2019) meant that connections already exist between Te Pā leaders and the researchers, providing a positive starting point from which to launch this kaupapa. The focus of this mahi is to create a localised microplastics education system in a Māori setting, and it is also hoped that this work will create a foundation for Kaupapa Māori based science education in other settings.

## Literature Review

This chapter provides an overview of relevant literature and form the justification for this research. This project aims to take a transdisciplinary approach (Goven et al, 2015) and thus this section will draw from a variety of research areas. This chapter aims to form the basis for an Indigenous Māori approach to teaching about microplastics. Topics explored include plastics pollution, Indigenous education models (including Kaupapa Māori education), and the relationships between Indigenous Knowledge and dominant science in this research.

## Whakapapa of Microplastics

This section discusses the whakapapa<sup>1</sup> of microplastics to build an understanding of the broader context of this research. In particular this section will focus on the effects of microplastics which are of concern to Indigenous communities, including contamination in marine species which provide sustenance and spiritual connections to these communities.

Plastics have been consistently detected in the environment since the mass production of plastics began in the 20<sup>th</sup> century. Geyer et al (2017) estimated that 8300 million metric tonnes of virgin plastics have been produced to date. Since the 1980s, the level of plastic pollution has been accelerating (Moore, 2008). Microplastics are the descendants of these legacies of plastics pollution. One of the te reo Māori terms for plastic, introduced by Associate Professor Hone Morris is 'kiri hou', made up of the two kupu 'kiri' meaning skin, and 'hou' meaning new (Peryman, 2022). Plastics are usually categorised as either macro (>5 mm) or micro (<5 mm) (Tremblay et al, 2020). Emerging research has described 'nano-plastics' as a distinct category, which have been commonly defined as either <100 nm or < 1000 nm (Gigault et al, 2018). Categorization of plastics as macro, micro, or nano has also been based on unique physico-chemical properties rather than size alone (Gigault et al., 2021; Hartmann et al., 2019). The definition of microplastics is a continued area of debate in the scientific community (Rochman et al., 2019). This research mainly uses the size categorization of microplastics as <5 mm, however due to the holistic interests of the project, plastics which fall outside of this category are still considered. This aligns with a whakapapa view of microplastics, which are inextricably linked to both macro- and nano-plastics through their production and degradation processes. Alongside size categories, microplastics may be categorised as either primary or secondary. Primary microplastics are produced for a specific purpose and may include microbeads (found in personal care products), fibres (used in textiles), and pellets or nurdles (used in industry, usually pre-production of larger plastics) (Tremblay et al., 2020). Secondary microplastics are the result of the degradation of larger plastic items released into the environment.

Degradation may result from exposure to ultraviolet-B (UVB) radiation in sunlight as well as interaction with seawater and other atmospheric factors (Moore, 2008).

Biological indicators of microplastics pollution include many marine species which are of cultural significance to Indigenous communities. The most examined group in plastics research are seabirds (Provencher et al., 2017). Seabirds are a food source for many coastal Indigenous communities globally, including in Aotearoa New Zealand and Canada (Borrelle, Provencher, and Ngata, 2021). The migrational pathways of seabirds along ocean currents and their surface feeding patterns make them particularly susceptible to ingestion of plastics (ibid.). Ingestion of persistent organic pollutants (POPs) found in plastics has been recorded as having acute and chronic poisoning effects on seabirds (Lavers and Bond, 2013; Tanaka et al., 2013, 2015). Additionally, there is evidence that these contaminants can be transferred into eggs (Lu et al., 2019), raising the possibility of transfer into the bodies of communities that feed on these species. Research partnerships have been developed alongside Indigenous communities in Nunavut, Canada, and Rakiura, New Zealand, which have the potential to create methods for monitoring the effects of plastics pollution in seabirds in a way which is culturally relevant (Borrelle, Provencher, & Ngata (2021). Tremblay et al (2020) identify key research gaps in microplastics research in Aotearoa New Zealand, including potential risks to taonga species, and increased human exposure to microplastics in customarily harvested species. Thus, there is simultaneously an increased potential risk to Indigenous Peoples from plastic pollution, and an underrepresentation of Indigenous Peoples in the current research literature.

The scarcity of research into microplastics (especially in Indigenous contexts) presents a unique opportunity for kaupapa to be developed from Indigenous philosophies to address plastics pollution. Plastics have previously been identified as an ideal case study with which to challenge accepted ways of thinking about environmental pollution (Liboiron, 2020). The Western model of pollution typically identifies 'threshold' concentrations of a given contaminant, above which the contaminant is considered a pollutant and below which it is not of consequence. This model does two things: 1) asserts that there is an 'acceptable' level of contamination, and 2) focuses the scientific discussion around the contaminant rather than the health of the land. Neither of these consequences align with many Indigenous models of pollution, which often consider any level of contamination to be unacceptable (Liboiron, 2020) and focus holistically on the health of the land through a cultural lens (Harmsworth & Awatere, 2013). Additionally, as microplastic pollution is indicative of a wider problem (the breakdown

of 'macro' plastics and societal dependence on single-use plastics), a simple threshold model is insufficient to identify solutions.

In plastics pollution research, Indigenous knowledge has the potential to shape research questions and priorities to ensure that research is relevant and provides information which is of use to Indigenous communities. For example, in the seabird examples discussed above), Indigenous communities' longitudinal knowledge of their environment informed decisions on where samples should be taken in order to obtain useful and correct data. There is a need to be cautious about the modes of utilising Indigenous knowledge alongside non-Indigenous science in research, as the important nuances of this knowledge may be lost when filtered through scientific analysis methods (Simpson, 2004). Borrelle, Provencher, and Ngata (2021) suggest that a focus on viewing research through an Indigenous lens may be a more appropriate priority to addressing plastics pollution and its unique Indigenous impacts. The following section will expand on discussions of Indigenous Knowledge and its relationship to science, as well as outlining the current literature on mātauranga Māori (an Indigenous knowledge system unique to Māori).

### Mātauranga Māori, Indigenous Knowledge and science

Mātauranga Māori is an Aotearoa specific term which describes the knowledge of Māori. In his pioneering work *Tikanga Māori*, Hirini Moko Mead defines mātauranga Māori as a concept which *"encompasses all branches of Māori knowledge, past, present and still developing. It is like a super subject because it includes a whole range of subjects that are familiar in our world today, such as philosophy, astronomy, mathematics, language, history, education and so on. And it will also include subjects we have not yet heard about. mātauranga Māori has no ending: it will continue to grow for generations to come."* (Mead, 2003, p. 337-8). In recent years there has been increasing interest in the relationship between mātauranga Māori and dominant science. Across the literature there are examples of studies showing how mātauranga Māori can add value to a variety of Western academic disciplines, including environmental science, marine science, geology and geography (Berry et al., 2017; Kainamu-Murchie et al., 2018; Pauling & Ataria, 2010; Skerrett & Ritchie, 2020; Wehi et al., 2013; Wehi & Lord, 2017; Wehi et al., 2020, Wilkinson et al., 2020). To a lesser extent, literature has been published concerning the nature of mātauranga Māori, and exploring mātauranga as a theoretical concept (Crawford, 2009; Cooper, 2012; Hikuroa, 2017; Mercier, 2007; Mika 2012; Stewart, 2019, 2020, Smith et al., 2016). In this area there is disagreement among Māori scholars as to the philosophical nature of mātauranga Māori and its relationship to Western academic disciplines, particularly science. Some

Māori academics see mātauranga Māori and Western science as entirely complementary, even the same (Hikuroa, 2017), while others caution against equating mātauranga with science (Mika, 2012). Some scholars argue that there is a balance to be struck, whereby some dimensions of indigenous knowledge align themselves well with aspects of Western science, while others do not (Cajete, 2012; Stewart, 2020).

The *Ko Aotearoa Tēnei* report (see introduction) outlines the unique rights of Māori in relation to mātauranga. Broughton & McBreen (2015) outline that mātauranga Māori is protected by article 2 of Te Tiriti o Waitangi as a taonga. The Waitangi Tribunal found that Treaty interests of Māori in mātauranga should be protected by intellectual property (IP) law, however the current law does not adequately account for the IP rights of Māori to mātauranga. This is an important concept as it situates mātauranga Māori within the wider context of Te Tiriti o Waitangi. This affirms mātauranga Māori as a body of knowledge which the New Zealand government has an obligation to protect, regardless of its relationship to science.

One of the main approaches being taken to protect and pass on mātauranga Māori is through its inclusion in New Zealand's educational curriculum. One of the ongoing changes is the inclusion of mātauranga Māori in the science curriculum (Stewart & Tedoldi, 2021). This inclusion aims to create parity for mātauranga Māori, and is also consistent with the current direction of science in Aotearoa (see the examples of projects utilising both science and mātauranga Māori above, which are by no means an exhaustive list). While many authors have argued for the inclusion of Indigenous knowledge in the science curriculum, the many variations in the philosophical conceptions of both Indigenous knowledge and science, as well as ethical and political motivations for creating change in curricula, have resulted in a lack of agreement of how best to achieve this. The literature reveals that the relationship between Indigenous knowledge and dominant science is a contested one, and one with particular relevance in the space of science education.

The relationships between mātauranga Māori, Indigenous knowledge and science are important in understanding the philosophical basis for science education, particularly in Indigenous teaching contexts. The debate around Indigenous knowledge and its place in science are located within a wider debate of constructivism vs positivism, two strands of philosophy which inform pedagogical approaches to teaching science (Smith, 1995). Commonly accepted definitions of Indigenous knowledge (also referred to as Traditional Ecological Knowledge/TEK, Indigenous science, and native science<sup>2</sup>) are constructivist and describe IK as localised and existing within a particular cultural context.



Understandings of science (sometimes qualified as Western, modern, or dominant science) can take either a universalist or constructivist viewpoint (McKinley, 2005). Universalist viewpoints argue that 'science' as both a method of obtaining knowledge and a body of knowledge exists separately from culture and is objective. Constructivist views argue that all knowledge is culturally constructed and thus is inextricable from the place, people and cultural values in which it is created. From a constructivist standpoint both Indigenous knowledge and dominant science are cultural knowledges, with science representing the values of the dominant culture (Lewis & Aitkenhead, 2001). Most of the literature which seeks to increase the prevalence of Indigenous Knowledge in science education takes the constructivist approach (McKinley, 2005) as it acknowledges that the knowledge commonly taught in science classes does not represent a universal truth. The following section will expand on the discussion of anticolonial and Indigenous science education.

### Anticolonial and Indigenous Science Education

There have been a variety of global critiques to, and efforts to indigenise, the commonly accepted Western models of science and environmental education. This section will explore some of these critiques and examples of pedagogies which attempt to address the shortcomings of dominant science education.

In the early chapters of *Earth in Mind*, David Orr (2004) presents a critique of the Western Eurocentric model of education, and states that modern education is founded on several incorrect assumptions: namely that (1) ignorance is a problem which can be solved with increased 'knowledge', (2) planet Earth can be "managed" with sufficient knowledge and technology, (3) an increase in knowledge is fundamentally a good thing, (4) the aspects of society which have been dismantled and damaged can be restored with knowledge, (5) the purpose of education is to give a "means for success", and (6) Western culture represents the "pinnacle of human achievement". Orr then presents a number of principles for rethinking education, including that education should emphasise impacts of knowledge on people and communities, and the responsibility which comes with increasing knowledge to be "well used in the world". Although approached from a Western point of view, Orr's points align strongly with many Indigenous critiques of Western education and Western science. Emphasis on localised, community-based learning echoes Māori wānanga-style approaches and connection to land and environment.

Culturally relevant pedagogy broadly aims to address perceived difficulties and underachievement in learning through classroom practice. Literature is broadly aimed at teachers wishing to improve their own teaching methods and speaks to the practical outputs of the previous discussion of knowledge

types. Beyond considerations of knowledge there are also pedagogical reasons for developing Indigenous approaches to science education, and education in general. For example, Ladson-Billings (1995) aims to develop a theory of culturally relevant pedagogy as a baseline with which to inform classroom practice. The theory is developed with the requirement that it must “*provide a way for students to **maintain cultural integrity** while **succeeding***” (Ladson-Billings, 1995, p. 476, emphasis added). *Success*, in this paper, refers to the ability of students to achieve high scores in the standardised tests employed in their nation’s schooling system. Ladson-Billings argues that while achievement on tests is not the only (or most significant) marker of success, it is a reality that all schools must adhere to. As well as encouraging cultural integrity and academic success, culturally relevant pedagogy must also draw attention to social inequities and give students the tools to recognise and critique these inequities. These three goals (cultural competence, academic success, and socio-political awareness) form the basis of culturally relevant pedagogy.

