Weaving Mātauranga Māori into Climate Change Education with Primary School Students in New Zealand

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Abstract

This thesis explores the integration of Indigenous knowledge, specifically mātauranga Māori, into climate change education for primary school children in Aotearoa (New Zealand). It engages with pūrākau (verbal narratives that encode knowledge) gifted by the local hapū (Rangitāne sub-tribe) to a kura (school). The study contributes to the growing body of research that addresses a gap in research and teaching practice, which, despite global calls for action, remains inconsistent in teaching at this age level or lacks direct curriculum guidance in Aotearoa.

The main question for this study was: In what ways can Rangitāne pūrākau engage and further the understanding of Year five and six ākonga (learners) in learning about climate change within a kura in the lower North Island of Aotearoa?

This research used a mix of different research methods to explore this question. A learning intervention wove a pūrākau, climate change concepts and kai (food) together to create a ten-week learning programme. This learning intervention was then implemented by a kaiako (teacher) with a group of 21 Year five and six ākonga. Data were collected using pre- and post-tests to assess what students learned during the learning intervention, a group interview with the ākonga to hear their voices in the study, and an interview with their kaiako to gain insights into how engaged the ākonga were, their opinion on their understandings, and how aspects of the intervention went.

Analysis of the findings shows that the use of pūrākau and other forms of mātauranga Māori helped ākonga connect deeply with the material, which contributed positively to their engagement and to them gaining a sound understanding of complex climate change concepts. The research suggests that presenting scientific information through a familiar cultural lens contributed to making the topic less confusing and easier for the ākonga to grasp. This approach not only helped to improve their understanding but also enhanced the mana of ākonga Māori and their connection to the whenua (the land).

This research has several main implications. The findings provide evidence that incorporating Indigenous knowledge has wider educational benefits in climate change education, supporting the body of research that states what works well for ākonga Māori works well for

all learners. The research also highlighted the importance of the concept of ako, literally meaning ‘to teach and learn,’ as the kaiako showed strength in being able to learn alongside ākonga. The thesis supports the use of Indigenous knowledge systems such as pūrākau alongside Western knowledge systems to develop holistic learning experiences. A recommendation from this thesis is to further explore the development of a climate change education model, relevant to the context of Aotearoa, which would centralise Indigenous knowledge. This could be modelled in the form of a waka hourua (double hulled ocean voyaging canoe) with the tohunga (knowledge holder and expert) on board signifying the use of Indigenous knowledge systems, with narratives such as pūrākau, playing a part in climate change education.

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Glossary of Terms

While I have translated kupu Māori for the context of my study, I am aware that the cultural depth of these kupu extends beyond a single English translation. Many of these kupu (words) encompass entire concepts in English and therefore can have multiple meanings, depending on the context.

Term	Definition
Ākonga	Learner(s)
Āko	To teach and to learn
Ao	World (for the context in this thesis)
Aotearoa	New Zealand
Atua	God or deity
Hauora	Health and wellbeing
Hapū	Subtribe
Iwi	Tribe
Kai	Food
Kaiako	Teacher/educator
Kaupapa	Topic, theme, plan, issue, programme
Kāwanatanga	Governorship
Kōrero	To speak or talk
Kupu	Word(s)
Kura	School
Kūmara	Sweet potato
Mana	Authority, prestige, control, power, influence, status, spiritual power, respect, charisma
Mana ōrite	Equality
Maramataka	Māori lunar calendar
Māra	Garden
Mātauranga	Knowledge
Ngā tikanga katoa rite tahi	All of the rights
Ngā whakapono katoa and te ritenga Māori	Religious freedom and Māori spiritual practices
Noa	Balance

Pākehā	New Zealand European
Pātai	Question
Papatūānuku	Atua of the Earth
Pūrākau	Verbal narratives that encode knowledge
Rangatahi	Youth(s)
Rangatira	Chief(s)
Ranginui	Atua of the sky
Rongo mā Tāne	Atua of the Kūmara and cultivated food
Rōpū	Group(s)
Tāwhirimātea	Atua of the wind and storms
Tangata Tiriti	Treaty partner
Tangaroa	Atua of the seas and fish
Taonga	Treasures
Tamariki	Children
Te ao Māori	The Māori worldview
Tika	To be correct, true, right, fair
Tinana	Body
Tino Rangatiratanga	Independence
Tohunga	Knowledge holder and expert
Tumuaki	Principal
Waka Hourua	Double hulled ocean voyaging canoe
Whakaaro	Thoughts, opinions, ideas, plans
Whakapapa	Genealogy
Whānau	Family
Whenua	Land

Chapter 1 Introduction

1.1 Overview

This chapter introduces the thesis by outlining the research background, my experience as an educator, the research question, and providing a synopsis of the subsequent chapters.

1.2 Background

1.2.1 Climate change

The United Nations defines climate change as "long-term shifts in temperatures and weather patterns" (United Nations, n.d., para. 1). These shifts can occur naturally due to fluctuations in the sun's activities or due to massive volcanic eruptions (United Nations, n.d.). An important concept to gain understanding of when learning about climate change is the difference between the weather and climate, which are related but not the same (National Institute of Water and Atmospheric Research (NIWA), 2020). The weather is what a person observes and experiences in the short term, usually over minutes, hours, or days. In contrast, climate refers to the conditions in a specific location over an extended period (NIWA, 2020). Since the Industrial Revolution began in the 1800s, humans have been the primary driver of climate change. The main reasons for this are the combustion of fossil fuels, including coal, oil, and gas, and the agriculture sector, all of which produce significant amounts of greenhouse gases (Godin, 2022; United Nations, n.d.). Greenhouse gases are atmospheric gases that prevent infra-red radiation (or heat) from escaping the Earth's atmosphere. Essentially, these gases create an artificial blanket around the planet, trapping heat that would otherwise be released into space. This results in a warming process known as the greenhouse gas effect (Hausfather, 2022; Hayhoe, 2022; NIWA, 2017). There are many greenhouse gases produced naturally and artificially. Each gas varies in potency and atmospheric lifespan, but all contribute to the greenhouse gas effect (Hausfather, 2022; Hayhoe, 2022; NIWA, 2017).

Researchers in Aotearoa (New Zealand) and globally are increasingly recognising the impacts of climate change, including changes in weather patterns, rising sea levels, and ocean acidification. Some known effects include:

- Hotter temperatures and heat waves.

- Increased frequency and severity of extreme weather events.
- Rising sea levels threaten coastal communities.
- Ocean acidification is affecting aquatic ecosystems.
- Disruption of ecosystems due to the effects on different animals in food webs and the interconnected species relationships (Godin, 2022).

Whether through more extreme weather events, changes in weather patterns resulting in areas receiving more or less rainfall, or rising temperatures affecting crop yields, climate change also influences food production.

As the science behind climate change has become more understood, and the overwhelming consensus of the scientific community has recognised the causes and impacts, responses to the impacts of climate change have commenced. The United Nations signalled that education is a key lever in the fight against climate change (United Nations, 2020, July 14). Throughout the world, there have been varied responses to this call to education from the United Nations. As in all forms of education, there are many diverse pedagogical arguments about which methods are best. This research investigates various methods and develops a learning intervention to trial a combination of pedagogical ideas in a primary kura (school) for ākonga (learners) aged nine to eleven in Aotearoa.

1.2.2 Climate change education and primary school

Climate change education has its roots in the environmental education movement, which gained prominence internationally in the late 20th century. In 1992, at the Rio Earth Summit, education was recognised as a pivotal component in the response to climate change (United Nations Educational, Scientific and Cultural Organisation (UNESCO), 2015). The United Nations continued to advocate for climate change education globally and in the early to mid-2000s, sought to integrate climate change into school curricula as part of the United Nations' Decade for Education for Sustainable Development (2005-2014). However, in the New Zealand Curriculum (New Zealand Ministry of Education, 2007), there was no direct mention or use of the term climate change at any curriculum level (Eames, 2017). UNESCO has been developing the Greening Education Partnership (UNESCO, n.d.). This initiative involves member states and organisations, including Aotearoa. They commit to a whole-system approach to greening education. The goal is to enable learners of all ages to gain agency. This

will help them address interconnected global challenges. These challenges include climate change, biodiversity loss, unsustainable resource use, and inequality (UNESCO, n.d.).

Interest in climate change education has grown substantially over the past three decades, with publications on the topic increasing from 12 articles in 1990-1999 to 1,489 articles published between 2010 and 2015 (Monroe et al., 2019). The content of this research has become more inclusive of a broader range of topics in climate change, whether that be integration of Indigenous knowledge systems (Bleazby et al., 2023; Cajete, 2020; Olstead & Chattopadhyay, 2024; Tanyanyiwa, 2019), exploring the impact of the colonial crises and climate change (McKenzie et al., 2023), or the effects the climate crisis has on the youth (McKenzie et al., 2023).

Climate change education has predominantly been taught at higher curriculum levels than in kura for primary education. However, there has been an increasing amount of academic research on climate change education at the primary school level (Monroe et al., 2019; Nepraš et al., 2022). Research suggests that there is a need for environmental and climate change education at this level. Having young people understand various climate change concepts at a young age lays the foundation for further learning at higher levels, which leads to more citizens possessing the skills required for inclusive and sustainable economic development within the context of the transition toward digital and green economies (UNESCO, n.d.). There is an increasing demand for this to be explicitly integrated into school curricula (Eames, 2017; UNESCO, n.d.).

There is an emerging body of research that suggests that the purposeful integration of Indigenous knowledge systems in climate change education has benefits to the understanding and engagement of a broader range of ākonga (Bleazby et al., 2023; Cajete, 2020; Olstead & Chattopadhyay, 2024; Tanyanyiwa, 2019; Thornton et al., 2019; Turner & Wilks, 2022). The integration of Indigenous knowledge systems creates a more holistic approach to climate change education. This creates a balance by complementing Western science, providing a deeper understanding of climate change, its impacts, and potential localised mitigations (Russell, 2024). Indigenous knowledge systems can help bridge the gap between humans and nature, a divide often seen in Western societies. By integrating this knowledge into climate education, we recognise humans as part of the ecosystem, interconnected with other species and the environment (Olstead & Chattopadhyay, 2024). This perspective promotes

responsible and intergenerational care for our land and oceans (Olstead & Chattopadhyay, 2024; Turner & Wilks, 2022).

The combination of the developing exploration of climate change education at the primary school level and research on Indigenous knowledge systems in education inspired the beginnings of this thesis.

1.2.3 My background

Ko Kapakapanui te maunga e rū nei taku ngākau,
Ko Te Awa Kairangi te awa e mahea nei aku māharahara,
Nō Kāpiti ahau,
Ko Pākehā te tāngata,
Ko Ryan Jackson tōku ingoā.
Kapakapanui is the mountain that speaks to my heart, Te Awa Kairangi is the river that alleviates my worries, I am from Kāpiti, and my name is Ryan (he/him). I am Pākehā and proudly Tangata Tiriti.

At the time of writing this thesis, I have been a kaiako (teacher) for 10 years, teaching ākonga predominantly at the upper primary age level. Prior to becoming a kaiako, I already had a deep passion for the environment. Over the years of teaching, I have observed this area of learning to be an innate passion for a diverse range of ākonga. With climate change being a generational issue for my, and seemingly every subsequent generation to come, I felt a research-based educational Master's Thesis would help me understand how I could better address this with my students at the kura.

1.3 Research question

The research question has stemmed from who I am and my experiences as an educator. The question that guided this thesis is as follows:

In what ways can Rangitāne pūrākau (verbal narratives that encode knowledge from the sub-tribe Rangitāne) engage and further the understanding of Year five and six ākonga in learning about climate change within a kura in the lower North Island of Aotearoa?

1.4 Context of the study

Te Tiriti o Waitangi is a founding document of Aotearoa, signed in 1840 between some 500 Māori rangatira (chiefs) and representatives of the colonial British Crown (Orange, n.d.). Te Tiriti o Waitangi articles speak of kāwanatanga (governorship), tino rangatiratanga (independence), taonga (treasures), ngā tikanga katoa rite tahi (all of the rights), ngā whakapono katoa and te ritenga Māori (religious freedom and Māori spiritual practices). Please note that this is a basic summary of a complex document. The four articles in Te Tiriti have direct ramifications and implications for the education system in Aotearoa. These documents are directly mentioned in the New Zealand Curriculum (New Zealand Ministry of Education, 2007) and the revised curriculum Te Mātaiaho draft (New Zealand Ministry of Education, 2023).

Primary school education in Aotearoa is compulsory from age six. There are approximately 1,930 primary kura across the country, including public, state-integrated and private kura (New Zealand Ministry of Education, n.d.). As of 2024, there were 470,517 ākonga enrolled across these primary kura in Aotearoa (New Zealand Ministry of Education, n.d.). The ākonga of these kura are taught based on one of two curricula. The New Zealand Curriculum (New Zealand Ministry of Education, 2007), which is the curriculum for English medium kura. At time of writing this thesis, The New Zealand Curriculum is being revised and will become Te Mātaiaho (New Zealand Ministry of Education, 2023). Te Mātaiaho is currently in a draft form with all learning areas being updated. The second curriculum, Te Marautanga o Aotearoa (New Zealand Ministry of Education, 2008), is the Māori medium curriculum for kura. Te Marautanga o Aotearoa is mainly used in Kura Kaupapa Māori (Māori immersion schools) level one and two kura but can be used in any kura in Aotearoa. The kura in this study is taught using the New Zealand Curriculum with some of the updated sections of Te Mātaiaho, as guided by the government at the time of this research.

Climate change education and the broader field of environmental education are not currently mandated learning areas in these curricula. However, within the learning area strands and goals, they incorporate concepts and language that enable environmental education and climate change education to fit well into the curricula.

This research was undertaken in a kura, which is situated in a city in the Lower North Island of Aotearoa. The kura has years one through six, with 250 ākonga enrolled, and of which more than 120 tamariki (children) whakapapa Māori (have Māori heritage). There were 21 ākonga in the akomanga (classroom) where the learning intervention took place. The school's community consists of a lower socio-economic background. Over the past six years, the kura has been developing a decolonised localised curriculum, with the support of the local Hapū (subtribe) Rangitāne. A central part of this has been the use of pūrākau across the learning areas.

Using pūrākau as the basis of learning was not an overnight decision for the kura where this research was based. The kura's localised curriculum journey started approximately six years ago, according to the tumuaki (principal). This focus began with the intentional hiring of staff from senior management to kaiako, including myself who was hired at the start of the process. The tumuaki and Board of Trustees hired staff based on their belief that these individuals would align with the vision and were passionate about the kaupapa (topic, theme, plan, issue, programme). According to the tumuaki of the kura, the critical next step was her ability to draw upon her relationships within the community, which were developed over a long period. These relationships with people in the local hapū and other professional development providers were only called upon when the tumuaki thought the staff of the kura were in the right stage to absorb that knowledge.