Examples of culturally relevant pedagogies specifically developed for Indigenous students often utilise place-based learning (Lowan, 2009). Place-based learning is based on the recognition of the close relationships Indigenous learners have with specific areas of land. For Indigenous Peoples, including Māori, cultural competency and connection to land are inseparable: Indigenous culture is tied to the land and vice versa. The next section will outline the unique landscape of science education in Aotearoa New Zealand.

### Whakapapa of Māori science education

The context of Māori science education is explored to generate a theoretical basis with which to create an educational initiative which is responsive to the needs of the Māori students taking part in this project. This section discusses the scholarship of Graham Hingangaroa Smith, Elizabeth McKinley, and Georgina Stewart, and provides some justification for the directions of this project. Kaupapa Māori Research requires that projects delivered to Māori communities must be carried out in a way that benefits and uplifts Māori. This section aims to focus this discussion on the experiences of Māori in science education to help to create a programme which delivers for Māori first and foremost.

In recent years New Zealand educational policy has begun to take seriously the conversation of Māori knowledge and its place in education, and particularly in science education this has led to increased debate around the nature of mātauranga Māori and its relationship to science. This is relevant to science education as the way in which knowledge is viewed affects the way that Māori issues are addressed in educational policy. Hikuroa (2017) argued for mātauranga Māori as a form of science which

differs from Western science only in the way it is communicated. Stewart (2019) argues that mātauranga Māori aligns more strongly with a 'philosophy of science' rather than science as a method or practice. Broughton and McBreen (2015) argue that mātauranga Māori as a taonga is protected under Te Tiriti o Waitangi, and thus the Crown has an obligation to fund programmes that aim to protect and grow the Māori knowledge base.

In Māori medium education, there are three main approaches to teaching science and/or mātauranga Māori (Stewart, 2019). One approach is to teach mātauranga Māori instead of the dominant science. Another approach is to translate the already existing science curriculum into te reo Māori (Stewart, 2019). Both approaches are utilised as part of Te Marautanga o Aotearoa, the Māori-medium schools curriculum, and the translation approach is preferred (ibid.). The translation approach as it has been developed through the Pūtaiao curriculum gives priority to both the scientific concepts being taught, and to a Māori worldview through the Māori language (McKinley, 1996; Stewart, 2017; Wood & Lewthwaite, 2008). The Pūtaiao curriculum mostly parallels the Science curriculum for English-medium schools in New Zealand and outlines additional aims that reflect the importance of a Māori worldview (Wood & Lewthwaite, 2008). The third approach, often utilised in English-medium classrooms, is a 'blending' of Indigenous and Western knowledge, where Indigenous knowledges on a particular topic are taught alongside the 'scientific' teaching of the knowledge (Stewart, 2007). The blended approach may include significant attention to the Indigenous histories and knowledges relevant to the topic, or a more superficial approach whereby a singular lesson or unit is taught to encompass all of the 'Māori' topics (ibid). The three approaches outlined are of course not mutually exclusive, and multiple can be utilised within the same setting (for example, blended knowledge teaching in te reo Māori). Often the privileging of the 'knowledge blending' approach over a language translation comes down to skill, as the number of science educators fluent in te reo Maori is low (Stewart, 2017) and the curriculum contains many novel words and concepts for which there either is no reo Māori equivalent, or the translation does not give an exact equivalent. Potential challenges with each approach have been raised. Teaching science exclusively in te reo Māori creates issues if aiming to create opportunities for taira Māori to pursue science at tertiary and higher levels as the science at these levels is usually communicated in English using highly specific, often academic, terminology (Stewart, 2019). Similarly, teaching mātauranga instead of science also diminishes higher level science opportunities where a base level of school science is needed. Wood and Lewthwaite (2008) raise that the perception of what a "successful" science education programme looks like may be different and the above issues specifically relate to the performance of Māori students in Western institutions. The markers of 'success' used here follow the approach laid out by Ladson-Billings (1995),

which asserts that culturally relevant teaching must equip students to achieve in the dominant academic system as well as within their own culture. Māori educational goals also align with this view, and aim to raise Māori students who can “*actively participate as global citizens*” (Durie, 2001, quoted in MacFarlane, 2019)

The ‘blended’ approach is similar to other ‘multicultural’ science education initiatives developed overseas (Kawagley & Barnhardt, 1998). The way in which a blended learning approach is realised differs greatly, in part due to the broad range of viewpoints on the relationship of Māori/Indigenous knowledge with science.

Hermes (2000) warns that ‘blended’ approaches often devalue Indigenous experiences as they continue to prioritise the dominant discourse. Furthermore, a blended approach which singles out Indigenous cultural knowledges as ‘other’ (for example, teaching a science lesson in which there is a ‘cultural component’) creates an artificial divide between what are seen as ‘academic’ and ‘cultural’ learnings. In order to shift the balance, there is a need to embed Indigenous philosophies at a systemic level. This differs from simply incorporating ‘Māori knowledge’ into an otherwise overwhelmingly Western teaching system.

### Summary

This section explored a broad range of literature on plastics pollution, mātauranga Māori and Indigenous science education. These topics provide a background from which to create a te ao Māori grounded education programme. The literature reveals many contentions in the ways in which Indigenous knowledge and culture interact with science in education and academia. Therefore, this research requires methodologies which are able to recognise these contentions and bring together multiple forms of knowledge in a way that is equitable.

## Methodologies

This project takes an intentionally culturally grounded approach to research. The goal of the project is to co-design an effective science education strategy which is based within Māori knowledge and culture and draws from Western tools to further Māori interests. Two key challenges are presented: to ensure that the project is genuinely co-designed with and by the participants, and to ensure that Western pedagogies are used which are complementary to Te Ao Māori (the Māori worldview) and Indigenous research methods. To ensure these requirements are met the project will use Participatory Action Research (PAR) as the main methodology, underpinned by Kaupapa Māori Research Methodologies.

Te Pā o Rākaihautū was developed within a blended model of education, where Māori culture is embedded within the structure of the school. Thus, in aiming to create a science education programme which utilises culturally relevant pedagogy, we are not 'starting from scratch' - being Māori is already the norm. The aim of this project, therefore, is to explore ways to teach dominant science while maintaining and affirming the cultural knowledges already present.

### Kaupapa Māori Research Methods

Kaupapa Māori Research Methods are a set of methodologies developed to address a recognised lack of self-determination for Māori in research (Smith, 1999, 2012). Historical research on Indigenous peoples in New Zealand has been done in a way which dehumanises Māori and which privileges Western ways of knowing and doing while simultaneously denying Māori knowledges (ibid). This has led to a disconnect between Māori and academia and in many cases a complete distrust by Māori of researchers (Smith, 1999, 2012). A lack of space for Māori knowledge, identity, and culture in research has significant implications both for Māori as a people and for research in Aotearoa. Academia is regularly seen as the forefront of knowledge and universities take on the role of the 'critic and conscience of society' (Jones, Galvin & Woodhouse, 2000). It is concerning, then, for academia in Aotearoa New Zealand to give little credit to Māori knowledges. The purpose of Kaupapa Māori research is to retrieve some of this space. In her groundbreaking work *Decolonising Methodologies*, Linda Tuhiwai Smith (2012) outlines three key aims of Kaupapa Māori Research: 1) to convince Māori communities of the value of research, 2) to convince research communities of the value of Māori-led research, and 3) to develop research approaches and methods which account for the legacies of previous research and improve upon them while valuing Māori knowledge, identity and culture.

Kaupapa Māori research has been and continues to be applied in a wide range of projects (Smith, 2012). As with many Indigenous epistemologies Kaupapa Māori research defies categorization. Graham Hinengaro Smith (1992, 1995) has written about Kaupapa Māori research in a way which locates it among wider Māori struggles for self-determination. Smith identifies several key elements of Kaupapa Māori research, namely that it is related to the experience of being Māori, draws from Māori philosophies, takes for granted the validity of Māori language and culture, and relates to “the struggle for autonomy over our own cultural well-being” (Smith, 1992).

This project draws from and uphold these principles to create a science education programme which is grounded in Māori epistemologies, language, and culture. The researcher aims to do so by empowering the participants to determine the direction of the programme and acknowledges their own areas of limitation due to some of their positionality as taurahere (non-local Māori).

### Participatory Action Research

Participatory action research (PAR) is a methodology located within the social science research space. It was created as part of a deliberate resistance to positivist ‘traditional’ research approaches and shares similar epistemologies to other interpretivist methodologies (Liamputtong, 2013). PAR is a reflexive approach to research which seeks to recognise all participants as researchers, with valuable insights and information. PAR emphasizes the role of participants in developing areas of inquiry and provides space for modes of research to be co-designed with the community in mind (Mertler, 2019; Reason and Bradbury, 2008).

PAR is characterised by a cyclic process of reflection, planning, action, and observation (Eruera, 2010). It is often difficult to pinpoint the beginning of a PAR project, which may occur when a group of people identify a concern or issue and a common goal. Communities may be approached by researchers or vice versa. Commonly there is an established connection between the researcher and community; either the researcher is a part of the community or is connected to the community in some way. PAR contrasts with other modes of natural and social science research such as controlled experimentation as it does not seek to create reproducibility (McTaggart, 1991) but rather aims to tell a holistic story which we might learn from. It also contrasts with traditional social science methodologies including participant observation which typically create a binary between ‘researcher’ and ‘participant’, and by extension create power imbalances in the research. Participatory Action Research is carried out *by and for* the community. In PAR the ‘researcher’ overseeing the project has the role of guidance and recording of ‘data’ (which may take

many forms), however they must ensure that all participants are engaged in both the process and products of the project.

PAR has been identified as suitable for research involving historically disadvantaged and/or marginalised groups (Liamputtong, 2013; McHugh & Kowalski, 2009; Tuck, 2009), due to how it intentionally critiques power structures and centres the voices of participants which in historical contexts may have been sidelined. Notably, McHugh & Kowalski (2009) suggest that Indigenous communities involved in research should be given the option of the PAR approach, and particularly advocate for the usefulness of PAR when working with Indigenous youth. PAR has been utilised with success in overseas projects involving low-socioeconomic, Black, and Indigenous groups (McHugh and Kowalski, 2009; Tuck, 2009; McTaggart, 1991). A critical literature review on Indigenous community-based participatory research highlighted the strengths of this approach for creating culturally relevant solutions (Simpson & Mendenhall, 2022). It also found that many projects, while creating significant actionable changes, often did not utilise Indigenous theory and frameworks in their writings. The authors identified this as a limitation and argued that grounding projects in theory creates broader learnings which are able to be linked to other projects. This creates applications outside of the localised context of a single project, while still recognising the value of locally focused research.

For community-based PAR, the issue of how to define a community may require considerable discussion. For Indigenous-led research the concept of community is central; however, it is often complex and involves multiple overlapping identities. McHugh & Kowalski (2009) wrote about the learning experiences gained from utilising PAR in a high school project researching body image issues for young Indigenous women in Saskatchewan, Canada. The broad community was a high school containing mostly Indigenous students and some non-Indigenous. Of these Indigenous students there were many tribal affiliations and cultural and social identities. The researchers drew from Smith (2012) to discuss 'self-defined communities', where multiple identities were given space to exist within the research. Participants considered their place within the wider communities. This is a key learning for this research as the project will take place within an environment with many overlapping Indigenous identities. Te Pā is guided by Rākaihautū narratives, and this will inform the overall direction of the project. Participants have varying ethnic backgrounds and identities. The main researcher is tangata whenua but does not have whakapapa links to the geographical location of the research, a specific positionality which must be considered.