These relationships are reciprocal. An example of this is that the tumuaki will meet each term with the local hapū's board spokesperson for education and discuss the planning of the ongoing localised curriculum; these discussions feed both ways, with the hapū having valued input in what they see as important in the education of their rangatahi (youth). Another critical step the tumuaki acknowledged is the specifically chosen professional development of the senior management team and kaiako. It is an important strategic decision. All professional development is provided by trusted providers, including local Māori historians, individuals within the local hapū, university experts in areas such as Te Tiriti o Waitangi, and authors of books that focus on uplifting ākonga Māori in English-medium kura. Research shows that what is positive for ākonga Māori is positive for all ākonga in education, but that is not necessarily the same in reverse (Bishop, 2003). These providers have the right positive intent for Māori, according to the tumuaki and the Board of Trustees. Finally, it has been essential to have the Board of Trustees entirely on board and supporting the kaupapa.

After considering all factors and holding discussions with the kaiako involved in the learning intervention, a decision was made to develop the learning intervention based on climate change concepts and their relationship to food. There were clear connections with the pūrākau that was going to be used in the kura, and nutrition was going to be another focus for the akomanga during that term. The kaupapa of the learning all fit together, and the kaiako believed the themes would engage the ākonga.

1.5 Outline of Thesis

The rest of the thesis is organised into four chapters.

Chapter two provides an overview of the literature relating to climate change education as well as aspects of wider environmental education. The chapter focuses on climate change concepts, climate change education both internationally and in Aotearoa, the use of Indigenous knowledge in climate change education worldwide, and the relationship between climate change and kai (food).

Chapter three presents the methodology used in this research. It explores the research question, the methodology employed throughout the research, the research methods used to gather and analyse data, and the learning intervention design. It concludes with considerations of the limitations and quality of the research.

Chapter four details the findings of the research. These findings are based on data collected from a group interview with ākonga, an interview with a kaiako, and data collected from pre-tests and post-tests completed by 17 year five and six ākonga.

Chapter five serves as the conclusion to the thesis by discussing the findings from this research in relation to the research pātai (question). The conclusion addresses the pātai and draws implications and recommendations that have arisen from the research findings.

Chapter 2 Literature Review

2.1 Introduction

This chapter begins with an overview of literature relating to the fundamental concepts of climate change pertinent to this study. These concepts underpin the learning intervention in this study; therefore, current research was explored to ground the learning intervention in the global scientific consensus on climate change knowledge and its impacts. The chapter then reviews education's response to climate change, as a global issue, from an international perspective and subsequently shifts to a more focused lens on climate change education in Aotearoa (New Zealand). Aotearoa's approach is influenced by international research and education programmes. However, the literature reviewed for this research indicates an emphasis on cultural responsiveness in Aotearoa's climate change education. The review then examines examples of Indigenous environmental education in schooling across the globe, drawing on examples from as close as Australia to further afield, including the Indigenous Peoples of the Americas and tribes in different parts of the African continent. Throughout, there are local contexts of Māori hapū (subtribe) and Iwi (tribe) within Aotearoa, as well as the Mātauranga (knowledge) Māori used in the environmental context, in some cases in kura (school) or with potential future applications in kura. Finally, the chapter concludes by examining literature that highlights the interconnected relationship between human food sources and climate change.

2.2 Climate Change

This section of the literature review focuses on the fundamental aspects of climate change and its global impacts. There is an initial focus on the differences between the weather and climate. It then moves on to greenhouse gases and the greenhouse effect, as well as what emissions are. Finally, there is a focus on some of the potential impacts of climate change around the globe, as well as specific impacts Aotearoa faces. It is worth noting that this is not a comprehensive list of impacts, but rather a condensed list relevant to the learning intervention in this research.

2.2.1 Climate vs Weather

When developing an understanding of climate change, one of the first important concepts to grasp is the distinction between weather and climate change (NIWA, 2020). Weather and

climate are closely related and can commonly be thought of as the same, but this is incorrect. The weather refers to what a person observes and experiences in the short term, typically over minutes, hours, or days. Conversely, climate describes the conditions in a specific location over a long period of time (NIWA, 2020). To determine the climate of a specific area, scientists examine the averages of weather patterns, such as rainfall, temperature, sunshine, and wind speed, over a more extended period, typically 30 days. These long-term averages of weather observations are referred to as climate normals. Establishing these climate normals helps scientists determine patterns and trends over much larger spans, such as years or decades. Climate, therefore, provides a general expectation of the conditions in a season of the year but will not tell us what the weather will be like on any given day. Meanwhile, the weather refers to the conditions we experience on any given day of a particular season or year (NIWA, 2020).

2.2.2 Greenhouse gases and the greenhouse gas effect

Greenhouse gases are atmospheric gases that block infra-red radiation (or heat) from leaving the Earth's atmosphere. Greenhouse gases, in essence, make an artificial blanket that wraps around the planet, trapping heat that would otherwise leave into space. This leads to a warming process called the greenhouse gas effect (Hausfather, 2022; Hayhoe, 2022; NIWA, 2017). Greenhouse gases let visible light in from the sun, which in turn heats the Earth. At night, as the Earth cools, some of this heat or infrared energy gets trapped by the greenhouse gases as it radiates back towards space. It is this trapping of heat that is comparable to a greenhouse, thus the origin of the name, even though actual greenhouses trap heat by stopping hot air from rising away, which is a very different effect. Without the greenhouse gases, the Earth's average temperature would be significantly lower, and Earth would be a frozen planet (NIWA, 2017).

Since the Industrial Revolution began, human activity has been producing increasing amounts of greenhouse gases. Over that time, the amount of greenhouse gases in the atmosphere has increased exponentially (NIWA, 2017). This has caused an imbalance in the system, meaning that Earth's average temperature has increased since the Industrial Revolution (Hausfather, 2022; Hayhoe, 2022). This global warming is leading to measurable changes in climate (Hausfather, 2022; Hayhoe, 2022).

There are different types of greenhouse gases in the atmosphere. In defining a greenhouse gas, NIWA states, “In general, any gas with molecules made up of three or more atoms absorbs infrared radiation and are therefore greenhouse gases” (NIWA, 2017, para. 2). The most commonly mentioned greenhouse gas when discussing climate change is carbon dioxide (CO_2). However, there are many more types of greenhouse gases, both naturally and artificially produced. These include water vapour (H_2O), methane (CH_4), nitrous oxide (N_2O), and artificial gases such as chlorofluorocarbons (CFCs) (Hausfather, 2022; Hayhoe, 2022; NIWA, 2017). The potency and time that the different greenhouse gases last in the atmosphere differ between each gas, but all contribute to the greenhouse gas effect.

2.2.3 Emissions

When discussing climate change, emissions refer to the production and discharge of greenhouse gases into the atmosphere (United Nations, n.d.). The primary emissions contributing to climate change are carbon dioxide and methane (Hausfather, 2022; Hayhoe, 2022; United Nations, n.d.). These gases can be emitted in various ways, but the primary activities that emit them include energy generation, industry, transportation, building, agriculture, and land use (United Nations, n.d.). In Aotearoa, according to the New Zealand Greenhouse Gas Inventory 1990-2017 produced by the New Zealand Ministry for the Environment (New Zealand Ministry for the Environment, 2025), the agriculture sector is responsible for emitting the highest amount of greenhouse gases in Aotearoa. It emits a combined total of 48.1% of the country’s greenhouse gases (New Zealand Ministry for the Environment, 2025). These emissions, in large part, are caused by the digestive systems of cows and sheep. As these animals are farmed intensively by the sector, 36.6% of emissions can be attributed to different forms of cattle farming and 12.7% to sheep farming (New Zealand Ministry for the Environment, 2025). The energy sector is the second biggest emitter of greenhouse gases in Aotearoa. When broken down, transportation accounts for 19.7% of emissions, manufacturing and construction for 8.6%, and electricity generation for 4.4%, respectively. Other key emitters in the Aotearoa emissions profile are industrial processes, which account for 6.1% of the overall emissions, and waste, which accounts for 5.1% of the overall emissions (New Zealand Ministry for the Environment, 2025).

2.2.4 Impacts of Climate Change

Researchers in Aotearoa and around the world are beginning to understand the various ways in which warming leading to climate change can impact the Earth and its inhabitants. Some

impacts, such as weather pattern changes, sea-level rise, and ocean acidification, are already evident. Other impacts are less clear. Climate change has the potential to impact all people and other species on the planet in various ways. Some of the possible ways that climate change can have an impact are:

- Hotter temperatures and heat waves (Godin, 2022).
- Dangerous risks posed by more frequent and extreme weather events (Godin, 2022).
- Rising sea levels, caused by the melting of ice in polar areas and glaciers, pose significant issues to coastal communities and low-lying islands (Godin, 2022).
- Ocean Acidification and the impacts this has on aquatic ecosystems and the animals that depend on these systems (Godin, 2022).
- Ecosystems, in general, are affected, as when one species is affected by the changing environment, all other species have flow-on effects due to their interconnected relationships as being part of a connected food web (Godin, 2022).
- Rising temperatures and extreme weather effects on food production. (NIWA, 2023; United Nations, n.d.).

Due to the massive span and complexity of climate change, the primary focus of the learning intervention in this study with primary school ākonga (learners) was the relationship between climate change and food. This focus includes what we eat and how that food is produced impacts our environment and the climate. Globally, about a third of all human-caused greenhouse gas emissions are linked to food (United Nations, n.d.). As outlined in Section 2.2.3, the agriculture sector contributes 48.1% of Aotearoa's emissions, the size of this making it relevant for ākonga to explore (New Zealand Ministry for the Environment, 2025). The main factors contributing to these emissions are methane from animal digestive processes, nitrous oxide from fertilisers used in crop production, and carbon dioxide from deforestation for the expansion of farmland (United Nations, n.d.). The impact that climate change has on food and its production globally are focused on changing temperatures in the growing environments, more frequent and extreme weather events such as heatwaves and flooding, increased pests due to changing temperatures, increased ocean temperatures and acidification of ocean environments and the effects this has on seafood stock, and the potential effects of water availability (Godin, 2022; United Nations, n.d.). Here in Aotearoa, climate change will probably have the most significant effect on agriculture through changes in climate variability and climate extremes affecting crop yields and the ability to raise stock (New Zealand Ministry for the Environment, 2001).

Climate change is a very relevant issue for every human on Earth. It is a complex issue with far-reaching global implications. Therefore, as highlighted by the United Nations (2020), educating youth across the globe to build an understanding of climate change, its impacts, and thereby a better understanding of how to mitigate these impacts, is one of the key levers in addressing this intergenerational issue (United Nations, 2020).

2.3 Review of climate change education and research internationally in education settings

2.3.1 Education is a key lever to addressing climate change

In major international climate change talks, such as the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC), education has been identified as a key lever in addressing climate change (McKenzie et al., 2023; United Nations, 2015, 2020). Education can encourage people to change their beliefs and behaviours, becoming more informed when making individual decisions, which, when each decision is tallied, can help collectively mitigate climate change impacts (United Nations, 2020). Including climate change education in national curricula across a broader range of countries will help to meet the Sustainable Development Goals set by the UN, which every participating country has signed in 2015 (United Nations, n.d, 2020). Currently, education is recognised as a vital space for addressing climate change. Current approaches sometimes fall short or, at worst, can contribute to denial and inaction, for example, using industry-influenced pro-fossil fuel curricula (McKenzie et al., 2023). McKenzie et al. (2023) and other researchers cited in this literature review argue that many climate change education programmes are lagging and have a disconnect with climate action.

Historically, climate change education internationally has focused primarily on scientific facts, often through STEM subjects (Science, Technology, Engineering and Maths), but this may not have led to effective changes in attitudes or to significant action. These latter types of education are often marginalised and overlook the deeper social, psychological, and justice aspects of the climate crisis (McKenzie et al., 2023). McGimpsey et al. (2023) suggest that although youth activism has grown over the past two decades, perhaps inspired by youth activist movements like school strikes for climate, education systems are not keeping pace. Even though climate change has become a more widely taught topic in schools over the past

decade, some of the ways it is being taught may not have led to young people changing their views or taking direct action (McGimpsey et al., 2023).

2.3.2 Personally relevant and meaningful learning

Throughout the literature reviewed for this research, a theme emerged highlighting the need for climate change education to move from a siloed, scientific lens to a more holistic view. Whether this was brought up in wide ranging systematic reviews of current climate change education practices in certain regions (Monroe et al., 2019; Nepraš et al., 2022), or closer looks into educational research (McKenzie et al., 2023), or specific learning models (Akaygun & Adadan, 2021), a commonality of these research papers was the need to not isolate climate change education into a scientific silo. McKenzie et al. (2023) highlight the potential of pedagogies that orient towards affective, interdisciplinary, and intergenerational thinking, including engaging with storytelling, literature, art-making, and creative movement as modes of climate change education, while also being aware of colonial narratives and instead highlighting indigenous conceptualisations. Climate change education has often focused solely on the science, rather than addressing the structural, psychosocial, and justice aspects crucial for achieving equitable climate futures (Monroe et al., 2019; Nepraš et al., 2022). The education paradigm should not rely solely on knowledge transfer about climate change but also needs to focus on social-emotional learning and action-oriented learning (Monroe et al., 2019; Nepraš et al., 2022).

These scholars argue for a more expansive and integrated approach to climate change education that encompasses social, emotional, cultural, and action-oriented dimensions alongside scientific understanding. Allowing for a more holistic approach, in turn, enables climate change education to be more personally relevant and meaningful for a broader range of ākonga.

In their systematic examination of climate change education for primary school ākonga, Nepraš et al. (2022) highlighted the specific benefits of place-based or geospatial curricula for younger learners when engaging in climate change education. Their review suggested that although older ākonga can engage with climate issues through a holistic and abstract approach, younger ākonga benefit from place-based learning. This is because ākonga often perceive climate change as something distant and abstracted. In contrast, place-based learning helps to make it more tangible and relatable by bringing the learning or action down to their

community level. Bringing learning to the local area is again highlighted as one of the key themes identified as particularly effective in addressing complex and potentially controversial topics, such as climate change, in Monroe et al. (2019). This moves away from only teaching in the akomanga (classroom) and engaging ākonga in practical, hands-on projects within their kura or communities that connect directly to climate action. This can make learning more relevant and meaningful to ākonga, empowering them to act on a small scale and see the impact of their efforts (McGimpsey et al., 2023; Monroe et al., 2019).

The location and context of the learning can significantly influence perceptions of climate change and how ākonga may think of and describe it, as well as its range of impacts (Sjöblom et al., 2022). When comparing responses of ākonga from two countries, Finland (a high-income country in Northern Europe, less vulnerable to climate change) and Tanzania (a lower-middle income country in East Africa, highly vulnerable to climate change impacts like droughts and floods), Sjöblom et al. (2022) found the responses to what climate change is and its impacts differed significantly. Tanzanian ākonga were more familiar with and concerned about the tangible, local impacts of climate change, such as floods leading to disease, soil erosion affecting crops, and increased refugees due to climate events. They recognised that climate change has a direct impact on their communities and families. Finnish ākonga were more concerned about global impacts, such as melting ice caps and endangered animals in distant countries. They generally did not perceive climate change as a direct threat to their future (Sjöblom et al., 2022). From this research, a kaiako (teacher) planning to teach about climate change should be aware of the place in which they are teaching and the potential impact that may have on ākonga thought processes around climate change and its impacts. Accounting for this involves considering both local and global impacts.

The learning that can be engaged with in climate change education can be confronting, heavy, and emotionally overwhelming for any human to interact with, especially for younger ākonga. Baker et al. (2021) highlighted the connections between environmental education's aims to increase knowledge around climate change and the links to the emotional needs of learners. The research suggests that both teachers and parents should have access to resources to help learners deal with emotions that come with learning about climate change (Baker et al., 2021). Many of the researchers' articles reviewed for this study shared a commonality in emphasising the power of hope in pedagogy (Dolan, 2021; Monroe et al., 2019; Sjöblom et al., 2022). They emphasise the need for programmes to inspire hope and create motivation to

act by connecting global issues on a local scale (Monroe et al., 2019). In the study by Sjöblom et al. (2022), the Tanzanian ākonga still maintained hope, despite already experiencing direct impacts on their local communities from climate change, due to their envisioned future roles in mitigating the effects of climate change. This emphasises the crucial role of teachers in empowering students and fostering constructive hope by helping them understand the problem and their potential to make a difference (Sjöblom et al., 2022).

2.3.3 Active and engaging teaching methods

Throughout the literature reviewed for this research, various pedagogies were identified that employed engaging and active methods in climate change education. Some of those methods highlighted for this review are discussed below.

The work of Monroe et al. (2019) reviewed various climate change education models and teaching programmes, highlighting several key themes for teaching climate change. Engaging in deliberate discussions about climate change is one such theme. Encouraging ākonga to engage in deep discussions about key concepts within climate change helps them to understand different viewpoints, clarify their ideas, and address misconceptions by comparing and critiquing ideas. Providing opportunities for ākonga to interact with scientists or other experts in their field and the scientific process is a further theme highlighted by Monroe et al. (2019). They suggest allowing ākonga to interact with scientists, collect data, use scientific tools, and to understand how scientific knowledge is built helps increase their interest, knowledge, and confidence in climate change science. The flow-on effect of this means that ākonga who could interact with scientists and the scientific process may be less susceptible to deliberate misconceptions about climate change. A final theme included in the work of Monroe et al. (2019) focuses on active and engaging teaching methods to directly address misconceptions. Successful programs specifically design interventions to uncover and correct common misunderstandings through experiments and guided discussions. These misconceptions may come from deliberate misinformation from so-called climate deniers or misconceptions developed from prior learning, such as confusing climate change with the ozone hole or general pollution.

The power of verbal narrative through lived experiences and learning through narrative was highlighted in McGimpsey et al. (2023) and Turner and Wilks (2022). The authors, based in Australia, presented the use of Aboriginal narratives, as well as links to similar Māori

knowledge concepts in education, particularly in early childhood contexts, as a pathway to create more culturally responsive frameworks for climate change education. These frameworks argue for highlighting indigenous knowledge in what is usually an unbalanced, Western scientific knowledge-centred topic (McGimpsey et al., 2023). This leads to "embodied and emplaced pedagogical approaches drawn from Indigenous wisdoms" that cultivate collective identity and relationality, which implicitly rely on shared stories and cultural narratives (McGimpsey et al., 2023, p. 5). This is not just simply the use of 'storytelling' in science but rather giving mana (in this context authority) to what are often 'othered' ways of knowing, and in doing this allows learners to connect to their narrative and prior knowledge that comes from the shared narrative and their whakapapa.

Furthermore, McGimpsey et al. (2023) highlight the use of dramatisation and visualisation as a pedagogical tool for climate change education, which has significant potential to impact the intersection of climate activism and education. Climate education pedagogy scholars recognise an often-unbridged gap between climate activism and action, and climate education (McGimpsey et al., 2023; McKenzie et al., 2023). Both these articles highlight the potential of utilising creative methods, such as visual art, digital media, and performance, to help young people understand and express their concerns about climate change, thereby engaging with their emotions and experiences (McGimpsey et al., 2023; McKenzie et al., 2023).

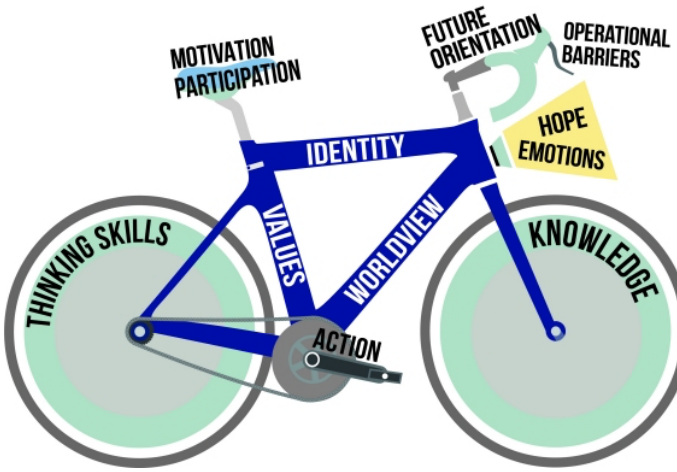
The role of digital media is seen to be valuable in "staging new possibilities for climate change education and activism" (McGimpsey et al., 2023, p.4), where young people "perform climate activism and construct new political subjectivities through affective investments of feeling and desire". These forms of visual and digital dramatisation can be seen as modern expressions of verbal narrative, using diverse media to convey experiences, emotions, and calls to action related to climate change. This use of modern and traditional verbal narrative has the potential to increase engagement in a wide range of ākonga.

A wide range of teaching models for climate change education have been designed by different researchers globally, some adapted from general pedagogies for their potential benefits in climate change education, such as the inquiry teaching method (Akaygun & Adadan, 2021). They recognise the essential role of inquiry-based instruction in climate change education, as it promotes students' scientific understanding of climate change among primary-aged ākonga. This method features interdisciplinary, first-hand learning experiences

and opportunities to co-construct learning with other ākonga, which the authors consider important (Akaygun & Adadan, 2021). Other broader models have been designed by researchers specifically for climate change education. One which has been chosen to review for the potential to sit well in this research is the 'Bicycle Model on climate change education' by Cantell et al. (2019) (see Figure 1).

Figure 1

The Bicycle Model on Climate Change Education



Note. This figure illustrates a model to help guide climate change education. Adapted from *Bicycle model on climate change education: presenting and evaluating a model*, by Cantell et al., 2019. Copyright 2019 by Taylor & Francis

This model is based on an extensive literature review of climate change education conducted by the authors. The purpose of this model is to highlight the aspects to give an overall impression of the essential aspects of climate change education, providing an easy-to-understand yet rigorous representation of how various factors contribute to effective climate change education. The key components of the Cantell et al. (2019) model are as follows:

The Wheels

- Knowledge: Understanding the scientific facts and concepts related to climate change.
- Thinking skills: Developing critical thinking and problem-solving skills, which are needed to interact with the often-complex climate issues.

The Frame

- Values: The moral and ethical considerations that guide actions and perspectives on climate change.
- Identity: How a person's own perception and affiliations influence their engagement with climate change issues.
- Worldviews: The overarching beliefs and assumptions that shape a person's understanding of the world and its environmental challenges.

The Chain and Pedals

- Action: The knowledge and thinking skills are put into practical action. The steps individuals take to confront and address climate change.

The Saddle

- Motivation and participation: A bike is useless without a rider, but a bike won't get used if it is too difficult or uncomfortable to ride. The saddle is the motivation and the internal drive to learn about and act on climate change. The participation and engagement in the decision-making processes of individual and collective climate action.

The Brakes

- The operational barriers: It is essential to understand the barriers to action in climate change, whether they be human tendencies, structural reasons, financial constraints, or psychological and socio-cultural barriers. One needs to identify and address, where possible, these barriers to create effective climate action and education.

The Light

- Hope and other emotions: Fostering the powerful emotion of hope, rather than developing despair, is crucial in any climate change education programme. "Instead of negativity, climate change education should stimulate hope and compassion in people" (Cantell et al., 2019, p. 721). As well as recognising and acknowledging other emotions that may arise during climate change engagement.

The Handlebar

- Future orientation: The future is a massive part of climate change education. The ability to look forward critically, in a positive light, for sustainable future(s) helps ākonga to engage with and foster possible ideas around climate change mitigation.

The bicycle model for climate change education (Cantell et al., 2019) provides people in education, from policymakers to individual kaiako, with the tools and guidance to develop a well-rounded climate change education curriculum or learning framework to make climate change education programmes.

2.3.4 Climate justice and Indigenous knowledge

In both international and local research into climate change education, a commonality that has appeared is the call for integration of indigenous knowledge to create engaging and relevant education, which is localised to the area where it is being taught. The more specific application of mātauranga (knowledge) Māori in climate change education is addressed in Section 2.4.2, and in Section 2.5 there is a broader examination of examples of indigenous knowledge in climate change education. Bishop (2003) in his foundational text on critical pedagogy, specifically critiques the colonialism and epistemological racism in education. Bishop (2003) argues that the inclusion of kaupapa (topic, theme, plan, issue, programme) Māori is a response that can create more culture diversity, rooted in Māori aspirations, experiences, and cultural understandings.

It is worth noting that several researchers mentioned that providing space for indigenous knowledge in climate change education can only benefit the programmes. McGimpsey et al. (2023) refer to cultivating trust in children's judgment, addressing their complex relationality, and fostering a collective identity in climate change education. They suggest creating culturally responsive frameworks for climate change education that incorporate both non-Western and Indigenous knowledges. The authors refer to research that proposes "listening to Māori and Aboriginal Australian worldviews as a way forward for intergenerational action" (McGimpsey et al., 2023, p. 5) on climate justice issues. In McKenzie et al. (2023), the authors highlight the pedagogical potential of anti-colonial verbal narrative, Black and Indigenous conceptualisations of relationality, and land and water-based creative approaches to climate change education. This suggests that the authors' perspectives on Indigenous knowledge and related pedagogical approaches are valuable and effective for climate change education (Bishop, 2003). Irwin (2020) suggests that there needs to be a shift in pedagogy,

toward an eco-centric orientation in response to climate change, a “reinvigoration of indigenous philosophy which understands human communities as the land, not in contrast with the land.” (p. 497). Incorporating Indigenous philosophical thinking is crucial for fostering a deeper, more interconnected understanding of environmental health, and sustainability, as suggested by Irwin, is vital for effective climate change education.

Section 2.3 has examined some examples of international climate change education and the research surrounding this, emphasising its essential role in tackling climate change. While education serves as an important tool, current methods may sometimes fall short and, in some worst cases, support fossil fuel narratives. Traditionally, climate change education has mainly focused on science, which can lead to the minimisation or omission of important social, psychological, and justice dimensions. There is a recognised need for a holistic, interdisciplinary approach that encourages personally relevant and meaningful learning. This approach should move beyond isolated scientific knowledge to incorporate emotional, interdisciplinary, and intergenerational perspectives, as well as creative and narrative-based methods. The following section has a focus on climate change education and research in Aotearoa specifically.

2.4 Review of climate change education and research within Aotearoa education settings

Within Aotearoa, the integration of climate change education into the national curriculum has been a prolonged and often inconsistent process. While the current curriculum, T*he New Zealand Curriculum* (2007), is undergoing a refresh, early drafts of this refresh, *Te Mātaiaho* (2023), did include explicit mentions of climate change; earlier curricula lacked direct emphasis, leading to fragmented implementation across kura in Aotearoa. This has resulted in climate change education often being dependent on individual teacher knowledge and confidence, with a tendency towards oversimplification or tokenism. Consequently, there is a recognised need to embed climate change education holistically across a range of learning areas, ensuring it is intergenerational and culturally responsive, acknowledging and integrating mātauranga Māori.

2.4.1 Climate change education in Aotearoa

At the time of writing, Aotearoa is revising the national curriculum. The current Curriculum, *The New Zealand Curriculum* (New Zealand Ministry of Education, 2007), is being redeveloped learning area by learning area into a new Curriculum, *Te Mātaiaho* (New Zealand Ministry of Education, 2022, 2023). In *The New Zealand Curriculum*, there is no direct mention of climate change or the broader learning area of sustainability education (New Zealand Ministry of Education, 2007). However, the learning objectives in the science and social science learning areas leave scope for kaiako to teach climate change concepts from a scientific or socio-perspective (New Zealand Ministry of Education, 2007). In the draft of *Te Mātaiaho*, there have been explicit mentions of climate change in the 2022 Te Ao Tangata (social science learning area) draft (New Zealand Ministry of Education, 2022), although not directly mentioned until the progress outcome, typically by the end of Year 10. In earlier progress outcomes, there are clear links that teachers can use in the "Understand, Know, Do" models to lead to climate change education. In early drafts of Te Ao Tangata, there were more direct mentions of climate change, focused on younger levels, but feedback (to the curriculum developers) suggested it was too depressing and repetitive (C. Lunjevich, personal communication March 30, 2023). The current documents have the potential to lay the foundations for understanding climate change in the early schooling years, and it is not until later in schooling that the more explicit teaching of climate change can fit more naturally into *The New Zealand Curriculum*. This has the potential to cause issues because the senior secondary subjects in which climate change education could be taught are often optional. In essence, this means that ākonga have the potential to go through their entire education with no formal school learning of climate change, its impacts and how we as humans may be part of solutions to this generational issue (Eames, 2017; Everth et al., 2021).

Perhaps, because of the lack of direct mention of climate change in learning areas in *The New Zealand Curriculum* from 2007 to 2022, research indicates that there is only sporadic coverage of climate change education in kura across Aotearoa (Eames, 2017; Everth et al., 2021). Much of the uptake in climate change education is therefore dependent on the individual kaiako and kura within Aotearoa. Teaching climate change education in Aotearoa varies and may depend on the confidence and knowledge of the kaiako teaching the topic, as well as the development of that kura's localised Curriculum (Eames, 2017). Everth et al. (2021) suggest that antagonistic or tokenistic approaches towards climate change education remain within Aotearoa school leadership. One common theme in various research studies on

climate change education in Aotearoa classrooms is the risk of oversimplification. Reynolds (2020) summed it up as the seduction of recycling, highlighting the one small action that, overall, has a relatively minor role to play in the systemic changes needed to address the rapid changes in the Earth's climate, yet in some climate change or environmental education learning, this action may become central in learning. This may lead to the oversimplification of climate change and, secondly, to ineffective responses to mitigate climate change (Reynolds, 2020).

There are, however, fantastic examples of climate change education throughout kura and community organisations in Aotearoa. Programmes that track and improve the health and biodiversity of awa in built-up city areas (Bolstad & Durie, 2024), kura-led initiatives to bring back animals from the brink of localised extinction (Bolstad & Durie, 2024); and use of a carbon calculator to identify ways of cutting carbon emissions (Bolstad & Durie, 2024).