Tuck (2008) discusses the positionalities of Indigenous PAR and explores how PAR might be considered using Indigenous epistemologies. She argues that PAR "hinges on theory/ies of change" and thus

discussion should be based around how change is made, and what change is needed. Researchers may be driven by desire to see large scale, systemic change - particularly in indigenous contexts. but for PAR the 'action' goals of the project cannot always (or even often) be on this scale). Through a discussion of two projects working with marginalised youth, Tuck arrives at four "vantage points" through which we may view PAR:

1. Sovereignty – in particular sovereignty as an epistemology, recognised as “a call for recognition and full realisation of rights to social, cultural and spiritual (tribal) identities” (p. 56). This is a well-recognised feature of Indigenous research theory and is often described in Aotearoa through discussions of self-determination and *tino rangatiratanga*. In Indigenous research, change is achieved through the ability of Indigenous communities to self-govern.
2. Contention – described through a process of interruption which encourages participants to confront colonial powers in order to achieve change, and argues that this confrontation is necessary to achieve harmony or peace.
3. Balance – the ability to balance internal and external voices, different roles and responsibilities throughout the research. Indigenous communities understand the need to maximise strengths while ensuring that tangata are aware of their specific responsibilities and limits. Tuck argues that balance of roles is necessary for decolonisation.
4. Relationships – in particular the experience of collectivity which begins and is driven by the needs of a group.

The vantage points described above create a framework for viewing PAR through Indigenous epistemologies of creating (“re-visioning”) change. While these vantage points were not created in an Aotearoa-based context there is clear overlap between many Indigenous epistemologies, including with Kaupapa Māori Research Methods. For example, the notions of sovereignty and contention with colonial powers are a common thread throughout Kaupapa Māori Research.

In an Aotearoa-specific context, researchers including Te Aika & Greenwood (2009), Eruera (2010), Solomon (2022), and Smith (2006) have identified the value of PAR and its alignment with Kaupapa Māori principles to deliver results which serve Māori. In a 2006 discussion paper, Linda Tuhiwai Smith places PAR and Kaupapa Māori within a whakapapa of research methods which resist colonial practices, stating:

*“participatory action research, Kaupapa Māori research, oral histories, critical race theory and testimony are just some examples of methodologies that have been created as research tools that*



*work with marginalised communities, that facilitate the expression of marginalised voices and that attempt to re-present the experience of marginalisation in genuine and authentic ways.” – (Smith, 2006, p. 7)*

In a book chapter on ‘A Māori Approach to PAR’, Te Aika & Greenwood (2009) outline four key themes of PAR in Māori communities. The themes are based on four PAR projects undertaken by the authors and show significant overlap both with Kaupapa Māori methodology and international Indigenous views on PAR (Tuck, 2008). Key themes woven through each project include:

1. Tino rangatiratanga – this was reflected differently in each project, but strongly based around self-determination for Māori and showed similar reflections to international discussions of sovereignty.
2. Participation & ownership – the idea of participants owning the direction of the project and guiding the actions was extremely important. This aligns with discussions of self-determination which drive Kaupapa Māori Research.
3. “nested projects” & cycles - each project drew on connections with many others, as well as connections with wider Māori communities.
4. reciprocity and succession planning - intergenerational thinking was relevant in many projects particularly around revitalisation. The authors discuss the importance of living in Te Ao Hurihuri (‘The Changing World’) and adapting to the challenges and issues of modernity.

Eruera (2010) discusses the value of PAR and its alignment with Kaupapa Māori principles in the context of whānau research. Community PAR was used in the context of a marae community looking to re-engage whānau to participate in more hapū and marae activities. A kapa haka wānanga was held which had positive results and led whānau to begin discussing other similar activities which could be held. This led to the formation of a PAR group containing three generations of whānau. Feedback was sought from the community on their experience with PAR methods. The feedback was overall positive with whānau stating that they were happy to participate in a project which would directly benefit their community. The participants agreed that other whānau would be willing to be involved in similar projects, though they highlighted that this would depend on the positionality of the researcher. The author was able to engage due to their existing relationships with the community and this was cited as a key driver for the positive outcomes of the research. Participants agreed that for a similar project to be successful, the researcher(s) must be Māori and have some connection to the participants. This echoes several of the principles of Kaupapa Māori research which emphasise the importance of Māori involvement and existing relationships

(Smith, 2012). Other feedback included differences in opinion of how tikanga should be implemented throughout the PAR process. For example, several native reo speakers found it important to begin with karakia and mihihi to validate the research process. While most participants agreed with this view, there were differing views on the level of proficiency in te reo which should be incorporated, with worries it would formalise the process too much and exclude those who were not fluent in te reo Māori. This feedback is important as it highlights the diversity of Māori, and the fact that Māori research in communities must be reflexive.

The positionality of PAR as community-based and resistant to colonial structures aligns with the placement of Kaupapa Māori research in Aotearoa. PAR and Kaupapa Māori Research both aim to acknowledge and amplify the expertise of communities to create meaningful social change. It is important to note however that PAR has been constructed from a non-Māori and non-Indigenous worldview – though it aligns with many aspects of Indigenous research it is underpinned by Western worldviews. For this reason it must be utilised in a way which centres tangata whenua and is carried out and evaluated using culturally appropriate methods.

## Developing a Kaupapa Māori driven science education programme through Action Research

Kaupapa Māori Research Methods demand that research must serve a purpose and create meaningful change (Smith, 1999). This chapter will therefore expand on the previously outlined methodologies to discuss the practical outputs of the research project, including justifications of the sampling and analysis methods chosen for microplastics and a summary of the lessons carried out both in the field and in the classroom. The final structure of the project was developed through a combination of conversations with community members and iterative learnings during and between lessons.

### Project development through Kaupapa Māori focused PAR

Participatory Action Research is defined by iterative cycles of reflection, action and planning (Liamputtong, 2013). Crucially, PAR is responsive to the needs and interest areas of the research participants. For a microplastics education programme, this presented an interesting challenge as the overall research direction needed to be somewhat 'shaped' in advance of the classroom sessions in order to ensure that the science experiments could be designed with sufficient rigour, and the correct equipment was accessible. This led to some constraints and discussions as to whether this represented a truly 'cyclical' PAR project (see later chapters for a deeper discussion of this).

Kaupapa Māori research and PAR both prioritise the creation of locally relevant knowledge and solutions over the pursuit of replicability. Throughout this project we intentionally chose to pursue areas of interest which were relevant to the specific participants, and which aligned well with the goals of KM and PAR. The following explanation of the project structure is therefore intended as a guide, rather than an instruction manual which can be taken and transplanted into a different organisation. Those interested in carrying out their own investigations of microplastics could adapt this programme to fit their own environments and areas of interest and concern.

### Overview of sessions

A total of 4-6 learning sessions over 8-10 hours were initially planned during the early stages of the research. This included an introductory session to build personal connections with the participants as well as introducing them to the overall kaupapa of the project. The first 1-2 sessions were intended to create an overview of microplastics, and their whakapapa from oil extraction and refinement to create the basis for the forms of plastics familiar to us in everyday life. This would be followed up by a 'pātai' session guided by myself for the participants to develop the questions that they wanted to answer by the end of

the programme. This helped to ensure that the direction and scope of the following science sessions were chosen by the participants, within the bounds of the project. The sampling and experiment would be carried out in 1-3 sessions depending on the topics chosen and would likely include: a field trip, a visual analysis of microplastics (either at the field site or school) and some more detailed analysis (which depending on required equipment, could be carried out at school or during a visit to the university). Finally, students would spend a session working on a presentation of their learning – oral, visual or written. This structure allowed for the project to be shaped with enough flexibility to meet the requirements of iterative PAR within the bounds of a busy teaching environment.

Early in the programme development the kaiako, supervisors and myself discussed multiple options for appropriate field sites to carry out a microplastics investigation. Potential site types included freshwater, marine, sand, soil, and urban (e.g. road dust). When choosing an appropriate site, we considered factors including time and equipment constraints, level of complexity of the sampling and analysis methods, and relevance of the site environment to the students. During the initial two introduction sessions, students conveyed an understanding of and interest in the prevalence of plastic pollution in the moana. A sand sampling trip was chosen after consideration of the above interests, and the relative simplicity of taking sand samples as very little equipment is needed both for sampling and analysis (see accessibility discussion below).

The structure of the programme was loosely adapted from Falkner et al (2018) with the guidance of researchers with expertise in outreach and microplastics sampling. The programme is made up of six sessions, including two science sessions (sampling and analysis) as well as connections to broader societal implications of plastic pollution through the creation of art. The beach trip and analysis lessons were developed with reference to this programme, though the step-by-step instructions were written independently.

### Summary of sessions

Ingoa	Summary
Introduction	General whanaungatanga introduction – kōrero about myself & mahi, ideas of sustainability & plastic pollution, microplastics

<b>Introduction to sampling methods and art activity</b>	<p>Long time between sessions because of COVID and school holidays – went over many of the same topics. Went over posters from last term &amp; key questions they wanted to explore</p> <p><b>Mātauranga Māori</b></p> <p>Concepts explored during discussion:</p> <p>Whakapapa of plastics (see Introduction) - relationship to Papatūānuku</p> <p>Impacts of plastics on atua: Tangaroa (ocean), Papatūānuku (Earth)</p> <p><b>Science skills</b></p> <p>Introduction to sampling methods used for microplastics in sand</p> <p>‘Plastic survey’ (counting the number of plastics) during 10 min hīkoi</p> <p>Number of plastics counted: 73</p>
<b>Haerenga ki tatahi</b>	<p><b>Mātauranga Māori</b></p> <p><b>Identification of atua present at sampling site: Papatūānuku (Earth), Hinekirikiri (Sand), Tangaroa (Ocean)</b></p> <p>Encouraged to think about the interactions between the plastics and atua</p> <p><b>Science skills - <i>sampling</i></b></p> <p>Sampling for microplastics along high tide line (for more detail, see Sampling &amp; Analysis below)</p> <p>General beach cleanup</p>
<b>Sampling recap + visual analysis</b>	<p>Recap session of sampling technique – tamariki had to explain &amp; draw how they sampled for sand</p> <p><b>Science skills – <i>visual analysis</i></b></p> <p>Visual analysis of plastic – laid out (some of) sand on a table outside. Kids used magnifying glasses to examine sand for visible microplastics. These were put in a separate container</p>

<b>Experiment – density separation</b>	<b>Science skills – <i>density separation</i></b> Experiment to remove plastics from sand samples using flotation in a salt solution. Steps were explained beforehand using a powerpoint & short activity to name experiment tools (microscopes, funnels, filter paper)
<b>Microscope session</b>	<b>Science skills – <i>visual analysis using microscope</i></b> Used microscopes in classroom science lab to investigate morphology of microplastics. Discussed possible origins of plastics.

### Microplastics Sampling and Analysis Methods

The sampling and analysis methods were developed with the guidance of other researchers working in microplastics science and outreach. Although the methods were designed for the needs of the local context, I was mindful of the potential for similar mahi to be carried out in other communities and therefore made intentional efforts to opt for easily accessible equipment where possible. For example, sand samples were collected using a dustpan and brush and sieved using a 0.3mm stainless steel kitchen sieve. Samples were stored in recycled glass jars in between sessions. The density separation was carried out using a salt solution created by mixing table salt with tap water, and filtered using coffee filter paper. For a full list of equipment and instructions for the sampling and analysis, see Appendix 1.

## Analysis – Thematic Analysis & Kaupapa Māori

This research is grounded in Kaupapa Māori Methodologies so these should underly the analysis steps including thematic analysis. A google scholar search for studies which have used TA within a KMR approach was done to identify common themes, structures and guidelines as well as some experiences of thematic analysis within a Māori framework. Many of these studies focus on highly specific kaupapa so not all learnings will be directly applicable, however it is important to develop a background / whakapapa of previous mahi by Māori scholars.

### Literature Summary

Studies found include research from a **health science** standpoint e.g. osteoarthritis (McGruer et al, 2019), pēpi feeding practices (Tapera et al, 2017), gout (Te Karu, 2013), health tools (Te Morenga, 2018), fitness (Karaka, 2015), and physiotherapy (Wikaire, 2011), as well as kaupapa relating to **identity/tuakiri** e.g. Christianity (Rangiwai, 2019), student experiences in psychology (Morunga, 2009), whānau (Rolleston, 2021), Māori identity (Gillon, 2016).