2.4.2 Embracing both mātauranga Māori and Western science

There is great potential for the use of both Western science and mātauranga Māori for climate change education, and for these two branches of knowledge to be used together in a uniquely Aotearoa approach to climate change education. There are examples of this happening in both English-medium kura and kaupapa Māori kura (te reo Māori medium kura) around Aotearoa within the broader context of sustainability education currently (Bolstad & Durie, 2024; New Zealand Ministry of Education, 2020; Russell, 2024). However, there is scope and encouragement from educational researchers for this approach to become a standard in science education and the broader concepts of climate change education (Bolstad & Durie, 2024; New Zealand Ministry of Education, 2020; Russell, 2024).

The research by Hipkins et al. (2022) discussed enduring competencies for science education with a key suggestion being the concept of mana ōrite (equality) in science education. This means recognising that both mātauranga Māori and Western Science are "valuable, rigorous, and reliable knowledge systems for understanding the natural and physical world, and particularly for understanding how to live sustainably together in Aotearoa New Zealand" (Hipkins et al., 2022, p. 8). The authors go on to suggest that both knowledge systems have norms for assessing validity, though these differ between the two knowledge systems. They both seek an authoritative version of how things work, although these can change and evolve, and they strive to be as factual as possible without directly linking to social issues. However,

a contrasting difference is that in Western science, context is deliberately lacking, whereas in the mātauranga Māori, context is critical (Hipkins et al., 2022). This need for context in mātauranga Māori drives the need for relationships between kura and local hapū and iwi to help develop localised curricula that bring mana (in this context: authority) to the potential science and mātauranga Māori blend possible in climate change education. This relationship is critical for an interface between mātauranga Māori and science to be successful (Hipkins et al., 2022).

There are numerous potential examples of how mātauranga Māori and Western science could be combined to develop effective climate change education within an Aotearoa context. These are explored further in section 2.5 where Indigenous environmental education is reviewed.

2.4.3 What could Aotearoa climate change education look like?

There are many suggestions from the research and literature reviewed for this study suggesting where climate change education may be headed and what might be best for ākonga learning in Aotearoa. Some of the key aspects are highlighted below.

Climate change education and the broader concept of sustainability education could be introduced earlier in the educational system. As already cited in this literature review, in Te Ao Tangata draft, part of the curriculum refresh draft of *Te Mātaiaho*, the first direct mention of climate change is in the learning progressions for year 10 ākonga (New Zealand Ministry of Education, 2022, 2023). There is a clear need for learning about climate change earlier in the curriculum; however, without direct mention in the curriculum, it is up to individual kaiako and kura to decide when or if to engage in climate change education earlier. This lack of direct mention in the curriculum has the potential to lead to a continued lack of consistency and underrepresentation at younger ages across the kura of Aotearoa that is currently experienced in the education system (Bolstad & Durie, 2024; Everth et al., 2021). The United Nations cites education as "a critical agent in addressing the issue of climate change" (United Nations, 2020., para. 1), continuing to explain that the organisation aims to increase climate literacy in young people, including primary school-aged ākonga. The authors involved in the report *Building capacity for climate change education in Aotearoa New Zealand schools* (Everth et al., 2021) suggest that, in the curriculum refresh, climate change should become one of the key learning ideas and be incorporated throughout the curriculum. This aligns with

guidance from the United Nations and would be a significant step towards meeting obligations under the Paris Agreement in 2015 (and subsequent agreements that followed) that Aotearoa signed.

Several research studies that explore climate education in Aotearoa and look towards what may be possible converge on some key themes. They include concepts such as learning must be personally relevant at both a local and global level, include and centralise climate justice, provide ākonga with the space to connect with whenua (land), practical activities, learning be empowering for ākonga, and the ripple effect from kura to home and the community (Bolstad & Durie, 2024; Everth et al., 2021; Reynolds, 2020).

Both Reynolds (2020) and Bolstad and Durie (2024) emphasised the need for climate change learning to be relevant to ākonga on both a global scale and locally. Understanding the importance of climate change's effects on both global and local scales is crucial. Therefore, solutions can start at a local level, where ākonga can be key contributors to increasing engagement and harnessing both kaiako and ākonga's desire to do something positive.

Climate justice is a broad, intersecting concept that emerged in the 2000s. Leah Thomas (Thomas, 2022), an activist and academic, was one of the first people to draw attention to the intersecting relationship between climate change and a range of other issues. The concept of climate justice developed from this understanding. Bolstad (2022) defines climate justice as:

> Climate and environmental justice are a shorthand to explain that environmental and climate challenges are not just about science or economics—they are inherently social justice issues and human rights issues. Climate change and environmental harm affect everyone, but some people will be more severely affected than others. The people and groups who are most affected are often the least responsible for creating the problems. A climate and environmental justice approach says that the needs, rights, voices, and aspirations of the most affected people and groups must be centred on how societies respond to, and take action on, climate change and sustainability... Climate and environmental justice also acknowledge the inherent rights and value of the more-than-human world, including other species and ecosystems, and spiritual and metaphysical dimensions (p.1).

Including concepts related to climate justice in climate change education is crucial for addressing broader systemic issues that affect everyone in society. Bolstad and Durie (2024)

suggest it is a step towards decolonising environmental education and helps to enable youth who will become leaders and decision-makers in the future.

The importance of dedicating time during learning to whenua/nature-based learning was another key finding of Bolstad and Durie's (2024) study. Creating time for ākonga to experience and be present in outdoor spaces while engaging in climate education was a vital component of the case studies at Te Ahi Kaa and the Climate Action Campus (Bolstad & Durie, 2024). Being in the māra (garden) or lying down on the whenua created time and space for informal conversations and connections to self/others that may not have necessarily happened in a traditional classroom setting. Connecting learning to whenua was significant and enjoyable for many learners in the various case studies explored by Bolstad and Durie's (2024) research, and it held particular significance for ākonga Māori.

Climate change affects the planet on such a global scale that it can often feel overwhelming and take a massive emotional toll on people who are learning about it and working towards a better future for the planet. In the case studies of Bolstad and Durie (2024), kaiako and ākonga highlighted the holistic well-being benefits of hands-on activities, such as environmental restoration, growing food, repairing clothes, painting murals, and engaging in community service. There seem to be many benefits to engaging in hands-on, action-based learning in climate change and environmental education. Given a chance to develop their own actions, if ākonga had a strong personal drive and were motivated, they tended to invest greater time, focus, and energy into their projects, resulting in more impressive outcomes (Bolstad & Durie, 2024). Ākonga and kaiako felt empowered when they could take tangible actions, which is a key contributor to increased engagement in their learning (Bolstad & Durie, 2024). A key suggestion from Everth et al. (2021) is that the refreshed curriculum prioritises education that empowers youth to better understand and respond to the climate crisis. They further suggest that "readiness to inhabit a climate-altered world" should be designated as a key graduate attribute for ākonga at all levels (Everth et al., 2021. p. 44).

A final approach highlighted in the literature regarding effective climate change education is for ākonga to engage with their learning in the akomanga and then create a ripple effect from the akomanga out to their whanau and the wider community (Everth et al., 2021; Reynolds, 2020). This ripple effect offers the opportunity to debunk potential myths and misleading

information about climate change through conversations around the dinner table or on the couch at home (Everth et al., 2021).

In summary, climate change education in Aotearoa has progressed inconsistently, with earlier curricula lacking explicit mentions of climate change, resulting in varied and often superficial implementation, which often relies on individual educator capabilities. While recent curriculum updates in Te Mātaiaho (2023), now mention climate change directly, a holistic and culturally responsive approach remains essential to move beyond fragmented, at times too simplified teaching. This necessitates embedding climate change education across various learning areas, ensuring it is interdisciplinary and meaningfully integrates mātauranga Māori, thereby moving beyond tokenism to address the complexities of climate change effectively within a culturally responsive, Aotearoa-specific framework. Next, the review delves more deeply into the use of Indigenous knowledge in environmental education across the world, with a particular focus on the use of mātauranga Māori in education in Aotearoa.

2.5 Review of Indigenous environmental education

This section of the literature review examines some of the existing landscape of Indigenous knowledge used in environmental education and research, both internationally and within Aotearoa New Zealand. This includes reviewing some key aspects, such as the use of Indigenous knowledge systems to make more holistic and just climate change learning, the use of local context in climate change education, creating a balance in the way both Indigenous and Western knowledge is used and shared in a classroom, and the use of Indigenous narrative to pass on knowledge intergenerationally. A combination of all these and other forms of indigenous knowledge, specific to the area of teaching and learning, helps to decolonise the curriculum of climate change education.

2.5.1 The centralising of Indigenous knowledge systems for holistic and just climate change education

The authors of research reviewed for this literature review almost always centralised the concept of an Indigenous knowledge system, or something similar to this but under a different name, to help guide climate change education, which traditionally has been predominantly taught under the premise of Western Science (Bleazby et al., 2023; Cajete, 2020; Olstead & Chattopadhyay, 2024; Tanyanyiwa, 2019; Thornton et al., 2019; Turner &

Wilks, 2022). The concepts within the differing Indigenous frameworks for climate change education are unique to the Indigenous peoples they represented; however, similar themes emerge throughout. Indigenous knowledge systems are a complex concept to define due to their inherently localised nature; however, they represent intricate knowledge systems encompassing technology, social, economic, philosophical, learning, and governance systems. This knowledge is deeply connected to specific places, environmentally determined. It forms the basis for decision-making and survival strategies for Indigenous peoples, being informed by socio-economic, physical, and spiritual understandings developed over long periods (Tanyanyiwa, 2019).

Almost every framework reviewed had an aspect that directly touched upon the importance of place and local context in Indigenous knowledge-centred climate change education (Bleazby et al., 2023; Cajete, 2020; Datta, 2018; Russell, 2024; Tanyanyiwa, 2019; Turner & Wilks, 2022). Allowing for and centralising learning to be outside, connecting to local land gives a chance to ground the otherwise abstract concepts of climate change (Bleazby et al., 2023; Turner & Wilks, 2022). Seeing the local effects of climate change and perhaps contributing to small forms of mitigation can increase engagement, understanding and provide hope for learners (Bleazby et al., 2023; Datta, 2018; Turner & Wilks, 2022).

Another common theme that appeared in many of the Indigenous knowledge systems highlighted in the readings as part of this research was the power of alternative perspectives and the positive impacts this can provide for learning in climate change education (Cajete, 2020; Datta, 2019; Russell, 2024; Olstead & Chattopadhyay, 2024; Tanyanyiwa, 2019). Indigenous knowledge systems can create a balance in climate change education by complementing Western science, providing a deeper understanding of climate change, its impacts, and potential localised mitigations (Tanyanyiwa, 2019). These alternative perspectives can foster greater engagement and enhance understanding of what is often a complex and abstract topic (Russell, 2024).

A common thread that was also reported in most Indigenous knowledge systems is the importance of deconstructing the human-nature divide that is deeply entrenched in Western science (Cajete, 2020; Olstead & Chattopadhyay, 2024; Tanyanyiwa, 2019; Turner & Wilks, 2022). This represents a significant paradigm shift in climate change education, which is often heavily biased toward Western science. This shift fundamentally represents a

movement away from viewing humans and nature as separate, with nature being treated as a resource, which has led to an extractivist economy that depletes and destroys environments worldwide, directly contributing to the rise of climate change (Cajete, 2020; Olstead & Chattopadhyay, 2024). The integration of Indigenous knowledge systems into climate education instead positions humans as part of the ecology, interconnected with place, part of a wider web involving other animals, plants and the earth or the ocean (Olstead & Chattopadhyay, 2024). This in turn leads to an emphasis on reciprocal, responsible, intergenerational care of the land and oceans (Olstead & Chattopadhyay, 2024; Turner & Wilks, 2022).

In the context of Aotearoa, the Indigenous knowledge system that is central and relevant to the learning intervention is Kaupapa Māori, which centralises te ao Māori (the Māori worldview) and mātauranga Māori in the framework (Bishop, 2003; Highfield & Webber, 2021; Hikuroa, 2017; Hipkins et al., 2022; Lee, 2009). Within mātauranga Māori, there are numerous forms of knowledge, many of which share similarities with the Indigenous knowledges presented throughout this section.

A central pillar of mātauranga Māori is the use of pūrākau, explored further in in Section 2.5.3. Another pillar is maramataka. Maramataka is defined by Hikuroa (2017) as a calendar that divides the Māori year into lunar months, serving as a framework that marks time, based on the moon's orbit around the Earth. It contains centuries of detailed observations, built upon evidence, and hypotheses that were tested and critically analysed to show the natural rhythms and variations of the lunar cycle (Hikuroa, 2017). At Te Wharekura ō Arowhenua, maramataka is used in planning to determine when to undertake certain activities, such as sports events during high-energy phases, and calmer activities during lower-energy phases (Heke, 2022). Jenny Neill, a kaiako in an English medium kura, when interviewed by Heke, said, "Maramataka allows us to connect with the vibration of nature, time, students and our community" (Heke, 2022, p.47). Another pillar of kaupapa Māori that is relevant to climate change education is having learning that is localised to the area is also another important aspect of kaupapa Māori (Heke, n.d.). This localised learning links directly to the concept of whakapapa, the Māori concept of genealogy. From a Māori perspective, everything in te ao Māori has whakapapa; therefore, the connections between the local area and its different environments and beings are intrinsically related (Heke, n.d.). These concepts can be deeply embedded in climate education.

Overall, integrating different aspects of the local Indigenous knowledge system *with* Western science can create a more holistic learning environment for learners to engage with climate change education (Bleazby et al., 2023; Olstead & Chattopadhyay, 2024; Turner & Wilks, 2022;).

2.5.2 The importance of local context and place

Almost all the research reviewed as part of this literature review highlighted the importance of local place and context within Indigenous knowledge systems (Bleazby et al., 2023; Cajete, 2020; Datta, 2018; Russell, 2024; Tanyanyiwa, 2019; Turner & Wilks, 2022). Although touched upon in 2.5.1, this concept was of such importance throughout the various research studies that it needed to be expanded upon.

Turner & Wilks (2022) highlight in their research, which followed several primary schools as they co-designed a place with Gumbaynggirr Elders in Australia, how the use of local place is crucial for learning about climate change. These interactions and learning environments enabled learners to engage with climate change in a tangible and experiential way, allowing them to observe and feel its impacts directly in their local surroundings. This approach connects abstract global climate issues to their real-life experiences and community contexts, fostering a deeper and more personal understanding. It also cultivates a stronger sense of care and responsibility for their specific environments (Turner & Wilks, 2022).

Tanyanyiwa (2019) links the use of place in climate change education to a direct recognition of the inextricable connection between Indigenous knowledge and the lands of Indigenous peoples. Tanyanyiwa emphasises the relevance of local context and space as part of the Indigenous knowledge system for climate change education because Indigenous communities and their knowledge are often tied to social-ecological margins (such as forests and the oceans) where the consequences of climate change are most acutely experienced (Tanyanyiwa, 2019). This direct connection makes Indigenous knowledge systems crucial for understanding and responding to the impacts of climate change (Tanyanyiwa, 2019).