Thematic analysis has been utilised effectively alongside Kaupapa Māori Research Methods in many Māori-focused studies. The practices & ways in which this is achieved are variable and context-specific – this aligns with views of KMR and mātauranga Māori as being local, place-based epistemologies. There are some consistencies throughout the literature. Firstly, the outputs of thematic analysis are often described through concepts familiar to Māori using specific kupu which exist in Te Ao Māori and may not have Pākehā/English equivalents e.g. mātauranga, aroha, manaakitanga. Similarly, several studies ascribe their identified themes to other previously adopted Māori frameworks e.g. Te Whare Tapa Whā (McGruer et al, 2019; Te Morenga, 2018). This again situates studies within rangahau Māori (Māori research). Studies are broadly framed around centring Māori participant voices & some equate this to maintaining tino rangatiratanga and mana motuhake (Cram et al, 2013; King & Cormack, 2022; Te Karu, 2017). There was variation in how studies described their positionality in relation to KMR – some described studies as Kaupapa Māori Research while others described studies as “*informed by*” (King & Cormack, 2022), “*guided by*” (Te Karu, 2017), or “*consistent with*” (Tapera et al, 2017) KMR principles. Occasionally KMR was mentioned as a theme rather than a central methodology (Morunga, 2009). This highlights that KMR is not a one size fits all approach and is a set of principles for researchers to aspire to achieve. What does and does not constitute KMR is difficult to conceptualise. Consistently KMR was used to guide and describe the outputs of Thematic Analysis so that they maintained their Māoritanga. This likely flows quite

naturally in studies which utilise KMR principles throughout data collection as the space for cultural values has already been paved.

Themes were identified using Clarke and Braun's (2006) six-phase process. The dataset consisted of multiple media including recordings, self-reflections, visual media and written communications. In phase 1, I dedicated several sessions to re-familiarising myself with the various forms of data. One of the most helpful tools for analysing the data was simply taking the time to manually transcribe the recordings taken throughout the teaching programme. Viewing transcription as a key part of the analysis process is recommended by Braun & Clarke (2006), and I would highly recommend this method to researchers conducting similar mahi. I wrote continually throughout this process, jotting down potential links and whakaaro which would morph into my codes and themes. The data was approached with the research question in mind ('how do we create a science education programme in a setting where mātauranga Māori is normalised?') to guide the creating of themes. Thus, while the analysis was data-driven, the research question and researcher interests were kept at the forefront and therefore the analysis had more in common with a theoretical rather than inductive approach. The goal here is not to explain each piece of data but to weave important aspects of the research experience to make some sense of a complex set of research questions, while ensuring that cultural viewpoints are always centralised. Kaupapa Māori Research Methods were helpful in framing the analysis process and ensuring that it remains culturally relevant. I am hesitant to label this as Kaupapa Māori Research, as Western frameworks made up most of the analysis, however the processes followed were similar to those described in the summary above as I utilised key kupu (words) and values to shape a Te Ao Māori lens. During phase 2 (generating initial codes), I used a bilingual approach, naming codes in English or Te Reo Māori accordingly. Where a clear Māori lens was needed (e.g. quotes about atua), an appropriate kupu Māori was found, but otherwise language was allowed to flow naturally, without aiming to fit into a particular Kaupapa Māori framework (e.g. Te Whare Tapa Whā). Phases 3-5 (searching for, reviewing, and defining themes) utilised a similar bilingual approach which will be evident throughout this chapter. The themes, outlined below, convey a small part my experience navigating the Plastics education space as a Māori researcher, including ideas of disconnection and (re)connection with te taiao through atua and te reo (kupu) Māori, reflexivity and...(kaingākau? Conservation?).



## Themes

### Disconnection

A theme which I identified early in the research journey was one of disconnection – in particular a disconnection between the Māori lens through which the researchers view the world and the dominant science frameworks and resources which have previously been constructed to describe plastics pollution. In many ways this disconnection was what the research question hoped to address as the creators of the project recognised that resources for teaching about microplastics in a mātauranga Māori setting were few and far between. However through the course of the research this disconnection between the dominant science and Te Ao Māori was found to be more pervasive than I first considered. During the very first class discussion which aimed to find out what the students already knew about plastics and pollution, the taura quickly identified plastic as a polluter of the ocean which harms species including turtles, fish and whales, however it was noted that *“a lot of the creatures identified weren’t Aotearoa specific – when prompted students came up with tuna but didn’t seem particularly interested”* (field notes, day 1.).



Figure 1: images of posters drawn by tamariki - see images of turtles, fish, whales

Students were very familiar with broad concepts and independently brought up pollution, climate change, global warming and species decline. The students also appeared comfortable in Te Ao Māori and mātauranga Māori concepts were a natural part of the classroom, including kōrero, waiata and haka (reo Māori/kupu Māori theme link). However, it seemed that the students did not draw the connections between these two worlds without prompting from those guiding the learning (lead researcher, kaiako). Subsequent discussions and reflections after this initial session explored some potential reasons for this

– for example, the fact that “[plastics] resources aren’t Māori” (reflections, day 1). Learning is a social process, and children are exposed to information about climate change and sustainability in their everyday lives and in the media they consume. This media is (for the most part) shaped by a Western or Pākehā lens which views the Earth in a culturally constructed way. Exposure to media which is culturally separate is unavoidable in a global society and our goal is certainly not to remove foreign influences; indeed, microplastics and broader plastic pollution are issues which increasingly point to affecting all of the environment, both human and non-human. Instead, we aim to ensure that students’ senses of identity are maintained when exploring global issues. *Want to add more thoughts in discussion– reference to G. Stewart’s ‘crisis in science/pūtaiao ed’, how to adapt science into te ao māori, decolonising/indigenising the space. Also links to non-māori medium ed – still most māori students go to mainstream schools – if this is an issue in māori education it is massive in mainstream*

A key goal of this project was to whakamana the students by creating resources which show their ability to affect the health of their world. The theme of disconnection highlights the importance of creating resources for Māori which speak through a Māori lens. Microplastics, like other pollutants, are an issue which directly affects Indigenous communities and speaking about it only through a white lens creates the illusion that there is no connection between Te Ao Māori and pollution. This is both untrue on a practical level (see literature review discussions on waste colonialism) and directly in opposition to a Māori view of the world which recognises the Land and Ocean as ancestors or relations. Once this issue of disconnection had been identified early in the project it became vital to centre the placement of Atua and te reo Māori in the classroom sessions. This brings us to our second theme of (re)connection, which will be discussed through the two sub-themes of Atua and Kupu Māori.

### Reconnection

The purpose of this theme is to highlight the importance for researchers in the Māori science space to make concerted efforts to reaffirm Te Ao Māori throughout their projects. I learned very quickly that the reconciliation of the new plastics ideas with Te Ao Māori frameworks must be done continuously and intentionally; that is, it would not simply ‘happen’ due to the science taking place in a ‘Māori space’. The two key ‘vehicles’ which I used to recentre Te Ao Māori were Atua (ancestors<sup>1</sup>) and kupu Māori (Māori words)

## Atua

A key component of Indigenous Knowledge is the coding of knowledge into stories which often are based around atua, or tūpuna. The importance of atua to conversations about pollution was discussed from the early stages of research.

Once a disconnection between the participants' own lenses and the language of science was identified, I began making a more concerted effort to centre atua in the classroom sessions. Three atua in particular made their way into many of our kōrero – Papatūānuku, Hinekirikiri and Tangaroa.

Framing conversations about pollution around Papatūānuku is not unique to this project and is a common way of communicating within te ao Māori. A note is needed here on atua as non-Māori reading this may falsely equivocate atua to Christian God(s) or other deities. Some may question the relevance of so-called 'spiritual' or cultural beliefs to scientific education. Though Māori have diverse views on atua they are often more similar to ancestors or relations, and describe aspects of the natural environment. Thus when I choose to frame environmental conversations around Papatūānuku it is a reminder to situate ourselves in our responsibility to care for the Earth as a relative. Papatūānuku represents the Earth itself – we see her in the environment. Lots of environmental conversations were around looking after & 'saving' Papatūānuku – this especially helped us to focus on the positive actions & give mana to the Earth when creating learning around the often overwhelming issue of plastic pollution.

The site chosen for the sampling session was New Brighton Beach. This site was chosen in part due to convenience as it is located close to the school, as well as sand sampling being a reasonably straightforward science method for the age group. The location of the beach presented some interesting avenues for discussion. Before our haerenga I gave an overview to the class on what we would be doing at the beach. During this session we revisited the questions we had posed initially (see whiteboard photo) including the question of why "*plastic is bad for Papatūānuku*". I introduced some further thoughts to expand this discussion of Papatūānuku by asking what other atua were present at the beach (& therefore, which atua may be most heavily affected by plastic pollution). We brainstormed the atua present at the beach, including Tangaroa and Hine-moana, the atua commonly personified as male and female entities of the moana (ocean). I asked the pōnonga if they knew the atua of sand, however, most did not. We then had a class discussion about Hinekirikiri, the atua of the area between sea and land, who guards and protects the beach. This kōrero allowed us to place our haerenga within a wider context and gave purpose to our actions: by performing a beach cleanup, we were helping Hinekirikiri to guard the sand, and by taking samples to analyse for further plastics, we could find out more about what harms Hinekirikiri and

by extension, Papatūānuku. After the discussions on Hinekirikiri, we were careful with the sand samples & put them all back in container after use to not be wasteful. Separated out any plastic that we found (in experiment and visual analysis).

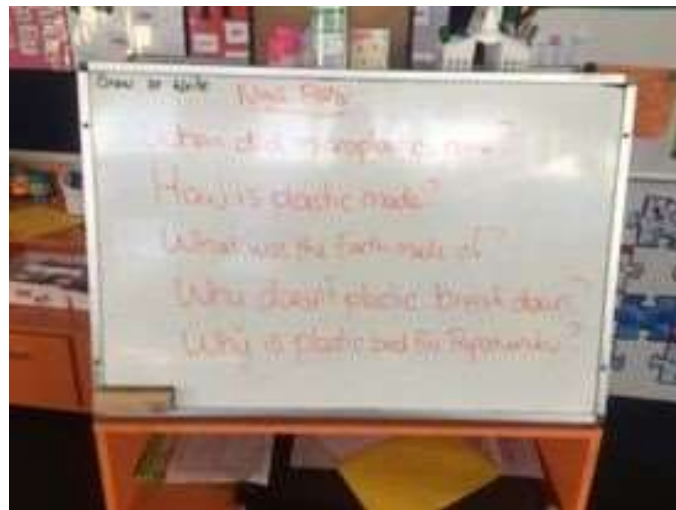


Figure 2: “Why is plastic bad for Papatūānuku?” – pātai from students (picture of whiteboard notes 14 June 2022)

*“most kids hadn’t heard of Hinekirikiri as being the atua of sand and were interested & carried on that conversation” - reflections*

#### *Kupu Māori*

Another key component of the reconnection journey and grounding the Project in Te Ao Māori was the intentional use of kupu Māori. Te Pā o Rākaihautū is not a Māori-medium school, however te reo Māori is a regular part of everyday life and a working knowledge of key kupu (words/terms) was extremely helpful in the creation of the project. For this reason I chose to word this theme as kupu Māori rather than te reo Māori.

My own relationship to reo Māori as a researcher allowed me to be reflexive and adapt to the varying levels of usage by members of Te Pā. My reo journey is ongoing and my fluency is conversational only – this allowed me to pick up on key kupu and phrases used within the classroom and adapt to the various levels of fluency present in the school. An understanding of tikanga and kawa and general familiarity with being in Māori spaces also helped to strengthen this relationship.

Because Te Pā is not a Māori medium school, the lessons were delivered mainly in English with Te Reo Māori weaved in both naturally and intentionally. The reo was tailored to be similar to the way it is already used in the classroom.

The use of kupu Māori by participants yielded some interesting results which highlight the different ways plastic pollution is perceived in te reo Māori and te reo Pākehā. For example, during our sampling and subsequent isolation of microplastics at the beach, one of our kaiako continuously referred to the plastics collected as *“taonga”*. This was immediately picked up by myself and the tamariki, and helped us to ensure that samples were kept safe – especially as we were often working with extremely small pieces of plastic which needed to be collected into jars (figure 2). The word ‘taonga’ is often translated to mean ‘treasure’ and may refer to something held in high regard. Te Aka Māori Dictionary’s translation includes *“property, goods, possession, effects, object”* as well as *“treasure, anything prized - applied to anything considered to be of value including socially or culturally valuable objects, resources, phenomenon, ideas and techniques.”* Although the word taonga evidently has meanings beyond ‘treasure’, students did use the words interchangeably in their feedback for the lesson (*“I liked finding treasures on the beach, and I learned microplastics stay on the surface.”* – pononga, van recording ) In a hui following this lesson, one supervisor raised potential concerns with using the word taonga to describe plastics, pollutants which have demonstrably negative impacts on the environment. This draws attention to several key experiences of incorporating te reo into a predominantly English speaking world: firstly, the difficulty in translating uniquely Māori concepts into English and in new and unfamiliar situations. Taonga is a concept which is not easily translatable, as evidenced by the wide range of meanings in the dictionary translation. So while referring to a known pollutant as a ‘treasure’ may be problematic for some, the word ‘taonga’ may have different connotations. Additionally, te reo Māori and the uses of kupu have changed and continue to change as Māori adapt to new situations – for example the creation of the term ‘taonga species’ to describe native species of great importance to us as Māori. For our rōpū the finding of microplastics at a familiar beach was a new and unique experience, and it was therefore helpful to assign familiar terms to the experience. Other quotes from the pononga, kaiārahi and kairangahau (e.g. *“Why is plastic bad for Papatūānuku?” “students drew ‘clean’ and ‘dirty’ wai”, “turtles choke on plastic bottles”, posters*) support the fact that the plastics were not viewed as a positive ‘treasure’ and the issue of plastic pollution was given sufficient weight.

*“I liked, um, finding treasures on the beach, and I learned, um, microplastics stay on the surface.”* – pononga, van recording



Figure 3: example of a typical sized microplastic isolated during science experiment

*“plastics that we had found were collected, we called them our taonga”* – reflections (field trip week)

#### Reflexivity / kei te pokea e te mahi (overworked, busyness)

Leading Māori scholars including Linda Tuhiwai Smith (1999) have emphasised the importance of being reflexive when conducting research in and with Māori communities. This is especially relevant in so called ‘co-designed’ research projects, which are being increasingly embraced among non-Māori organisations. Indeed the wording of ‘co-design’ was used in the initial briefs of this research. While co-designing projects with mana whenua or a given Māori community (e.g. Te Pā) and researchers is a significant improvement from research which silences, speaks for and over Indigenous voices, consideration must still be given to the roles and responsibilities of Indigenous research participants, which are often multifaceted and may not be immediately obvious to non-Māori. This also applies to Māori involved from the researcher side, as quite often we are still representing non-Indigenous organisations and have access to significant resources, including time. A good friend who has conducted significant research on plastics with Te Kawerau-a-Maki, Matt Peryman (2022), summarises my thoughts on this topic in his Masters thesis: *“Initially, I had idealistic expectations about working intimately with [mana whenua]....[However] they did not have the availability to collaborate as closely as I had hoped given their other responsibilities and the difficult pandemic context. This is often the reality of community-based research, as Linda Tuhiwai Smith (1999) has acknowledged: “Idealistic ideas about community collaboration and active participation need to be tempered with realistic assessments of a community's resources and capabilities [or rather, availability], even if there is enthusiasm and goodwill” (p. 140).”* – p.40. I entered this project with much

the same enthusiasm and idealism as Matt, and felt it important to amplify both of our positionalities. Though we are Māori, we have different responsibilities from the community members we work with, and this must be drawn attention to. For non-Māori researchers, positionalities must again be reflected on.

The theme of reflexivity and busyness made up a large portion of the research project, even before it 'officially' began. Early discussions with Te Pā began in July 2021, when myself, supervisors and key people at Te Pā met to discuss possible avenues of projects and linkages with ongoing mahi happening at the school. Several months later a kaiārahi who had not been at the initial meeting agreed to be a part of the project alongside her class. We met in November 2021 and I travelled to Te Pā to meet with her (then) class for 2022. It was agreed that the project would begin in Term 1 2022. In the following months Te Pā, like the rest of Aotearoa, was significantly affected by COVID-19. Between January and April 2022 the New Zealand response to the Omicron variant meant that numbers of gatherings were limited. Te Pā like many Māori organisations was (and continues to be) impacted significantly by COVID-19 and the decision was made to postpone the project until the situation was more manageable. In the meantime the our Kaiako was moved to a different class, so the project restarted in June 2022 with a new and excited group of pōnonga.

Our earliest session with the tamariki who would lead the remainder of the project was in mid-June 2022, near the end of Term 2. The plan was to carry out the project over 4 weeks with multiple sessions per week, on either side of the mid-year school break. Unfortunately, after the first session I came down with COVID-19 and isolated at home for the government's mandatory isolation period. Since it was now the final week of school for the term, we made the call to start again at the beginning of Term 3. As this was a busy term for Te Pā with haka regionals approaching, the structure of the project shifted from a concentrated few sessions to weekly slots over a six-week period.

### Taiao and conservation

The aim of this section is to find a term to describe the conversations around pollution, plastic (including sampling methods & microplastics identified, conversations about plastic types, morphology) and vitally around "[saving] Papatūānuku" (student posters). Discussions were had by the wider support team and other relevant people about the importance of taking care in how these conversations are framed – we felt that basing the conversation around pollutants (i.e. plastics) takes focus away from the world that these pollutants are affecting i.e. the natural environment. Plastics were chosen as the case study/focus for this project because of their relevance and promise as an issue for the science classroom, however it

is important to keep in mind that they are not the start and end of the project. We are concerned with the health of the environment including the whenua, moana, awa, and taonga species. Thus this section chooses to discuss microplastics through the wider themes of Taiao and conservation

#### *Note on Kaitiakitanga and conservation*

The word 'Kaitiakitanga is often used to describe conservation in New Zealand law and policy. In this analysis I have chosen to steer away from a focus on Kaitiakitanga, and instead look at Taiao as a broader theme encompassing discussions relating broadly to conservation. This decision was made for several reasons: firstly, kaitiakitanga is a politically loaded word which has taken on many new meanings due to its use in policy. Also, kaitiakitanga often focuses specifically on the responsibility felt by mana whenua to safeguard their ancestral environment, and in this project though the participants are majority Māori we have a variety of ancestral connections and thus do not speak for the mana whenua of the rohe in which we were working. Thirdly I find that kaitiakitanga is somewhat overused by non-Māori in environmental science spaces and is often falsely equated to Western ideas of sustainability and conservation. In reality, kaitiakitanga is broader than this and describes the unique connection to and responsibility of mana whenua over their ancestral lands.

The next chapter provides a richer discussion of the themes created through thematic analysis.



## Discussion

The previous chapter provided an overview of the narrative of themes generated by analysing particular experiences of the research journey. In this chapter I will aim to give wider context to these themes and show how they connect to earlier discussions around Indigenous plastics research, and in particular the Aotearoa educational, legal and scientific contexts. This chapter will also reflect on the PAR approach including transparency on where this approach didn't work as planned, and I hope that this will provide some truthful insights to other Indigenous researchers wanting to use PAR in community education research.

### Taiao – WAI262, Sovereignty, Waste Colonialism – balance of heavy topics with rangatahi

This section will expand on the themes of taiao and conservation and frame them within relevant environmental contexts including Land sovereignty and alienation, and waste colonialism. This discussion follows the same direction as previous discussions in this thesis, where I have chosen to frame discussions of pollution through the lenses of the environments being affected, rather than the pollutants themselves. Thus, this section will incorporate discussions of the sampling and analysis methods used in this project for identifying microplastics, through the lenses of the environments where the plastics were found. I have chosen to begin the discussion with land, as it is a common thread woven throughout this entire project. While Taiao was a theme on its own, through this chapter it will hopefully become clear that concepts around Land and natural environments are present within and around each theme which arose throughout the project.

Connection to land is an extremely important concept for Indigenous peoples and many of the discussions around disconnection stem from the displacement of Indigenous youth from their ancestral lands. Two themes identified previously were those of disconnection and reconnection. The intent of these themes was to bring to light the lack of Indigenous narratives in environmental education and the pervasiveness of this issue as it is still present when science is being taught by and for Indigenous peoples. When we begin examining the roots of these phenomena, we can establish links to colonisation and land alienation. We can also see that the methods of reconnection which allowed us to discuss microplastics through a kaupapa Māori lens have links to conversations of sovereignty and ownership, and so are rooted in relationships with Taiao as well. Liboiron (2021) asserts that all conversations around pollution and decolonisation are based on land as *“pollution is not a manifestation or side effect of colonialism but is rather an enactment of ongoing colonial relations to Land”* (Liboiron, 2021, p. 6).

The WAI262 claim and subsequent 'Ko Aotearoa tēnei' reports (discussed previously in the literature review of this thesis) provide necessary context in discussing the alienation of Māori from conservation efforts and ability to have decision-making power over native flora and fauna. While the reports themselves were beyond the content taught in this project, the kaupapa of conservation from a Te Ao Māori worldview, kaitiakitanga, and the protected status of Indigenous knowledge and mātauranga Māori all contributed significantly to the shaping of the teaching resources and were reflected (in simpler terms) in discussions with the research participants.

Themes of protecting, conserving, and 'saving' the natural environment made their way into classroom conversations before any prompting occurred. As part of my preparation for this project I carried out a literature review on microplastics (among other relevant topics) to try to understand the current state of the science before developing tools to teach it. Most papers I found discussed microplastics from the scientific background of the author – their morphology, size, chemical composition, emissions, and interactions with microbial communities. In our first classroom section, we did a similar investigation – students were put into groups of three to four and prompted to create posters answering the question 'what do we know about microplastics' and posing a further question they wanted answered. The overwhelming majority of posters looked at microplastics through the holistic lens of taiao – discussing the concepts of 'clean' and 'dirty' polluted water, the mauri of sea creatures who ingested plastic straws, and including slogans such as "save Papatūānuku". When asked to pose questions, students wanted to know why plastic was harmful to the taiao ('Why is plastic bad for Papatūānuku') as well as asking morphological questions about microplastics ("when did microplastics come", "why doesn't plastic break down?"). There was no separation between what might be considered the "hard science" of microplastics, and the broader societal implications of these plastics. There is increasing interest in the development of intersectional approaches to environmental problems. Indigenous Knowledge has often been put forward as a potential solution to the lack of intersectionality in environmental science due to what is commonly referred to as its 'holistic' nature. While this notion has promise it is perhaps more important to look at what it is about the nature of environmental research that prevents intersectionality from being realized. To do this we must explore the colonial legacies of science as an approach to acquiring knowledge and the way these have shaped how society values different forms of knowledge. In the next section I will explore this legacy and how it manifested in our own Indigenous science research.