The term ‘sacred ecology’ is used by Cajete (2020) in their framework, which defines the Indigenous connections to the natural world, rooted in sustainable living, spiritual practices and cultural values. Cajete went on to connect this intrinsic connection to the environment

with traditional ecological knowledge, which is identified as a vital part of Indigenous science, offering profound insights and time-tested strategies for observing, understanding, and adapting to environmental changes. This knowledge is derived from extensive, long-term observation and a spiritual connection to specific places (Cajete, 2020). Throughout their essay, Cajete highlights these factors as vital in Indigenous knowledge systems, making the connection between place and environment essential for understanding climate change through climate change education that integrates Indigenous knowledge systems.

Autoethnography was an approach employed by Datta (2018) to examine how land-based education can challenge and transform Western environmental education within an Indigenous community context. Throughout their paper, they discuss land-based educational stories from Dene First Nation Elders (who come from the Northern Boreal, Subarctic and Arctic regions of Canada), knowledge holders, and teachers, and how this can facilitate unlearning, rethinking, relearning, and reclaiming environmental education (Datta, 2018). Datta believes that the use of land-based environmental education can act as a crucial bridge between Western and Indigenous educational systems, acting as a gateway to the decolonisation of environmental education (Datta, 2018). They note that "Western science education is no longer sustainable for the planet and, furthermore, is separated from practice" (Datta, 2018, p. 52). The inclusion of land-based learning has transformative potential of integrating Indigenous knowledge into environmental science education, leading to a more holistic and culturally relevant approach.

2.5.3 The use of verbal narrative in education

Much of the research read as part of this literature review specifically highlighted the use of narrative as a means of knowledge sharing in climate change education (Hikuroa, 2017; Russell, 2024; Turner & Wilks, 2022). Many Indigenous populations use a form of verbal narrative, particularly through storying, to impart knowledge intergenerationally, utilising it as a verbal codex for epistemological constructs, cultural codes, and views to be shared in understandable ways (Hikuroa, 2017). These verbal narratives are seen as vital aspects of teaching and learning in many Indigenous knowledge systems (Hikuroa, 2017; Turner & Wilks, 2022). In a study involving year 6 and 7 students on Gumbaynggirr land in New South Wales, Australia, the use of verbal narrative by Gumbaynggirr Elders about the histories, cultures and knowledge of the place was "instrumental to the students' learning" (Turner & Wilks, 2022, p.8) when the learners were helping to design the park, creating a climate

change resilient location and refuge for some climate refugees such as water birds that had their migration patterns disturbed by climate change impacts (Turner & Wilks, 2022).

In the local context of Aotearoa, pūrākau are a form of verbal narrative specific to mātauranga Māori. Pūrākau are a traditional form of Māori narrative, containing philosophical thought, epistemological constructs, cultural codes, and worldviews (Lee, 2009). Pūrākau are a central pillar of mātauranga Māori, used to encapsulate knowledge and understanding into concise and easily comprehensible forms (Hikuroa, 2017). There appears to be potential for using pūrākau as a guiding narrative for climate change education, utilising local or well-known pūrākau to inform aspects of learning (Cliffe-Tautari, 2020; Hipkins et al., 2022). This has the potential to create space for exploring a Māori worldview and provide identity for those who whakapapa Māori (have Māori identity) (Cliffe-Tautari, 2020; Hipkins et al., 2022). With guidance, the use of pūrākau can also create space for those who do not whakapapa Māori to engage with mātauranga Māori as an opportunity to explore and understand Māori worldviews. However, it does not provide them identity (Cliffe-Tautari, 2020; Hipkins et al., 2022). Charmaine Russell (2024), Head of the Science Department at a Wellington, New Zealand, high school, utilised pūrākau, an indigenous verbal narrative, to support the teaching and learning for ākonga in the school's science subjects. This helped foster an understanding of the local area, including providing alternative perspectives on scientific concepts in the region. She found the use of pūrākau to be an effective way to share knowledge, as well as to increase engagement in learning for the ākonga involved (Russell, 2024). Russell stated:

> The excitement from the students on the field trip was unbelievable. When they saw the changes along the fault line, they could understand how they came about through both worldviews. Students could identify the surface features along the Wellington fault and connect this to the Science and local history of tangata whenua (local Māori people). (Russell, 2024, p. 3)

2.5.4 Education as a tool for decolonisation

The use of, and equal status for, indigenous knowledge in climate change education can be a crucial tool in the decolonisation of education (Olstead & Chattopadhyay, 2024; Thornton et al., 2019). Colonisation of education refers to the process by which a dominant culture, often a colonial power, imposes its educational systems, curricula, and values on a subjugated

group. This typically involves replacing indigenous knowledge systems, languages, and teaching methods with those of the colonising power (Freire, 1970). The fundamental reframing of humanity's relationship with the environment is a key aspect to decolonising climate change education (Thornton et al., 2019). Two pieces of research draw on indigenous philosophy, particularly in the context of environmental education, with one originating from an Australian Aboriginal context (Thornton et al., 2019) and the other from a First Nations perspective in Canada (Olstead & Chattopadhyay, 2024). Though many thousands of kilometres apart, they draw very similar steps and conclusions about how indigenous knowledge can be a crucial tool in decolonising climate change education.

A first step that both research teams suggest in decolonising climate change education is the validation and integration of Indigenous knowledge systems into the curriculum (Olstead & Chattopadhyay, 2024; Thornton et al., 2019). The integration of Indigenous knowledge systems into the curriculum is viewed as a fundamental act of decolonisation. This act acknowledges and validates diverse ways of knowing and being, challenging the dominance of Western science ontologies and epistemologies and enriching environmental understanding with many centuries of place-based knowledge (Olstead & Chattopadhyay, 2024).

A further interconnected mechanism for change in climate change education is the reconceptualisation of the environment around us from space to place (Olstead & Chattopadhyay, 2024; Thornton et al., 2019). This involves a mindset shift from a Western perspective, where the environment is viewed as a space, a mere subject matter, where humans are separate from nature, and it is a space of exploitation and extraction (Olstead & Chattopadhyay, 2024; Thornton et al., 2019), to place, which in the Indigenous sense, is not merely a geographic location but a living entity imbued with deep spiritual, cultural, and reciprocal relationships, responsibilities, and ancestral connections (Olstead & Chattopadhyay, 2024; Thornton et al., 2019). Education, when it utilises and gives equal status to indigenous knowledge, can foster a deeper, more interconnected, and reciprocal relationship between people and their surroundings, thereby dismantling the colonial frameworks that underpin environmental degradation (Olstead & Chattopadhyay, 2024; Thornton et al., 2019).

Olstead & Chattopadhyay (2024) use the metaphor of circles and lines to illustrate the differences between Indigenous cyclical ontologies and Western linear ones. Colonial thought, symbolised by the "line," emphasises progress, extraction, and a disconnection from both the past and the future. In contrast, Indigenous "circular" thinking promotes relationality and interconnectedness, viewing time as cyclical. This perspective is essential for developing sustainable relationships with the environment (Olstead & Chattopadhyay, 2024). This shift in philosophy, in how one looks at and therefore teaches climate change education, was highlighted in another way by Thornton et al. (2019). They suggested that the predominant Western philosophy in current educational curricula is a barrier to decolonisation. They assert that reintroducing and coupling environmental education with philosophy is vital (Thornton et al., 2019). Including philosophy in curricula in their view is one of the interconnected mechanisms for change, providing tools for critical reflection on the dominant paradigms in environmental education (Thornton et al., 2019).

A final interconnected mechanism for decolonisation in climate change education, touched on by both articles highlighted in this section, is the core transformation and inclusion of holistic education, which centres around the interconnectedness of all beings (humans, non-humans, land, water, and sky). This suggests a move away from only Western Science and economic views, disrupting these dominant stories for ones that promote reciprocal relationships where humans are part of, not dominant over, the natural world (Olstead & Chattopadhyay, 2024; Thornton et al., 2019).

It seems that when education can utilise the best of both Western and Indigenous knowledge systems together to create a well-rounded climate change education curriculum, then all ākonga and the environment we are part of benefit. Etuaptmumk or two-eyed seeing is a concept developed by Mi'kmaw Elder Albert Marshall (Bartlett et al., 2012) encapsulates this concept. Two-eyed seeing uses two distinctive perceptions, both Indigenous knowledge and Western knowledge to understand the world. Two-eyed seeing helps to gain a richer, holistic, and more comprehensive understanding (Bartlett et al., 2012). For education to be an effective tool for decolonisation, this transformative approach needs to be integrated across all educational levels, from kindergarten through tertiary education. This broad implementation is crucial to creating a profound and lasting societal shift away from colonial mindsets and toward a more equitable and sustainable future (Olstead & Chattopadhyay, 2024; Thornton et al., 2019).

In summary, this section highlights that effective climate change education should make a fundamental shift from centralising prevailing Western scientific paradigms toward inclusive, culturally responsive approaches. It highlights the critical importance of centralising and giving equal status to Indigenous knowledge systems local to the place of learning, such as mātauranga Māori in Aotearoa, which offer holistic and place-based understandings of environmental interconnectedness. This integration not only enriches learning by providing alternative perspectives and fostering deeper engagement but also contributes to decolonising curricula and promoting social justice. Ultimately, a balanced and comprehensive climate change education should acknowledge and value diverse epistemologies, moving beyond reductionist views to empower learners with the agency and understanding required for meaningful climate action. In this thesis, I chose to focus this through the context of food, being both relevant and authentic for the learners.

2.6 Food and climate change

There is a complicated relationship between climate change and food, the two interact with each other in many ways. In this section, there is a specific focus on two central interactions: the relationship between human eating habits and the impacts these habits have on the climate and wider environment (Godin, 2022; Oram, 2021; United Nations, n.d.; United Nations, n.d.), and the way the impacts of climate change affect food and its production (Godin, 2022; Myers, 2022; Oram, 2021; United Nations, n.d.). This section concludes with some suggested ways to mitigate the impacts of the food humans consume on the climate and environment around us.

2.6.1 The impact of human eating habits on the climate

Human eating habits are a significant contributor to climate change and pose a global issue (Clarke, 2022; Oram, 2021). Food systems are arguably the single most significant driver of environmental degradation that the planet faces today (Clarke, 2022). Food systems are responsible for approximately 30% of all greenhouse gas emissions, occupy about 40% of the Earth's surface, and account for at least 70% of the Earth's freshwater use, as well as being a leading driver of biodiversity loss (Clarke, 2022).

The impact of different food sources varies significantly. In a broad sense, to simplify the discussion, there are three sets of food that range from the least to the most significant

impacts per calorie on the climate and environment. Plant-based foods have the lowest impact (Clarke, 2022; Oram, 2021); dairy, eggs, poultry, pork and most fish have between five to 20 times the impact of plant-based food (Clarke, 2022; Oram, 2021); and then some fish, and meat from goats, sheep, and cattle have upwards of 20 to 100 times the impact compared with plant-based foods (Clarke, 2022; Oram, 2021).

When examining the specific impacts of red meat and dairy products, which are very relevant to Aotearoa food consumption, significant climate effects are observed across the entire production of these types of food (Clarke, 2022; Oram, 2021; Vermeulen, 2022). There are significant links between deforestation and the grazing land or land required to produce extra feed for the intensive farming of cattle and sheep (Clarke, 2022; Oram, 2021; Vermeulen, 2022). This deforestation leads to approximately 10-11% of global greenhouse gas emissions (Oram, 2021; United Nations, n.d.). Livestock contribute to two-thirds of the agriculture sector's entire greenhouse gas emissions and 78% of its methane emissions, which are released naturally during digestion (Oram, 2021; United Nations, n.d.). In Aotearoa, nearly half of the total emissions result from the agriculture sector (New Zealand Ministry for the Environment, 2025), and similarly to the global agriculture emissions, nearly three quarters of these emissions are derived from methane (New Zealand Ministry for the Environment, 2025).

Nearly 94% of the world's global fishing stock is either maximally exploited or overfished (Johnson, 2022). Fishing has become increasingly unsustainable as it has become more industrialised. Industrial seafood production has significant adverse effects globally, whether that be trawling, which destroys seafloor ecosystems, or aquaculture, which can lead to mangrove destruction - both of which contribute to greenhouse gas emissions (Johnson, 2022). For example, "fishing emits over 200 million tons of carbon dioxide annually, as more boats chase fewer fish. Much of this overfishing is fuelled by an annual $20 billion in subsidies, which the United Nations says must be eliminated." (Johnson, 2022, p. 346).

In comparison to fish, dairy, and meat, adopting a higher level of plant-based food sources is generally a better choice, with a lesser impact on the climate and environment (Oram, 2021; United Nations, n.d.). Growing plants requires less land, uses less water, and produces fewer greenhouse gases than animal equivalent food sources (Clarke, 2022; Oram, 2021; United Nations, n.d.; Vermeulen, 2022). This is not to say that all plant-based food options are

perfect. Examples of plants that have a higher negative impact than others include coffee, tea, and cocoa crops, which due to massive demand in many populations globally have led to deforestation and loss of biodiversity (Clarke, 2022).

2.6.2 Climate change's impact on food

As the food sources the human population consumes impact the climate and environment, so too does climate change have significant impacts on human food production (Godin, 2022; Myers, 2022; Oram, 2021; United Nations, n.d.). There are impacts from global average temperature rises, rise in atmospheric levels of greenhouse gases, changes in rainfall patterns, increases in ocean acidification and temperature, and increases in the rate of and levels of extreme weather events, all of which impact soil health, crop and animal production (Godin, 2022; Myers, 2022; Oram, 2021; United Nations, n.d.).

There is a direct correlation between the levels of carbon dioxide and the nutritional value of staple food crops (Godin, 2022; Myers, 2022). In a scientific experiment, staple food crops were grown on three different continents at current carbon dioxide concentration levels of approximately 417 ppm. Then, at 550ppm concentration levels (the expected carbon dioxide levels mid-century), the staple food crops had "significantly lower amounts of iron, zinc, and protein that identical cultivars of those crops grown at today's carbon dioxide levels" (Myers, 2022, p. 150). The lowered nutritional value in staple crops has projected subsequent adverse effects for tens of millions of people, who become more prone to diseases, experience increases in infant and child mortality rates, and, in general, have a less healthy population (Myers, 2022). Myers concluded that from their study findings that "Nutrition is one of the most alarming ways in which our actions are coming back to haunt us [regarding climate change]" (Myers, 2022, p. 151).

As the global average temperature increases due to climate change, this can push food crops to the limit of survival. Research has been conducted to determine the failure temperature of various food crops, including wheat (34 °C), rice and corn (35 °C), and soybeans (39 °C) (Godin, 2022). Corn, wheat, rice, and soybeans account for three-quarters of global calorie consumption (Godin, 2022). A rise in temperature levels could have severe consequences for the survivability of food crops, resulting in reduced production levels and, consequently widespread food shortages for an already growing human population (Godin, 2022). The oceans of the planet are also affected by rising temperatures, whether through increasing

average sea temperatures or marine heatwaves, which have numerous adverse effects on the animals that inhabit the oceans (Godin, 2022). This further stresses the already stressed fish stock levels that many of the world depend on as a food source (Godin, 2022; Johnson, 2022).