### (Re)connecting to Te Ao Māori is the key to Māori engagement with Pūtaiao

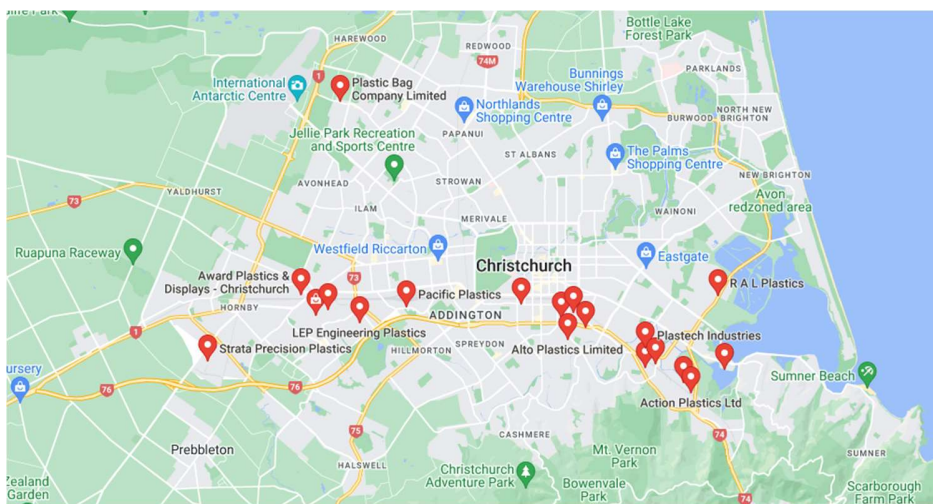
The narrative(s) which carries through the analysis included themes of disconnection between science education and kaupapa Māori, even when Māoritanga is strong in other areas. It is imperative for educators of tauira Māori to have an awareness and understanding of this, both for educators working in Indigenous and non-Indigenous spaces. The experience of disconnection speaks to the legacy of colonisation in science. Although there are scientists who have claimed that “Science itself does not colonise” (Clements et al, 2021, in the now infamous ‘Listener letter’), we must question why it is that Indigenous students, even those confident and comfortable in their Indigeneity, do not see themselves in science unless prompted. While I have no desire to go into the content of the Listener letter, the context which led to it is extremely topical to this discussion and more broadly to the Māori science education space. At the core of this research project is the acknowledgement that current methods of teaching science do not serve Māori. Leading Māori science education scholars Graham Hingangaroa Smith and Georgina Stewart have described Māori underachievement in science compared to non-Māori peers as a “Māori crisis in science education” and draw attention to the need to prioritise structural change over cultural and behavioural efforts which place the blame for inequities on the students who are not achieving (Smith, 1995; Stewart, 2017). In other words, we must ask what it is about the space of science education which causes Māori students to lose interest. To do this we must explore the narratives which currently exist in environmental science, and in education on relevant topics including climate change, pollution and plastics.

During my initial literature review for this project, I began exploring climate change educational initiatives in search of resources to use as a starting point for the development of my own teaching materials. In many of the resources I found, a similar narrative was explored. It goes something like this: in the 14<sup>th</sup> and 15<sup>th</sup> centuries, the Enlightenment Period began, science came into existence and humans realised they could use the Earth as an unlimited resource. This led to innovation and the creation of many modern comforts, but also increased and normalised high levels of consumption, which led to climate change. All humans caused climate change and so it is the responsibility of all humans to fix the problems we have caused. This narrative has been repeated so many times that many people (including well-meaning environmentalists) may think of it as fact, and I am not suggesting it is entirely untrue. However, we must examine who is excluded from this narrative, and who benefits from it. For example, retells of this narrative often ignore the ways in which much of the land was secured for use as an unlimited resource. This is what Quijano (2007), and Mignolo (2007) refer to as the concept of Modernity/Coloniality, where

the developments associated with modernity (modern science, technology, society) and the long-standing power structures of Coloniality, driven by colonisation and land theft, are *“two sides of the same coin”* (Mignolo, 2007, pp. 457) and cannot be separated. In the example of climate change, the accepted narrative speaks to concept of modernity – the development of science was driven by rationality and objectivity and allowed for the creation of modern technology through industrialisation. When we follow this narrative, the overconsumption of resources and the emission of harmful greenhouse gases like carbon dioxide, methane and nitrous oxide is framed as an unfortunate side effect of these modern developments. Similarly, the prioritisation of cheap, reliable and long-lasting materials led to the creation of plastic polymers which are creating new problems we are still learning about. Flipping the coin to the side of coloniality allows us to explore the parts which have been left out of this narrative. The acceleration in industrialisation and development of new technology was made possible by the acquisition of land from Indigenous peoples, and the labour of the working class. The problems of plastic pollution and greenhouse gas emissions were recognised too late in part because of the power imbalance in movement of waste known as waste colonialism (Liboiron, 2021), whereby Indigenous lands and oceans are used as an endpoint for the waste created by first world (colonial) societies. This is extremely relevant for Te Moana Nui a Kiwa (The Pacific Ocean) and its communities, including Māori. Climate change and plastics education which ignores the Coloniality side of the coin is not only scientifically inaccurate, but also does a disservice to Indigenous learners.

The absence of Indigenous narratives in education on microplastics is more alarming when we remind ourselves of the heightened effect of microplastic pollution on Indigenous peoples. Reports of plastic pollution in marine environments have been commonplace since at least the 1970s (Andrady, 2011), and the growing presence of microplastics in Te Moana Nui a Kiwa has been an increasing topic of scientific interest in recent years (Ferreira et al., 2020, Zhang et al., 2020). This has profound implications for Indigenous communities in the Pacific, including Aotearoa, who rely on the Moana as a food source. Microplastics have been shown to carry high concentrations of organic contaminants (Andrady, 2011) and heavy metals (Liu et al., 2021) which can be ingested by kaimoana species. For Indigenous communities which rely on kaimoana to feed their whānau and ensure adequate protein intake, the presence of microplastics in the marine environment is of extreme importance. Production of plastics is also an issue which affects Indigenous communities in particular ways. The creation of plastics involves the extraction of oil, often from Indigenous land, and the emission of airborne pollutants including nitrous oxides, particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>), and organic pollutants which contribute to respiratory problems. Communities including low socioeconomic, Black, Indigenous and People of Colour (BIPOC) are

disproportionately exposed to particulate matter (Tessum et al, 2019). The majority of plastic manufacturing plants in Christchurch are located in the Eastern Suburbs (Google Maps, accessed Oct 2022), which also have higher scores of socioeconomic deprivation (Christchurch City Council, n.d.). It has been shown that disadvantaged communities including Māori communities are disproportionately affected by air pollution in Christchurch (Pearce et al., 2006)



*Figure 4: locations of plastic manufacturers in Christchurch. Note the high concentration on the East side*

Mana whenua and other concerned groups have consistently raised concerns with plastics pollution and microplastics and the effects on the health of the environment, however this is an emerging area of research in academia. The role of science education for rangatahi, as well as teaching important skills of investigation, research and rigorous experimentation, should be to bring awareness of topical science issues. It follows then that Indigenous youth should have a strong understanding of the environmental problems which are likely to affect themselves and their whānau. In New Zealand, Māori communities (particularly coastal communities) are likely to experience the health effects of microplastics in the marine environment more than non-Māori and non-coastal communities. It is alarming, then, that Māori students show lower rates of science literacy and engagement with school science than non-Māori. This is not to say that Māori do not understand the issues that face us; Māori are certainly aware of pollution and climate change, and Indigenous voices are among the strongest of those advocating for climate action.

Having gone through the mainstream New Zealand education system as a Māori student with an interest in science, the discussions from Smith (1995) and Stewart (2017) confirmed my experiences and felt familiar. I was immensely privileged to be able to pursue science and most of the time I didn't feel unwelcome in the classroom, however it would be a stretch to say I felt comfortable being Māori in a

science space. Going into this research I was hopeful that the experiences of the pononga I worked with would be different: in part because I am optimistic that science education has become more equitable in recent years, and in part because I assumed that the normality of Te Ao Māori in the research setting would naturally extend itself to normalising Māoritanga in our discussions of plastic pollution. The fact that this did not occur suggests that the socially created disconnection between science and Indigeneity is subconsciously internalised by Indigenous youth early in their experience. This of course affirms the whakaaro of Māori education scholars, that the “Māori crisis” is a problem not with Māori but with the education system. This position has become increasingly accepted in the New Zealand educational space, and efforts have been made in mainstream education to reduce inequities for Māori in science. My goal in raising these complex issues is not to suggest solutions but hopefully to demonstrate how pervasive such issues can be, and to highlight some small, practical steps which helped bridge the knowledge gap in our small case study.

The two sub-themes which demonstrated these steps were reconnection through atua and the use of kupu Māori. Both of these themes demonstrate reconnection with land in the cultural context of Aotearoa. In Māori creation stories, humans are a part of the genealogical traditions created by the unity of Ranginui (the sky) and Papatūānuku (the Earth). In many pūrākau it is told that Tāne, one of the children of Rangi and Papa, created the first human woman, named Hineahuone. All humans are descended from Hineahuone and therefore from atua. Hikuroa (2017) explains that pūrākau are accounts which contain scientific truths told from a Māori worldview. The pūrākau of Hineahuone shows us that humans are descended from the Earth itself and are a part of the natural environment. This differs from many non-Indigenous viewpoints which draw artificial separations between human and non-human environments. The intentional privileging of kupu Māori and tikanga Māori also served to reaffirm the position of Māori worldviews in this project. Skerrett & Ritchie (2020), discuss the geographical significance of te reo Māori as *‘the first language mapped on to this land, finely tuned to the geography and ecology of this space and place’* (p. 1103). Thus the use of te reo Māori in an environmental science education kaupapa is not simply a matter of translation, but represents a shifting in the way in which the science is conceived of in the minds of learners. To revisit the earlier examples of conservation and atua, a common classroom discussion was on how plastic pollution might affect Papatūānuku, and how reducing the amount of plastic waste might help to care for Papatūānuku. A fully English-speaking classroom with similar goals of conservation might use the words “save the Earth” rather than “save Papatūānuku”. While both of these statements are discussing the same problem, there are subtle differences in the way Papatūānuku, or the Earth, are perceived. The pūrākau above explains that humans have a whakapapa link to Papatūānuku

and so the need to protect Papatūānuku is familial, like an obligation to an ancestor. This is a familiar concept for many Māori and actually is not novel in New Zealand policy either: Te Awa Tupua, or the Whanganui River, has been recognised as an ancestor of mana whenua and granted legal personhood (Waitangi Tribunal, 1999). The slogan “save the Earth” while having a similar goal of conservation, removes the familial aspect - “the Earth” sounds more akin to an object, or perhaps a resource. The language shift is subtle but in our context maintained familiar worldviews while discussing science concepts which contained a lot of unfamiliar language.

The incorporation of Indigenous Knowledge through atua narratives and kupu Māori into a microplastics education programme which otherwise largely followed the same steps as previously developed Western plastics education initiatives is in my view a positive example of bilingual science (Stewart, 2017). Scholars of science education have discussed the “hidden curriculum” created by the legacies of scientific racism, which lead to unscientific ideas of what qualifies as ‘knowledge’, ‘objectivity’ and ‘truth’ tailing behind the science which is explicitly taught (Rahman, 2013; in Stewart, 2017). Much of the scholarship that has aimed to address this issue focuses on multicultural science and the incorporation of Indigenous Knowledge into the science classroom (ibid.). However, the addition of Indigenous Knowledge into the external (visible) curriculum may not address the problems of the hidden curriculum. Additionally, the approach of simply translating the English curriculum into Te Reo Māori also presents problems as it does not address the philosophical challenges of the hidden curriculum, only translates them into an Indigenous language. Bilingual science (with any possible variation of the amount of English and te reo Māori spoken) provides opportunities for science to be taught in a way that is culturally relevant and accessible. Bilingual science should also include consideration of the hidden curriculum mentioned above, which may include the intentional inclusion of knowledge which is not considered ‘objective’. I found that the placement of this research in an institution guided by Kaupapa Māori, made this easier in some ways. There was no need to justify the inclusion of atua narratives or to validate Indigenous Knowledges according to colonial conceptions of knowledge. Māoritanga was a normal and accepted part of the classroom, and this meant that (for want of a more academic term) we could simply ‘get on with it’. This I think explains why our ‘solutions’ for reuniting plastics science with Te Ao Māori were fairly simple. How this would manifest in a mainstream schooling institution I am unsure. Science education which includes atua narratives and kupu Māori may not be sufficient in an institution which doesn’t recognise Te Ao Māori outside of that scenario. Indeed, if done in the wrong way these solutions may move dangerously close to the ‘tick-box’ traps that well-meaning Pākehā educators often fall into – a clumsily explained Māori creation story and then back to business as usual. It is important to reiterate that my goal in

explaining what worked for us is not to create a 'one size fits all' approach, and especially that this approach is unlikely to be able to be transplanted into a non-Māori institution and achieve the same results. The hidden curriculum discussed is not unique to science (though the legacy of science as a tool of colonisation means it has unique characteristics in science) but may also apply to the guiding principles and values of Western learning centres. Thus, the philosophies of knowledge, and where Indigenous Knowledge fits into this, must be addressed at a higher level in order to change the culture of the school and the science classrooms within it. This isn't to say that including Indigenous Knowledge within a Western learning centre cannot or will not be beneficial and it may make a significant difference for Māori students in the classroom. It is simply to highlight that such additions need to be made with care and, where appropriate, consultation with relevant knowledge holders. For those who have the ability and seat at the table to address educational policy, knowledge of the legacies and philosophy of dominant science would certainly be helpful.

### Reflexivity and PAR – Balancing commitments with opportunity

One of the hallmarks of Participatory Action Research is the status of participants as researchers and vice versa; participants have the opportunity to guide the direction of the research (however, we must remember that this opportunity is limited to the bounds created by the main researcher). PAR has many philosophical similarities to Kaupapa Māori Research Methods, as discussed in the methodologies chapter: in particular, the intentional resistance against research norms which place objective and replicable data as superior. PAR by definition cannot be objective and does not aim to be, as the data is driven by the experiences and worldviews of the participants. This is again echoed by Kaupapa Māori Research where membership, or at least affiliation with, the community being researched, is of the utmost importance. In this section I will aim to evaluate the success of PAR as a research method in this particular research context and discuss the relationship between PAR and the themes of reflexivity and busyness discussed in the previous chapter.

The epistemological similarities between PAR and a Māori worldview were what initially attracted me to using PAR for this research. During initial kōrero with our research partners, I was very optimistic about the extent to which the project would be community-driven. However, a lesson I failed to initially consider was the time commitment required to carry out PAR research in a meaningful way. While the research aimed to be participant driven, in practice I found that this is not always possible. The setting of this research in an educational facility meant that there were always other things pulling the focus away from



the project. My positionality as a university researcher came with many privileges, one of which was my ability to concentrate the majority of my focus on carrying out the research project; however, for the participants, there were other focuses which often took priority. In some situations, the PAR-driven need to guide the direction of the research simply spelled out extra work. There is a balance which needs to be found in Indigenous research to ensure that too much burden is not placed on the participants who have given their time to the project. Indigenous scholars have written about historical and ongoing research which is “extractive” (Smith, 1999, 2012), where researchers (often non-Indigenous) appropriate the knowledge of Indigenous participants to further their own interests, and the participants are not appropriately acknowledged for their work. This is one of the main problems Kaupapa Māori Research Methods, and Indigenous PAR, aim to address. However, there is a possibility that through trying to restore the power to Indigenous participants, we may unintentionally recreate the inequitable power imbalance which characterizes extractive research. Balance must be struck between providing the opportunity for a project to be equitably co-created, and not expecting too much work from participants without the resources and background to do so.

The cycles of PAR (reflection, action, planning, observation) were utilised with varying levels of success at different points in the project. Before classroom sessions began, myself and the kaiako conducted several planning hui both with and without the presence of several supervisors. Initial plans were affected by COVID-19 and various changes within the school as chronicled previously, so the planning hui included reflections by necessity – on what was working successfully at Te Pā, on previous collaborations, and on how classroom planning had changed in the pandemic context. Once classroom sessions commenced, it became more complicated to timetable in dedicated reflection and planning sessions with pononga and kaiārahi. My supervisors recommended having ten minutes at the end of each session set aside for reflection, with questions and prompts (e.g., ‘which of today’s activities did you find helpful/exciting/interesting?’). However, while our sessions were timetabled, they were often interrupted or cut short by other responsibilities in the school day, so it became difficult to rely on the end of the session to be available for reflections. To ensure I had enough data to plan for the next session, I took the question prompts (usually written in my field book beforehand) and used them to drive discussion during the learning activities, recording answers either on audio or by writing them in the logbook. For example, during a beach cleanup and sampling session, I gave students my phone to record themselves answering questions about what they enjoyed and found interesting about the session. In my opinion this allowed for some insights which may not have been found if the reflection occurred later, as the pononga were ‘in the moment’ and therefore could speak to their experience as it happened. Some students asked further

questions about the nature and colour of the microplastics they had found, which may not have occurred had the samples been safely locked in a sterile storage closet rather than forming an active part of the narrative. There were also disadvantages to carrying out reflections in this way, as one could argue that they were not really 'reflections' but simply a part of the action of the sampling activity. Having a dedicated time for reflections would have been helpful to add context and to allow the participants to continue to think about and build on their learnings from the sessions. It also would have allowed the participants to take on a bigger role in the planning of follow-up sessions. Instead, after each classroom session I combined the pononga and kaiārahi voices with my own reflections in order to plan out the next session. While this is consistent with the cyclical nature of PAR, it would be unwise to ignore the fact that this approach prioritised my own voice as lead researcher and opened possibilities of misinterpretation of participant voices in my reflections. This experience is one of many reasons I am hesitant to describe this research as 'co-designed' with participants, despite it having been labeled as such by some outside parties. That isn't to say the approach isn't valuable – I would suggest that quite often the desire to have a project which is fully co-designed is idealistic and ignores the power imbalance which exists between the participants and the lead researcher. The participants' reflections and contributions did inform the project's direction, and thus the research may have been co-designed, albeit not equally. I only wish to be careful with the wording used, in large part because terms such as co-design take on politicised meanings in Indigenous contexts. Co-design for Māori represents a taking back of decision-making power which has historically excluded Indigenous people. Thus, to claim research as co-designed requires an acknowledgement and due consideration of the legacy of exclusion.

As part of this reflection on the success of PAR in this project I would like to revisit the 'vantage points' described in the methodologies section of this thesis, which were described by Eve Tuck (2008) as a lens to investigate PAR from an Indigenous viewpoint. Where relevant I will also incorporate kupu Māori such as those used by Te Aika & Greenwood (2009) which described similar themes from a Te Ao Māori perspectives. The vantage points are described as: Sovereignty (and similarly Tino Rangatiratanga), Contention, Balance, and Relationships. The discussions around Balance and Relationships helped frame my analysis of the theme of reflexivity and give an additional theoretical basis for discussions on co-designed research partnerships. Tuck discusses Balance in terms of balancing roles and responsibilities and understanding one's responsibilities in Indigenous spaces. In this research one of the more difficult areas to find balance was the area between providing opportunities for participants to take on leadership roles and expecting too much labour from participants. Another dimension is added when we consider the unique responsibilities which exist for Māori, as we often must answer to our own communities as

well as the institutions (both Māori and Western) we are working for. For example, Te Pā as a learning facility must answer to the requirements of New Zealand's teaching standards, while maintaining its responsibilities to the whānau and wider communities (including mana whenua and Māori more broadly) whose goals may not align with the institutional standards. This manifested in day-to-day life within the project when students who were part of kapa haka were unable to take part in some of the science experiments due to scheduling conflicts. It was explained to me that Te Pā was built upon haka, and so to ensure they are aligned with the kaupapa of the school, haka must take priority. This creates a tension with the NZQA standards as these must also be met. A mainstream school which doesn't prioritise cultural activities like haka would not experience this tension and would have more hours in the day to complete the standards given to them. In addition to both haka and NZQA standards Te Pā has other kaupapa which they aim to cover during term time, which align with the school's Te Ao Māori values. Our project was located within the kaupapa of Whenua and Papatūānuku, and so helped to ensure that this kaupapa was covered. However, the kaupapa were lowest in priority after haka and NZQA standards, and thus reflexivity was necessary to ensure any meaningful work could be done. Mainstream schooling would simply not have this issue, as a science kaupapa would likely fit into a standard which could both meet the teaching requirements and be aligned with the school's individual learning goals, and so would be higher in priority and fit more easily into a school day.

Kaupapa Māori Research prioritises making change by uplifting Māori communities (Smith, 1999), while Participatory Action Research is driven by identifying a need for change (Tuck, 2008). Both of these research methods emphasise aspects of research which are practical and result in tangible outputs for the participants. In Kaupapa Māori, there is an added element which states that research should be conducted to uplift Māori (Smith, 1999) - in other words, "it can't be all hui and no dui" (Hollie Russell, kaiārahi at Māori zero waste organisation Para Kore – quoted in Peryman, 2022, p. 61). This philosophy of transformative action stuck with me throughout the development of this project, and on a practical level meant that I prioritised creating educational resources which were accessible and easy to understand for as many Māori students as possible. The equipment used for sampling included options which are easy to obtain – jars, coffee filter paper, kitchen sieves and funnels. Experiments which did require scientific equipment (such as microscopes in the lab) were not necessary to carry out the majority of the work, but rather a 'bonus session' if the equipment was accessible. Additionally, the lessons were delivered bilingually in majority English with the incorporation of te reo Māori. Though the proportion of Māori who are fluent in te reo Māori is growing with 34% of Māori aged 15 or over reporting that they could understand te reo Māori at least fairly well (Stats NZ, 2022), only around 1 in 6 Māori speak te reo Māori

fluently (ibid.). I felt it important that Māori science education resources be accessible to Māori regardless of fluency and so I did not endeavour to translate the entire project into te reo. Though we were working in a Te Ao Māori focused organisation and the kaupapa was tailored to suit this, I am constantly aware that most Māori students still receive their science education in mainstream classrooms (Stewart, 2017), and these students deserve access to resources which support their identity and status as Indigenous People. A philosophy of bilingual science such as that described in the section above allows for the value of te reo Māori in the science classroom to be recognised, and the actual proportion of reo spoken to be tailored to the level which is normalised in the scenario where teaching is taking place. These 'actions' provide small examples of the ways in which the action part of PAR can be realised according to a worldview guided by Kaupapa Māori Research. Choices were made with the needs in mind of both the participants in this study and the wider community of Indigenous learners.

## Gaps and Potential

In this section I wish to discuss some aspects of the initial research proposal which were unable to be explored for various reasons. It is important in my view to maintain transparency in my accounts of the research journey, as it would be easy to simply leave kaupapa which were not included in the final education programme out of the discussion. However, these kaupapa were initially suggested for good reason and some were simply not explored due to time restraints, lack of resources or expertise. Thus, my hope for this section is that such kaupapa can be explored in future work by the appropriate people.

## Rākaihautū and Mātauranga-a-hapū

Culturally relevant education, particularly within a Kaupapa Māori framework, should prioritise the incorporation of localised and place-based knowledge. In the initial talks about how this project might look, we discussed narratives of Rākaihautū as an opportunity to discuss environmental changes caused by plastics pollution in a locally relevant manner. As an Indigenous scientist from a different rohe the idea was that I would be equipped with the scientific knowledge of microplastics and cultural understandings of Te Ao Māori in a broader sense, while the participants' expertise in the mātauranga of their learning centre would be uplifted and contribute to the direction of the programme. This was an idea which was met with much enthusiasm, however as with many community driven kaupapa, the enthusiasm did not match the level of resourcing, as the kaiārahi able to work more closely with me did not whakapapa to the land of Rākaihautū so did not have the mātauranga-a-hapū/iwi (locally specific mātauranga) which would have been required to embed Rākaihautū narratives fully in the kaupapa. I also had concern about

my own status as a Māori researcher not descended from Rākaihautū in my ability to seek out the most appropriate knowledge. What instead resulted from our discussions was a more 'pan-Māori' philosophy where we embraced kōrero about ancestors all Māori have in common, such as Papatūānuku. The publishing of mātauranga-a-hapū in an academic publication such as this is in my view something which requires great care and involvement of members of those communities, which I do not feel I sufficiently carried out. Further research into locally specific Indigenous science education may find it helpful to explore mātauranga-a-hapū from culturally correct standpoints. The 'pan-Māori' approach which resulted from our diverse group of participants was an approach which I think will be valuable, particularly to other educators with similar backgrounds and learners who wish to incorporate culturally relevant lessons but either do not have the resourcing or are in situations where it is not appropriate to seek out mātauranga a hapū. Views on the tapu status of local knowledge are varied among Māori and there are many views which support the guarding of hapū and whānau knowledge from outside influences and thus would not see the value in lending such tapu knowledge to science educators. The role of science educators in these scenarios is not to seek out this knowledge, though as scientists we often find ourselves feeling as if we need to understand new concepts fully. It is more important to respect local Indigenous Knowledge and its status, rather than to fully understand it.