The climate and agricultural pest levels are interrelated (Godin, 2022). Insect physiology is sensitive to changes in temperature, meaning that as temperature levels increase, their metabolic rates increase, leading to accelerated food consumption, development, and movement (Godin, 2022). A recent study reported in *Science* showed how a °C increase in temperature can cause massive crop losses due to insect pests (Godin, 2022). In the 2°C temperature rise scenario, Europe and North America face significant potential losses of wheat and maize (Godin, 2022). In Western Europe, nearly 75% of its wheat crops could be lost to insect pests (Godin, 2022).

As greenhouse gas levels increase, the Earth's temperature rises, which in turn increases water evaporation levels, resulting in more moisture in the atmosphere (Godin, 2022; Salinger, 2022). As water evaporates from the oceans, heat is transferred from water to air. As storms pass over oceans, they pull up more water vapour and heat. This results in stronger winds, increased rainfall, and more frequent flooding (Godin, 2022; Salinger, 2022). The increased levels of extreme weather events and the changes in rainfall patterns can impact all forms of food sources (Godin, 2022; Salinger, 2022). Whether it be a primary food source, such as plants that humans eat, or a secondary food source that feeds animals that humans, in turn, eat, the increased number of extreme weather events leads to decreased yields in food crops (Godin, 2022). The change in rainfall patterns due to climate change has similar adverse effects on crop and animal production levels, resulting from droughts caused by a lack of rain in some areas and flooding due to increased rainfall in other areas (Godin, 2022; Salinger, 2022).

2.6.3 Reduction of impact on climate change based on eating habits

It seems clear that the food sources that humans eat and the way that these food sources are produced have consequential and lasting effects on the climate and environment (Clarke, 2022; Godin, 2022; Johnson, 2022; Oram, 2021; United Nations, n.d.; United Nations, n.d.). These impacts on the climate, in turn, exacerbate climate change, creating a feedback loop that leads to further impacts on food production (Godin, 2022; Myers, 2022; Oram, 2021;

United Nations, n.d.). The choices humans make about food sources, both at the individual and systemic levels, can therefore have either negative or positive cumulative effects on the climate and the environment (Godin, 2022; Oram, 2021; United Nations, n.d.).

The United Nations has stated that one of the most effective ways to reduce emissions is to switch to a more plant-based diet and away from a diet high in meat, especially red meat (United Nations, n.d.; United Nations, n.d.). A switch to a more plant-based diet is especially relevant for populations in the Global North, which, to meet health guidelines, could reduce their meat intake by approximately 80%. This reduction would enable the Global South to increase its intake, resulting in a healthier global population and lower emissions from food-related production worldwide (Clarke, 2022; Eshel, 2022). The global impacts of significantly reducing meat consumption in a diet could be positive and far-reaching (Clarke, 2022; Eshel, 2022; Godin, 2022; United Nations, n.d.). Livestock production, which involves grazing pastures and promoting feed growth, accounts for approximately 80% of all agricultural land use (Godin, 2022). A reduction in meat consumption could free up this land for a range of uses, such as plant-based food production to feed humans or for forest regeneration, which would in turn create carbon sinks and places for biodiversity to regrow (Godin, 2022; Monbiot & Wrigley, 2022).

Growing one cattle as a food source requires 15,415 litres of water, which is approximately 48 times the amount needed for the average vegetable to grow (Godin, 2022). In a time when drinking water is becoming more of a scarce commodity (Gleick, 2022; Godin, 2022), this potential water usage saving could be redirected for human consumption globally, which may also help address the inequities surrounding freshwater use and consumption (Gleick, 2022). In Springmann et al. (2016), research was reported that explored the potential climate and health benefits globally if the world were to adopt three different dietary scenarios. One scenario based on global guidelines for healthy eating and energy intake, another based on vegetarian diets, and the final based on vegan diets. Based on the global guidelines for healthy eating and energy intake, there would be a 29% reduction in food-related emissions in 2050 projections (Springmann et al., 2016). Based on the vegetarian diet, a 63% reduction in emissions from food-related emissions in 2050 projections (Springmann et al., 2016) and in a vegan diet scenario, a 70% reduction in emissions from food-related emissions in 2050 projections (Springmann et al., 2016). It has been claimed that if the human population shifts

to a much more plant-based diet, this could represent significant reductions in greenhouse gas emissions globally (Eshel, 2022; Springmann et al., 2016).

Another significant, though not as large, contributor to greenhouse gas emissions is the food waste and loss that occurs every year (Godin, 2022; Oram, 2021; United Nations, n.d.; Vermeulen, 2022). Food loss can occur at any stage of the supply chain, including production, storage, processing, or distribution. Food waste is factored from the stage at which it is edible (Godin, 2022). The combined food loss and waste emissions account for approximately 8% of total human-caused greenhouse gas emissions (Godin, 2022; Oram, 2021; United Nations, n.d.). The United Nations Food and Agriculture Organisation approximates that one-third of all food produced is lost or wasted (Godin, 2022). Taking both individual steps and making systemic changes to reduce food wastage, such as preplanning meals, using correct portion sizes, and when needed, composting food scraps, are all small steps to help minimise food waste.

Other smaller steps can be taken to reduce the negative impacts of food on the climate. Shopping locally and organically can help reduce the negative impacts of food production on the climate and the environment (United Nations, n.d.). Shopping, eating locally and in season, helps reduce food kilometres and can save individuals up to 1.1 tons of carbon emissions each year (United Nations, n.d.). If possible, eating organic food options can also help reduce emissions by eliminating synthetic fertilisers in their production, which release nitrogen oxides into the atmosphere (Oram, 2021; United Nations, n.d.; Vermeulen, 2022). Organic farming often incorporates regenerative agriculture techniques that reduce emissions, improve soil health, and increase the nutrient content of our food. (Oram, 2021; United Nations, n.d.). Incorporating organic food choices can reduce one's carbon footprint by up to 0.9 tons annually (United Nations, n.d.). Composting is another step that could be taken both individually and implemented systemically to help reduce greenhouse gas emissions (Godin, 2022; United Nations, n.d.). When food is wasted, it often ends up in landfills, where anaerobic fermentation that occurs during the rotting process emits methane, a potent greenhouse gas (Godin, 2022; United Nations, n.d.). Diverting food waste into composting, which utilises an aerobic fermentation process that prevents the release of methane, could reduce greenhouse gas emissions from food waste by 50% (Godin, 2022). Composting also means that the recycled food waste can be put back into the soil, providing essential nutrients and trapping carbon in the ground (Godin, 2022; United Nations, n.d.).

2.7 Chapter Summary

The literature review has explored fundamental concepts of climate change, providing a critical foundation for the design of this research's learning intervention — setting a clear stage for the science of climate change to be robust. There appears to be a wide range of responses to climate change internationally, with a variety of differing opinions on how to teach it, what should be included, and at what age it should be taught. In recent years, there seems to be a growing emphasis on the inclusion and recognition of Indigenous knowledge in climate change education, notably Mātauranga Māori and local contexts within Aotearoa. This creates a more culturally responsive education, helping to decolonise education. The literature on climate change education originating from Aotearoa appears to be developing and growing, with an increasing number of publications each year. However, in comparison to other countries, there is still a smaller volume of research available. There also appears to be limited published research in an Aotearoa context on the use of mātauranga Māori in climate change education, as far as the author had access to at the time of the literature review.

A key theme throughout the review is the importance of culturally responsive approaches within climate change education. The literature highlights the need to move beyond purely scientific explanations to incorporate Indigenous knowledge systems, such as mātauranga Māori, which offer holistic understandings of human-environment relationships. The literature suggests effective climate change education must acknowledge and integrate diverse ways of knowing, fostering a sense of agency and collective responsibility.

Several clear themes emerged in the publications covered in this literature review regarding the relationship between kai and climate change. Food production has a direct impact on climate change, and climate change can have a direct impact on food production. There is a strong interrelated relationship between the two. Therefore, human decisions about the food they consume and the quantities of various types of food they consume can have a direct impact on Earth's climate. Climate change, through changes in weather patterns, temperature increases, and more frequent and severe weather events, can directly impact human food sources.

These insights directly informed the design of the learning intervention. By recognising some of the potential limitations of conventional, science-centric approaches and the importance of cultural relevance, the intervention was developed to integrate the Indigenous knowledge systems local to Aotearoa, mātauranga Māori and local place-based contexts. This aimed to ensure the learning

experience was not only scientifically accurate but also culturally appropriate, fostering deeper engagement and a more nuanced understanding of climate change within the unique socio-cultural landscape of Aotearoa. The emphasis on interconnectedness is highlighted in the literature and provided guidance for the development of activities that promote holistic thinking and collaborative problem-solving, aligning the intervention with the principles of culturally responsive pedagogy. How this was done and how I researched the impact on learning is described in the next chapter.

Chapter 3 Methodology

3.1 Introduction

This chapter presents the methodology used in this research. It addresses the research question and outlines the methodological framework employed to navigate this research. This is followed by an exploration of the research methods used to gather data and the research design, which includes the learning intervention design, sample and setting, data collection methods, data analysis, and the limitations of the research. The final section reflects on measures to enhance the quality of the research.

3.2 Research Question

Formulating a research question is a crucial first step in any research (Agee, 2009). The consideration of what the researcher wants to learn or find out is put into focus and honed into a research question or questions. The formation of the research question provides the researcher with a metaphorical map that helps to direct them in the kinds of information they may need and how this information will be gathered. Developing this question or questions is an important initial stage of research, providing the researcher with focused time to set the aims of the study, the scope of the research, and to begin developing the design and methods for gathering and interpreting data (Agee, 2009; Neuman, 2011). To complete the metaphor, without a map to guide them, the researcher may become lost and fail to achieve their goals.

This research was conducted to explore effective ways to engage primary school-age ākonga (learners) in climate change education, with the aim of enhancing their understanding of climate change concepts, its impacts, and ways we might mitigate it. The research question was:

> In what ways can Rangitāne pūrākau (verbal narratives that encode knowledge) engage and further the understanding of Year five and six ākonga in learning about climate change within a kura (school) in the lower North Island of Aotearoa (New Zealand)?

This question guided the research from its inception, helping to direct it, from research design and methodology to data analysis, which ultimately helped to answer the question.

3.3 Methodological Framework

A paradigm is a shared set of beliefs and agreements among researchers examining or researching worldviews, ways of thinking, or phenomena (Cohen et al., 2018). Since the 1960s, following Kuhn's groundbreaking approach to research, paradigms have been a central approach to methodology in research (Cohen et al., 2018; Neuman, 2011). Paradigms, regarding educational research methods, include ontology (the study of being, the reality and nature of humans in the world), epistemology (the philosophical study of nature, origin, and the limits of human knowledge), and methodology (the means in gaining knowledge about the surrounding world) (Denzin & Lincoln, 2013). A paradigm is essentially a broad set of beliefs that shapes how researchers comprehend reality and the nature of truth. It influences their understanding of knowledge, their actions and roles, their perceptions of participants, and how they share information gained from a research project.

Without considering a paradigm, the research can lack the foundational element that provides direction, structure, and philosophical grounding for rigorous and meaningful educational research. Choosing a paradigm for research is not simply a matter of determining the 'best' paradigm, but rather selecting the one that best aligns with the proposed research (Cohen et al., 2018; Denzin & Lincoln, 2013). As this research focused on a perceived problem and possible solution(s) to that problem, where there was a potential need for varying types of small datasets, I felt that this research fell within the pragmatic paradigm, also known as mixed methods research.

The pragmatism research paradigm prioritises practicality, effectiveness, and problem-solving over adherence to a single rigid philosophical stance (Cohen et al., 2018; Pabel et al., 2021). The research question(s) are critical, as the philosophical assumptions and methodological choices made to address those specific problems are crucial. Pragmatic research often aims to generate knowledge that can be directly applied to improve situations, inform policy, or contribute to social justice (Cohen et al., 2018). The value of research is seen in its ability to lead to positive change. At its core, pragmatism is about finding solutions to real-world problems, embracing mixed methods for finding answers in research (Cohen et al., 2018; Pabel et al., 2021), often combining quantitative methods, (in the case of this research pre and post test data), with qualitative research. In the case of this research, qualitative data included interviews, both individual and small focus groups, as well as the

kaiako's weekly reflections and opinions on ākonga engagement. These reasons in sum were influential as to why the pragmatism paradigm was chosen to help frame this research.

As previously mentioned, both qualitative data and quantitative data were used in the research to help find answers to the research question. This mixed methods approach was chosen because the question explored ways to enhance both understanding and engagement in learning. Qualitative research focuses on understanding the 'why' and 'how' of human behaviour, experiences, and social phenomena (Cohen et al., 2018; Neuman, 2011). In this research, qualitative data were collected through interviews with a small group of ākonga and kaiako (teacher), which provided a rich personal narrative from some of the participants involved in the learning intervention. In comparison, quantitative research is a more systematic investigation of observable phenomena using numerical data and statistical, mathematical, or computational techniques (Cohen et al., 2018; Neuman, 2011). In this research, quantitative data were gathered using pre- and post-test data, providing some raw numerical data as a further method to analyse the possibility of increased ākonga's understanding throughout the learning intervention.

3.4 Research Methods

A research method is the approach or approaches used to gather data in educational research, which serve as the basis for analysis, explanation, and prediction throughout the research (Cohen et al., 2018). When working within the pragmatism framework, the type of research methods used is driven by the research question(s), with the fit-for-purpose principle of the pragmatism paradigm guiding this thinking (Cohen et al., 2018). For this research, a pre- and post-multiple-choice test, an interview, a group interview, and kaiako engagement data were used to gather information.

3.4.1 The Pre- and Post- Multiple-Choice Test

Cohen et al. (2018) describe the use of tests by researchers as a powerful method for gathering numerical data from an ever-expanding variety of tests. Tests can cover a range of aspects, depending on what the researchers are testing and what knowledge they want to gain. For the research that I undertook, I sought to gain an understanding of what the ākonga knew about climate change, food and some concepts relevant to the topics about te ao Māori. This understanding was checked before the learning intervention and then after the learning intervention had taken place, to provide insight into what the learners may have learned from

having undertaken the learning intervention. Due to this need, pre- and post-tests were chosen for this research, where understanding of what a person may know was the focus of the data.

The test format chosen for the questions was multiple-choice. This format had benefits that suited both the research and the people participating in it. Some of the benefits of the multiple-choice format, when designed thoughtfully, include allowing for consistent measurement of knowledge, eliminating assessors' bias in marking, enabling a broad range of knowledge to be assessed, and identifying common misconceptions in the targeted knowledge (Neuman, 2011). Using a multiple-choice format, combined with the need for a before-and-after check of understanding, allowed for straight-forward and fair comparisons of this knowledge. One response was created to embody an accurate or 'correct' response, based on scientific or cultural evidence. There are limitations to multiple-choice questions, some of which include a focus on recall, susceptibility to guessing, and the provision of typically limited diagnostic information about *why* a student answered incorrectly (Neuman, 2011).

Some consideration had to be taken into account for the pre- and post-test aspects of the data gathering method to ensure that, to the best of my ability, the data gathered was fair and usable. Though the pre- and post-test questions can be different, the decision was made to keep the tests the same due to the length of time between the test (ten weeks) and the age of the ākonga (nine to ten year olds). This also helped ensure that the post-test was at the same level of difficulty as the pre-test.

After discussion with the kaiako of the akomanga involved in the learning intervention, the decision was made to make the pre- and post-tests formatted in a more 'enjoyable' way through a digital test platform that allowed ākonga to use a device that they were already familiar with. It was through our combined thinking that we believed this approach might alleviate some of the stress associated with testing that the kaiako had observed negatively affecting the ākonga's ability to show their understanding in other tests. The Kahoot! format chosen also aligned well with the multiple-choice format of the test.

3.4.1 Interviews: Individual and Small Group

Moving toward qualitative data sources, interviews were used during this research. One type was a one-on-one interview with the kaiako involved in this learning intervention, and the

second was with a small group (four) of ākonga. The use of interviews in research shifts away from viewing humans merely as subjects, a source of data, towards regarding knowledge as something generated between humans, often in conversations (Cohen et al., 2018; Denzin et al., 2024). Interviews, regardless of who the participants are, enable them to discuss their interpretations of the world they live in and how they perceive things from their own perspective (Cohen et al., 2018; Denzin et al., 2024). The interview enables the use of multisensory channels of information, including verbal and non-verbal cues, making it a flexible tool for data collection (Cohen et al., 2018; Denzin et al., 2024). Unlike other tools used in this research, this tool allowed for information to be explored in-depth, following the flow of conversation between participants. Though it is not a conversation in the everyday sense, the interviews in this research were guided by questions designed to cover a range of topics that stemmed from the research question. The semi-structured nature of the interviews meant the interviews were not confined to these questions alone, and a range of follow-up questions were enacted for further depth of understanding. This format allowed all participants to cover parts of the learning intervention they deemed important to share both positively and to critique (Denzin et al., 2024).

A single interview was conducted with the kaiako involved in the intervention at the end of the intervention. This interview took place in a space where the kaiako felt comfortable, their own home, which they had chosen, potentially helping to create a more relaxed and safer environment. The purpose of this interview was to understand and evaluate the learning intervention and gather important thoughts from an experienced kaiako. The second interview was a group interview involving four ākonga who participated in the learning intervention. These ākonga were chosen through a series of conversations between the kaiako and myself, with a focus of the ākonga representing the overall sample akomanga. A group interview was chosen because it can bring together people with a broader range of opinions and represent more versions of events, thereby completing a more comprehensive and reliable data set (Cohen et al., 2018). However, several known risks to a group interview were taken into consideration when choosing this interview method: groupthink, which can deter individual thought against the common stream, and the interactions between group members and how they may affect the individuals in the interview (Denzin et al., 2024).

Both interviews were recorded verbally, as a decision was made that filming the interview could create a more formal and potentially uncomfortable experience. A transcript was produced for both interviews and used as a source of data to be analysed later.

3.4.3 Kaiako Engagement Data

A final research method was used to gather data for this learning intervention. At the end of each week, the kaiako completed a 1-5 Likert scale to provide her opinion on the week's ākonga engagement (in learning) levels, and then, through conversation, record what she thought were the key factors contributing to that week's rating. Likert scales offer a range of responses to a question or statement, allowing individuals to express their opinions (Cohen et al., 2018). This form of data allowed for fresh takes on the kaiako's opinion each week regarding engagement, which helped to create a broader picture of one of the key components to the research question. These data were also used to refine the future weeks' learning, as it provided insight into the ākongas' response to the learning and what may need to be covered or readdressed to continue to build the knowledge.

3.5 Research Design

Research design is a term that encompasses all the processes involved in planning and completing a research project. The term broadly covers the entire process, from initial problem identification through to the publication of the research at its conclusion (Neuman, 2011). Section 3.5 examines the research design employed in this study, including the sample and setting, the processes involved in data gathering, the analysis of that data, and concludes with the identified limitations of the research.

3.5.1 Sample and Setting

Every research project must involve sampling, as no matter the scale of the research, it cannot include everyone. Sampling is the process of selecting a small, representative group (the sample) from a larger group (the population) to participate in a study. The goal of sampling is to gather data from this smaller group and use it to draw meaningful conclusions or make generalisations about the entire population (Cohen et al., 2018). A non-probability sampling method was used for this research. The specific sampling method used was convenience sampling, where the sample of ākonga and kaiako were chosen from a local public school. I had an established relationship with this kura and therefore both the kura and kaiako were

known to me. As mentioned in Section 3.4, the group interview sample was chosen as a representation of the ākonga within the kaiako's akomanga (classroom), according to age, gender, and ethnicity.

The kaiako and akomanga were chosen through conversations with kura senior management, the kaiako involved in the year five and six team and myself. The kaiako identifies as a female of Tongan ethnicity. The akomanga involved in the study were aged 9-11, in years five and six. There were a total of 21 ākonga in the class, 13 of them identifying as female and 8 of them identifying as male. The ethnic breakdown of the akomanga was as follows: 57% ākonga Māori, 33% ākonga Pākehā (New Zealand European), 10% ākonga Pasifika. The ethnicities in this akomanga were representative of the ethnicities within the kura population. In the akomanga, all ākonga and their whānau returned their consent forms; however, only 17 ākonga completed both the pre- and post-tests, so for that specific data set, only data from those 17 ākonga were used.

For confidentiality and protection purposes, the kaiako and ākonga mentioned in the research chose pseudonyms. The kaiako's pseudonym is Whaea Tupou and the four ākonga who participated in the group interviews chose pseudonyms as Bartholomew, Mania, Kerim and Lucy. Their real names are only known to myself, the researcher.

3.5.2 The Learning Intervention

A learning intervention in educational research refers to a structured and intentional strategy designed to enhance student outcomes in specific areas (Cohen et al., 2018). The learning intervention utilised in this research was developed with the aim of increased engagement and understanding of climate change concepts. Researchers develop these interventions based on established theories or evidence and then implement them with a targeted group of students (Cohen et al., 2018). In some learning interventions, a control group is used to compare the effectiveness of the learning intervention. Ākonga are randomly assigned to either the intervention or a control group. This approach was not utilised in this research due to ethical concerns regarding students not having the opportunity to learn the concepts, which could be attributed to chance factors such as being part of the intervention or not, as well as resource constraints for the research. Data are collected both before and after the intervention to assess its impact on student learning. The findings from this process help educators and

researchers identify the most effective teaching methods and resources, thereby contributing to the development of improved educational practices (Cohen et al., 2018).

During the design process of this learning intervention, co-design was employed on multiple occasions, both with the kaiako and ākonga. From the foundational aim of teaching climate change concepts and the use of pūrākau, discussions were held with Whaea Tupou about possible topics relevant to her ākonga and their inclusion in the long-term planning. The concept of food and nutrition was selected due to several reasons, including:

- Links to the chosen pūrākau.
- An already planned nutritionist visit to the akomanga as part of a broader topic of healthy eating.
- Foods have clear relationships to climate change, both from the perspective of climate change's impacts on food sources, as well as the impact of human food choices on climate change.

Once this decision was completed with the kaiako, broad strokes of the intervention were drafted using ideas from literature, then discussed again with Whaea Tupou. Further edits were then made based on her insight into the ākonga involved in the learning intervention. At this stage, I met with a group of four ākonga from the akomanga involved in the learning intervention. I discussed the intervention's proposed structure, including what the learning may entail and the overall aims of the intervention. The ākonga gave their opinions and suggestions for what they would like to see within the learning intervention. As a result of these interactions with the kaiako and ākonga, the intervention planning took shape, and a completed draft was made. This draft was used and edited throughout the intervention as a working document, where aspects such as timings and learning were adjusted in response to feedback from the weekly engagement meetings with the kaiako.

The pūrākau used in this intervention, as discussed earlier in this thesis, was chosen in collaboration with the local iwi Rangitāne. It is a local narrative relevant to the whenua (land) on which the kura is situated, and in which this research is conducted. Below, I provide a summary of the pūrākau to gain insight into the themes it explores. However, out of respect to the people of Rangitāne and in acknowledgement of it being their intellectual property, I have not written the entire pūrākau.

Whāngai Mokopuna was a taniwha living in the Manawatū area and was the beloved pet of Tupatunui, who found him as a young taniwha at the river's mouth. As Whāngai Mokopuna grew, the iwi helped feed him due to his large appetite. However, when Tupatunui went away, the young people fed him stale eel heads, leading to a tragic incident where he unintentionally ate one of them. Heartbroken, Tupatunui banished Whāngai Mokopuna, who fled to the upper Whāngai Ranges, where he lived in solitude. To this day, whenever people from Manawatū visit Dannevirke, a heavy mist is said to be caused by Whāngai Mokopuna's tears of sorrow.

See Table 1 below, which outlines the week-by-week learning that occurred during the intervention, along with a brief synopsis of the rationale for this learning within the intervention. Refer to Appendix A for the complete learning intervention plan and its accompanying resources.

Table 1

Overview and Rational of Learning Intervention

Week	What Happened	Rationale
One	• Discussion about what pūrākau (verbal narratives that encode knowledge) are and why they are used? • Introduce the pūrākau - Whāngai Mokopuna. Follow-up activity: break the pūrākau down into mini cards, highlighting the key elements. • Kahoot! Pre-test	This week was about setting the scene for the learning intervention. Gather pre-learning intervention data through the pre-test, introduce the pūrākau, and start to build an understanding of what happens in it so the ākonga can use it throughout the intervention.
Two	• Develop visual freeze frames of the key events in the pūrākau. • Focus on food from pūrākau, where it featured and was it important? Started conversations around what food might have been eaten in the time of the pūrākau. • Nutritionists visit to do session(s) with ākonga about fuelling their bodies and supermarkets (Trip to local supermarket).	Ākonga continued to develop foundational knowledge and understanding of the pūrākau through the visual arts, using the images to help anchor the key events of the pūrākau. Ākonga then began to explore one of the key concepts of the learning intervention this week: food. A pre-booked nutritionist visit provided ākonga with an expert on healthy eating and examining what we eat. This learning was woven back into the pūrākau through examining the types of food mentioned in it and how food was considered important.
Three	• Descriptive writing based on the pūrākau, ākonga, to focus on different sections. Plus, ākonga to use an AI image generator to describe their own taniwha. • Explore what ākonga know about climate change (CC) through a digital brainstorm.	Continue to develop a strong foundational understanding of the pūrākau through different learning areas and bring something different to it with taniwha AI art. Begin CC learning by sharing prior knowledge as an akomanga, which can be used as a reflective tool later if the kaiako chooses to do so. Begin to build an

	• Start to develop foundational knowledge on CC: What is CC and compare it to weather and greenhouse gases (GHG). • Compare what the ākonga eat now to what the people in the pūrākau would have eaten. Create slides as visual aids to display on the wall.	understanding of the core concepts of CC, as described in the literature review chapter, which serves as foundational learning for later concepts. Building an understanding of the differences in the way we fuel ourselves so that the ākonga can use this understanding to link to CC later in the intervention.
Four + Five	• Consolidate learning from the prior week on greenhouse gases by using the NASA flip cards for the six primary GHGs. Create a quick, fun clip that introduces the gas and where it may come from. Share clips as an akomanga and groups share what they learnt about that GHG. • Develop slides about what we eat now (most weeks) to use in comparison to week three's traditional Māori kai (food) slides. • Explore the different types of kai that are eaten -they can all roughly be put into three categories from a nutritional point of view: high in carbs, high in protein, high in fats. Show the difference between ultra-processed kai and lesser/unprocessed • Using the wall display of what we eat currently with traditional Māori kai sources. Analyse the different categories explored earlier in the week and match them up. What are the differences between the two time periods?	*Note that week's four and five were combined due to class sicknesses and training for the sports tournament. Using clip making to engage ākonga in developing and sharing back to the akomanga an understanding of one of the six main GHGs. Takes the emphasis off kaiako, instead focusing on co-learning as an akomanga. Develop an understanding of different categories of food and how these help fuel the body. Explore the concepts of ultra-processed and less-processed foods, which can be linked further down to healthy food and possible connections to CC. Using the wall display to engage in conversation about recent learning on different types of kai and further preparing ākonga for conversations about food and kai.
Six	• NIWA science experiment - creating a GHG in a jar.	The experiment was used to help "see" the GHG effect in the experiment. Exploring and developing an understanding of the fact that humans have contributed to CC, through producing GHG. Look

	• Develop an understanding of the human impact on CC through GHG emissions. What are emissions? Analyse Aotearoa's emissions profile as an akomanga. • Explore the link between what we eat and the impacts to our climate/environment.	at Aotearoa's emissions profile and record noticings. Start to foster links between what we eat and the potential impacts on our climate/environment. This represents a significant understanding gained from the learning intervention, which is thoroughly explored through conversation and learning.
Seven	• Continue to develop an understanding of emissions (some difficulties were encountered last week, so further development of understanding is planned this week). • Complete learning on emissions and food relationships + wall displays: First one: current ways we fuel our bodies vs traditional Māori ways. Second one: Foods with bigger and smaller emissions profiles. *Some planned learning was moved to week 8 due to unforeseen events in the wider learning programme for the team.	This week, the concept of emissions was consolidated due to the kaiako's feeling that the ākonga were not yet fully understanding the concepts. More time was spent exploring the graphs from the Ministry of Environment. The second focus of the week is to continue strengthening the ākonga's understanding of the relationship between CC and the ways we fuel our bodies.
Eight + Nine	• Explore the impacts of CC, using a NIWA clip to help further their understanding in an Aotearoa context. Using pre-chosen and watched clips to help guide learning and make sure the learning is authentic. • Link the above learning to impacts on kai production. e.g. Cyclones' effects on kūmara (sweet potato) production. Focusing on making simple connections between core concepts.	After gaining a basic understanding of what CC is and what causes it, ākonga in these weeks focus on the potential impacts of CC, then further explore this in an Aotearoa context. Once the impacts have been explored, link these impacts to food production, using relatable and understandable Aotearoa contexts. These concepts were addressed in the literature review as important concepts to understand from the learning intervention.