#### Community dissemination of knowledge

One of the main goals of Kaupapa Māori Research is for the results of research to be accessible and of benefit to Māori communities. To this end, one could very much argue that academic writing (including this thesis) on its own is not an appropriate tool to communicate findings in a meaningful way to the communities that need it. An idea which generated great interest early in the project was to hold a whānau and wider community event after the education programme for participants to present and discuss the kaupapa of plastics pollution and what they had learnt. Unfortunately like many projects being written about at this time, we were heavily affected by the COVID-19 pandemic, as well as other commitments (see discussion on reflexivity)

## Rangahau ki te ao - connecting this research to broader society

This section will connect back to earlier discussions on tino rangatiratanga in environmental decision-making and further expand on the relevance of the WAI262 claim and subsequent reporting to the issues of microplastics, plastic pollution and Indigenous education outlined in the discussion chapter. Indigenous and anticolonial scholars have emphasised the need to view plastic pollution as symptomatic of a societal system built on corrupt values (Fuller et al., 2022; Liboiron, 2021; Liboiron & Ngata, 2020; Peryman, 2022). Much of this thesis has so far been focused on ‘bottom-up’ approaches to Indigenising science education, embedding culture in a small-scale teaching unit. While this is important mahi, I feel it is also important to zoom out and focus on the broader structures which have enabled a poorly managed plastics pollution system, and a lack of equity in science education. This section will reconnect to earlier discussions around WAI262 and expand on the necessity to prioritise the voices of Indigenous Peoples in science and policy approaches to the problem of microplastics pollution.

The Waitangi Tribunal (2011) affirms that Māori hold unique rights under Te Tiriti o Waitangi to natural resources in Aotearoa New Zealand and the Indigenous knowledge associated with taonga including flora and fauna, te reo Māori and other aspects of Māori culture (note: these taonga are intertwined by virtue of the nature of Māori knowledge but are often separated to clearly convey the key areas of interest of WAI262). Additionally, the Tribunal found that the Crown has continually breached these rights. The final chapters of the *Ko Aotearoa Tēnei* report lay out recommendations for the Crown to restore tino rangatiratanga to Māori in relation to these taonga. Some of the recommendations which have particular relevance to this research are as follows:

### *9.2.4 Protecting the kaitiaki relationship with mātauranga Māori and taonga species;*

This recommendation sets out the unique rights of kaitiaki communities and individuals with regard to the intellectual property of mātauranga Māori, and sets out a framework for positive partnership between mana whenua and researchers. The authors recommend that the Department of Conservation (DoC) lead the establishment of consulting with mana whenua to design a system of partnership in the protection of taonga species. Additionally, it is recommended that existing structures are adapted to protect the kaitiaki relationship. In these cases, Māori should be a part of the decision-making table and the structural changes should provide opportunity for this to occur.

#### 9.2.5 protecting Māori interests in the environment

*This recommendation addresses the current structure where environmental management is largely entrusted to local authorities which do not amount to the Crown upholding the responsibility of active protection of Māori interests. The authors also find that the Resource Management Act (1991) (RMA), while it attempts to balance kaitiaki and other interests in natural resources, does not do so sufficiently (p. 705). Currently the ability of iwi to influence decisions on natural resources is inconsistent and reactive. This recommendation highlights that the ability to improve the capacity of Māori is already present in the legislature through RMA sections 33, 36B, and 188. Therefore, the report recommends that the Ministry for the Environment alongside local authorities be required to actively explore options to transfer power to iwi under these sections. Funding opportunities should also be explored to ensure that iwi have the capacity to take on the role of kaitiaki.*

#### 9.2.6 protecting Māori interests in the conservation estate.

The focus of this recommendation is to ensure that the common goals of Māori and the Crown regarding taonga species are met through shared decision-making. Several reforms to legislature and policy are recommended to create a structure of responsible power-sharing and incorporate mātauranga Māori into decisions. These include: a general review of conservation legislation, the establishment of a Māori council to sit alongside the New Zealand Conservational Authority, and amendments to DoC's existing policies to make partnership with Māori a requirement.

These recommendations represent opportunities for positive change to ensure Māori interests in the natural environment are protected. However, several issues including the failure of the government to respond to the findings of the report have meant that progress has been lacking (Houghton, 2021).

In the previous chapter I discussed some of the alarming implications of the absence of Indigenous narratives in research and policy relating to plastics pollution and microplastics. This included the fact that plastics pollution has specific and dangerous effects on Indigenous communities due to 1) the negative health effects on marine species impacting the harvesting of kaimoana, 2) the increased concentration of plastic production facilities in areas with a high Māori population, and 3) the continued linear approach to waste management leading to the outsourcing of plastic waste to the Pacific Ocean. This is part of the

broader phenomenon of *waste colonialism*, whereby the waste products of high gross domestic product (GDP) countries are exported to lower GDP countries (Fuller et al., 2022). So far these discussions provide an ethical foundation for the inclusion of mana whenua in the decision-making process on plastic pollution. The findings of *Ko Aotearoa Tēnei* provide a legal foundation for Māori involvement in decision-making on the natural environment, including science and policy decisions regarding emerging contaminants.

Microplastics have been detected in species which have unique importance to Indigenous communities (Borrelle, Provencher, & Ngata, 2021). Emerging New Zealand research into microplastics has identified risks to taonga species, particularly species which are harvested by mana whenua, as a key area of interest (Barrick et al., 2021; Tremblay et al., 2020). Additionally, plastics researchers in Aotearoa have acknowledged the need for research and policy regarding plastic waste to align with Te Tiriti o Waitangi (Blumhardt & Prince, 2022; Jamieson, 2022; Tremblay et al., 2020). Interestingly, many of the recommendations for alignment with Te Tiriti o Waitangi are limited to the broad principle of ‘partnership’ and focus on engaging with mana whenua through consultation (e.g. Tremblay et al., 2020). While consultation is a positive step, this does not give due consideration to the rights of mana whenua to tino rangatiratanga over the taonga species being researched, as affirmed by WAI262. This approach may also prioritise the goals of dominant science and relegate mātauranga Māori to a consulting-only role. For research and policy to align with Te Tiriti o Waitangi, there must be true partnership in decision-making between mana whenua and Crown entities, and the intellectual property rights of mana whenua to species of interest must be affirmed and respected. These are broad goals, and the failure until recent of the New Zealand government to respond to the rulings of the Waitangi Tribunal mean there is a lack of policy guidance in how to navigate this space. However, there are practical steps that project leads can take in order to align their projects more strongly with Te Tiriti o Waitangi and its implications for environmental research. Early and genuine engagement with mana whenua is necessary, and project leads must be open to mana whenua shaping the direction of the research. Reflexivity is important as mana whenua often have a large number of commitments (see kōrero on reflexivity in the discussion chapter). Consideration should be given to having a tangata whenua project lead or co-lead, if appropriate. The concept of data sovereignty is crucial to any research which utilises mātauranga Māori and/or has a focus on taonga species. Project leads should ensure that any data collected is available for tangata whenua to use as needed, and permission should be sought before publishing of this data in academic journals, reports etc. It is important that these discussions are given due attention and carried out in good faith to ensure that Māori knowledge is not misrepresented or misused in any way.





## Conclusion

The aim of this project was to develop a science education programme to explore plastics pollution through a Kaupapa Māori lens. This project was guided by the mahi of many Indigenous scholars working across a range of disciplines. Through this research I hope to have contributed in some small way to the legacies of Indigenous and anticolonial science.

### **Key learnings, takeaways and future paths**

The use of Participatory Action Research in the case study at Te Pā revealed the importance of reflexivity from researchers in Indigenous communities. This includes being continually aware of one's positionality as an Indigenous researcher and acknowledging the vast range of positionalities present with a diverse group of research participants.

Additionally, this project highlights the importance of intentional connection to Te Ao Māori in science education. It was found that for Indigenous students with a strong connection to their identity as Indigenous people, educators must facilitate connection of Indigenous knowledge with the topics being taught. Though students may make some of these connections on their own, the role of an educator is to continue to highlight the value of cultural identities in learning. This will look different depending on the local context, however it is important to recognise and continually value Māori knowledge to create culturally relevant learnings for Indigenous students.

### **A challenge to plastics pollution researchers**

Researching microplastics through a Kaupapa Māori lens prompted me to constantly consider the systemic power relations which pervade all research. In particular it led me to consider the obligations of researchers and scientists working on Indigenous whenua.

Kaupapa Māori Research demands of us that our research must be focused on change, and particularly on improving outcomes for Indigenous communities. Indigenous theories of change such as those conceptualised by Eve Tuck (2008) contributed significantly to the methodological approach of this research. At the end of the research journey, it is therefore vital to consider what change was created as a result of this research, and what further action is required before true change can occur.

This research highlights that work is not yet complete, and ongoing research into plastics pollution and microplastics must recognise the value of Indigenous Peoples and Indigenous Knowledge. Indigenous Peoples in Aotearoa and worldwide have important contributions to make in contributing to the reduction

of pollution and solutions which are created must be equitable. Microplastics research and action in Aotearoa must include consideration of the obligations of the government under Te Tiriti o Waitangi. This means that Māori must be actively involved in decision-making processes around actions to address plastics pollution. Researchers must therefore recognise and respect the value of Māori knowledge, values, and worldviews, so that they are able to work collaboratively with Māori in a way that is equitable and creates positive solutions both for Māori and broader society.

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## Appendix 1: Equipment and Instructions used for sampling at New Brighton Beach

### **Gear list**

6 x sieves (4x big, 2x small)

1x 100m transect line

1x quadrat (4 lines + bag of bolts)

6x flags for marking out lines

2x flat digging tool

1x small metal trowel

Ziplock bags and/or glass jars (for storing samples)

Permanent marker(s)

Metal bucket

### INSTRUCTIONS – SAMPLING MICROPLASTICS AT THE BEACH

Today we are going to look for macro (big) and micro (little) plastics in the sand at New Brighton beach. We will learn about the ways that scientists take samples to find out where plastics are. You will work in groups to take your own samples and then we will analyse the samples next week

#### 1) Choosing our sampling site (whole class)

Scientists want to look for a place to take samples which is similar to the whole beach. We need to choose a spot which:

- Is easy and safe to walk to



- Is mostly flat
- Is mostly sand – not too many sticks and stones
- Has 100m with no buildings or structures (100m is about the size of a rugby field)

## 2) Measuring out the sample site (measuring team)

### Equipment:

- Transect tape
- Quadrats

### Instructions:

Walk the tape in a straight line across the sample site. Mark the start and end points by putting two flags in the sand.

After the tape has been put down, walk along and put flags in the sand at each number we picked earlier. Mark out the sampling squares (Tuahine Grace can help with this)

## 3) Sampling sand for little plastics (5 teams)

Some plastics at the beach might be too small for us to see – so we will take them back with us to look at under a microscope.

### Kaimahi:

- Diggers
- Sievers
- Baggers

### Instructions:

You need one trowel. Inside the measured square, scoop out sand from the top layer.

Work together to put your sand into the sieve and wash it through with water. Things that are left in the sieve can be put into bags. Write your team name on the bag so you know which sample is yours!

#### 4) Cleanup! Looking for big plastic (5 teams – 3-4 per team)

Kaimahi: Searchers & samplers

Equipment: Big ziplock bags (one per group)

In your teams, walk slowly down the side of the transect WITHOUT the squares. Look for anything in the sand that might be plastic. Pick up the plastic and put it in your ziplock bags

Look at the pictures of plastics if you aren't sure whether something is plastic

## Appendix 2: Density Separation – Instructions

### Equipment:

Salt water (30g)

Sand (5g)

Jars/containers

Filter paper

Funnel

Flask

Microscope

### Instructions

#### SEPARATING

- 1) Measure out 10g of sand
- 2) Scoop into a jar
- 3) Add salt water up to HALFWAY
- 4) Shake around
- 5) Leave for 10 minutes

#### FILTERING

- 1) Set up funnel with filter paper

- 2) Carefully pour solution through filter. Don't pour out the sand at the bottom

### **MICROSCOPE**

- 1) Rip open filter paper so it is flat
- 2) Put in a microscope slide and under microscope
- 3) Take turns looking through!