	• In Weeks 8, 9, and 10, all ākonga will spend several sessions in the kura's māra (garden) kai with a volunteer gardener. These sessions focus on: What is in our kura gardens and why we need to grow certain vegetables and fruits at specific times of the year. How to grow and look after the whenua (Composting and keeping the whenua healthy). Planting their own vegetables. • Accompanying learning inside the akomanga will focus on the benefits of growing and eating locally, as well as other facts such as cost, enjoyment, and helping their whānau. • Ākonga to explore the rich history Māori have with growing kai. Watch a virtual tour of traditional Māori kai in Tāmaki Makaurau. Introduction to maramataka and how this relates to planting, gathering and hunting for kai. Link back to pūrākau.	Learning then went outside, into the māra kai for some more hands-on learning for the ākonga. Exploring how to care for the whenua (land) and grow kai themselves. This was linked with learning happening in class, while exploring growing kai from a Māori context, and examined the mātauranga (knowledge) of maramataka (Māori lunar calendar). Developing further links to the pūrākau.
Ten	• Finish off any learning that had not happened in the prior week. • Post-test data gathering • Celebration of learning intervention: Design and cook a low-impact lunch for the akomanga, Mrs Green, Whaea Tupou and myself. Share kai and celebrate learning success!	At the start of the week, there was an opportunity to complete any prior learning that was not finished, and ākonga were given the chance to ask any questions they may have had about the learning. Post-test data was gathered via a Kahoot! for data comparisons. To conclude the learning intervention, a shared kai was planned, focusing on developing a low-impact menu that the ākonga wanted to eat. This was cooked and shared. All participants were thanked, and memories/learning shared.

3.5.3 Pre- and Post-Multiple-choice Test Process

The design of the test was based on the core concepts of the learning intervention: climate change concepts, the relationship between climate change and kai, and te ao Māori concepts that formed the framework for the learning that would occur. As such, the test was divided approximately into thirds. Each subsection of learning had questions that covered the range of learning over the 10 week term of the learning intervention. The test consisted of 20 multiple-choice questions, each with four possible answers to select from. These 20 questions were selected from a larger pool of questions I developed; the choice of the final 20 questions was discussed at length with my research supervisors before they were finalised. Each question needed a purpose and had to show a specific piece of data that could be related to a core concept and the research question as a whole. The test was then developed on an online quiz platform that the ākonga were familiar with, Kahoot! This allowed the ākonga to enjoy the process more than a standard multiple-choice test format and potentially reduce the test anxiety that the kaiako had spoken of prior to the test being designed. There were some specific settings on the platform that were altered from the standard delivery: the question timing was removed, the points system was eliminated, and the leaderboard was disabled. These edits were an attempt to remove the competitive nature of the standard settings and allow learners to take their time and focus on the questions and move through the test at their own pace. See Appendix B for the pre- and post-tests.

After the test design was finalised, a small pilot study was completed. All data-gathering instruments should ideally be piloted to test the effectiveness of the data-gathering mechanisms (Cohen et al., 2018; Neuman, 2011). Pilot studies allow researchers to verify that all questions and possible answers are clear and understandable to the target audience (Cohen et al., 2018; Neuman, 2011). It also allowed, in this case, the data analysis of the backend of the delivery platform to be tested. This ensured the data points were accessible and relevant for the research. Pilot studies should, where possible, be carried out on a similar group that will form the participants of the study undertaken in the research (Cohen et al., 2018).

A small pilot study was conducted with a few children from the same age group as the intended participants of the test. No significant changes resulted from the pilot study.

3.5.4 Interviews: Individual and Small Group Process

The two interviews were independent, one being an interview with the kaiako, the other being with a group of four ākonga.

The interview with the group of ākonga was included as part of the informed consent process for both the ākonga and their whānau. In the information included in the consent process, ākonga and their whānau were told that four or five ākonga would have a kōrero (talk/speak) with Matua Ryan over some shared kai at the end of the learning, which might take one hour. Whaea Tupou will help me select ākonga from those students who wish to help in these activities." This meant that, from all ākonga who were in the akomanga and had given consent, they were available to participate in the interview process. The kaiako and I discussed potential ākonga who might be part of the group, outlining that the group for the interview should, if possible, represent the akomanga group. The final selection for the interview, who were present on the day of the interview, consisted of two boys and two girls, representing the mixture of ages and ethnicities present in the akomanga. The second interview was with the kaiako who taught the entire learning intervention over the term. She had also given consent for the interview as part of the informed consent process.

For both interviews, a semi-structured interview process was employed, where questions were designed in collaboration with my research supervisors. The interview questions were piloted for the kaiako questions with another teacher who was of a similar age and background. The questions for the ākonga were not piloted due to access issues and ethical issues around consent for ākonga outside of the akomanga involved in the research. Six trigger questions were used to guide the interview for the ākonga group (see Appendix C). Nine questions were used to guide the interview with the kaiako (see Appendix D). These trigger questions aimed to cover a range of possible points of information and their opinions based on their experiences of the learning intervention and in consideration of the overarching research question. From the trigger questions, several possible probe questions were formulated before the interview to help further develop the conversation and thinking of the ākonga and kaiako involved in the interview.

The group interview with the ākonga was conducted at the end of the learning intervention, in an available area within their kura that allowed for privacy, and which they had the final say on. We began the interview by sharing some kai that had been cooked by everyone involved

in the research and having a casual conversation about it before formally starting the interview. This group interview lasted 34 minutes. The second interview with the kaiako was conducted at the end of the term, at the start of the school's non-contact time following the conclusion of the learning intervention, which was the kaiako's choice. This interview was conducted at a place of the kaiako's choosing, for her comfort. Before starting the interview, we shared kai, a hot drink, and engaged in some casual conversation. The interview with Whaea Tupou lasted 32 minutes. The audio for both interviews was recorded using a mobile phone and a secondary device. A decision was made not to have the interview recorded visually due to the potential effects of having a camera in the room for both the ākonga and kaiako, and how that might impact their kōrero.

Throughout the interview, a process was used where a trigger question, which I hoped would generate initial conversation about the selected topic of the question, was asked to the group, and then each ākonga had the chance to kōrero in response to that question. Possible probe questions were asked in follow-up. As the interviewer, I attempted to ensure that each ākonga had the opportunity to share their thoughts and that no one personality dominated the interview. In each round of trigger questions, a new order was chosen for the ākonga to kōrero. A final open question was asked to all ākonga if "there anything else you would like to tell me about the learning about climate change over the term?" which was designed to allow for the ākonga to share any other thoughts that may have occurred to them but they did not get the chance to share it or it did not line up with any if the previous questions.

3.5.5 Kaiako Engagement Data Process

For the kaiako engagement data, a weekly meeting was held on Friday at the conclusion of the school week in the kaiako's akomanga. This time was chosen to provide fresh reflection on the week that had just passed, and the kaiako felt it would allow her to speak most accurately to the engagement of the ākonga throughout the week. The meeting would start with the kaiako giving the learning engagement and understanding an overall a rating between one and five, using a Likert scale. Based on this rating, I would ask the kaiako about the main reasons she chose that number. These conversations provided a valuable opportunity to gain the kaiako's perception of engagement and understanding of the ākonga as the learning occurred, allowing for adjustments to be made in the learning intervention and the collection of anecdotal notes on the learning intervention that could be later paired with other data sources to create a fuller picture of the learning. I recorded these responses in

handwritten note form along with the Likert scale rating and typed the responses up later. The meetings lasted on average 20 minutes and were completed each week of the learning intervention.

3.5.6 Data Analysis

Data analysis is the process by which raw data are recorded, analysed, and interpreted. After gathering data from various sources, significant amounts of raw data can be generated, which can be difficult for the researcher and subsequent readers to read and understand unless the data have been interpreted and analysed (Cohen et al., 2018). At its heart, data analysis is the stage of research at which a researcher seeks potential answers to their research questions.

The data analysis arose from three parts in this research: the pre- and post-test data, the kaiako engagement scale and notes, and the interviews.

For the pre- and post-test data analysis, once both the pre- and post-test data were obtained via the tests administered by the kaiako at the start and end of the learning intervention, the raw data were downloaded from Kahoot! onto separate sets of Microsoft Excel spreadsheets and stored securely on a cloud drive. The raw data were then checked to ensure accuracy, which involved an initial review of both spreadsheets for any technical glitches that may have occurred during the download from the digital testing platform and verifying that each ākonga had completed both a pre- and post-test. If an ākonga was absent on the day of testing and therefore did not complete both tests, their data were removed from both sets. A check was made to ensure that each of the remaining ākonga had completed all the questions on both tests, allowing for a complete comparison between the start and end of the learning intervention.

Once all tests were completed, checked for accuracy and stored on separate spreadsheets, data analysis began. I began with a primary analysis, with a broader view of the data before moving into a more precise analysis. I analysed the two tests overall, comparatively, examining the percentage changes in correct answers as a whole, and then in each of the three subsections, before examining each question individually.

Subsequent graphs and charts were made based on these primary analyses. This process enabled me to interpret and analyse statistical central tendencies, including the mean, median

and mode of the data sets for potential changes in understanding of core concepts related to the research question throughout the learning intervention. This form of quantitative data analysis is considered descriptive analysis. Descriptive statistics are used to summarise and describe the main features of a dataset. They provide a clear and concise overview of the data, helping researchers understand its characteristics without making any generalisations beyond the specific sample being studied (Reid, 2014).

For the weekly kaiako engagement data, each week following the hui with Whaea Tupou, I transferred the handwritten notes into a Microsoft Word document, which was stored securely on a cloud-based drive. After this, I did an initial review of her thoughts over the following weekend, and at times, minor adjustments were made to the learning intervention for the upcoming week, which was then discussed with the kaiako. After the learning intervention, a more in-depth analysis was conducted of the Likert engagement scales throughout the entire learning intervention, linking these ratings to observations made by the kaiako at the time and to any comments that correlated with the Likert engagement scales in the transcriptions of both the ākonga and kaiako interviews.

The process of analysing qualitative data differs from that of quantitative data (Denzin et al., 2024). Data analysis in qualitative research is a continuous process characterised by induction as well as deduction. Categories emerge from the data, providing an interpretive description of the experience (Denzin et al., 2024).

Both sets of interviews were analysed in the same manner but separately. After their initial recording, the sound files from both devices were checked to ensure they had recorded properly and had good audio quality. The four files, two sets of recordings per interview, were then securely stored on a cloud drive. One file from each interview was selected as the primary file for further use. The transcript was given to Whaea Tupou to verify its accuracy after being transcribed.

The process of constant comparison, developed by Glaser and Strauss in 1967, guided the data analysis in this study. Constant comparison focuses on the inductive or deductive generation and creation of categories by comparing all the collected data. Data are coded into analytical categories as they emerge or when it fits an existing category. By comparing these categories during data analysis, some categories may be grouped together, while others may

be divided into more specific categories (Glaser & Strauss, 1967). This process of constant comparison encourages critical thinking, leading to the emergence of both descriptive and explanatory categories in the data analysis (Cohen et al., 2018).

After gaining an overview of the data, the analysis process involves two main tasks associated with interpretive description: identifying themes within coding categories and recognising themes across categories (Braun & Clarke, 2022). This process includes two essential analytical procedures fundamental to coding: making comparisons and asking questions. These procedures help to refine and clarify the concepts, providing them with greater precision and specificity (Braun & Clarke, 2022).

Initially, to begin the data analysis, I listened to an interview recording, without taking any notes, enabling the interview to be fresh in my mind. I then transcribed the interview, via an online transcription programme, which, when finished, was listened to and edited for accuracy. The transcript was then studied, and I began identifying and coding relevant sections from the transcript by rereading it. I coded sections that directly related to the research questions, as well as those that caught my attention. By comparing the similarities and differences among the various sections, I was able to provide appropriate labels for several of them. As a result, categories began to emerge.

As I analysed each transcript, I compared the information and the categories across the transcripts, noting similarities and differences again, coding and labelling. As categories emerged, I then examined the information within that category, which allowed me to clarify the category and, at times, create a new category or sub-category. Thus, these categories are flexible and are modified as further data analysis occurs (Braun & Clarke, 2022). This process enabled me to develop a clearer understanding of each category and the relationships between them.

After all the different data sources were analysed independently of each other, the three sources of data (pre- and post-tests, engagement scales and conversational kaiako notes, and the two interviews) were analysed collectively. This triangulation of data was a vital step in the research process, allowing for the examination of the links between the learning intervention, possible progress in understanding, engagement levels and the research questions.

3.5.7 Limitations of Research

Regarding the data sets obtained in this research, having only one akomanga of 21 ākonga could be considered a limitation. In the pre- and post-testing, the data, after cleaning, only included 17 ākonga due to some being absent or unable to catch up on the testing. Due to the small group size, obtaining statistically significant data was not feasible. Another limitation was that the impressions of what happened in the akomanga while learning occurred were all secondhand information from the kaiako and ākonga as there were no observations of learning. The decision not to conduct observations was a deliberate choice, given the close nature of my relationship with the ākonga and kaiako involved in the research. My presence in the akomanga may have been intrusive and impacted the way the kaiako taught and the way the ākonga behaved or responded to the learning happening. A decision was made before beginning this research that I would not teach the learning intervention myself. As a researcher, I was interested in seeing how a kaiako, who might represent a kaiako not so immersed in climate change learning and action, would teach a term's unit on climate change education.

Although the emerging themes were of interest, they should be regarded as merely indicative and cannot be generalised. Ideally, this research could have included a larger sample, with more akomanga and kaiako, perhaps across several communities in Aotearoa. This would have provided a better representation of the ākonga targeted in this age group.

3.6 Quality of Research

3.6.1 Validity and Reliability

All data collection methods should be reviewed critically to determine the extent to which they are likely to be valid and reliable (Bell & Waters, 2014). Validity is described in Bell and Waters (2014) as the design of research being crucial for drawing credible conclusions. It is essential to assess whether the evidence can support the interpretations made by researchers. This involves determining if the data accurately measures or characterises what the researchers claim it does. Additionally, it is important to ensure that the overall interpretations are consistent with the data. There are two main types of validity considered for the quantitative data: internal and external.

Internal validity refers to the degree to which a study establishes a reliable cause-and-effect relationship between its variables (Neuman, 2011). This involves asking, does the independent variable genuinely cause the observed effects in this research, or could they be due to other factors? To consider this there are some factors to take into consideration, such as whether the potential increase in understanding climate change concepts for ākonga was caused by the different aspects of the learning intervention, or whether some of this knowledge could have been obtained via other sources, such as kōrero with whānau after kura or self-guided learning after kura on YouTube. There is a possibility of this occurring; however, the correlation between patterns of increased understanding and engagement levels in the data sources obtained in the research suggests that the learning intervention was an influential source of knowledge across the akomanga. The test used to establish pre- and post-learning intervention understanding was pilot-tested with ākonga of the same age and peer-reviewed with the supervisors of the tests. These steps were taken to increase the validity of the data gathered.

External validity refers to the extent to which a study's findings can be generalised to different people, settings, and times (Neuman, 2011). This means reflecting on the question, can the results of this study be applied to a broader context? As this research centred on a single kaiako and classroom, there is potential for varied results due to the small sample size of the research. There are factors such as the kaiako was not a specialised environmental kaiako and additionally, the ākonga had previously had minimal exposure to climate change learning. These two factors when considered show that the kaiako and ākonga involved in the research represent a potential average kaiako and akomanga, in the fact that they have not had extra specialised training or knowledge than any other kaiako or ākonga in this setting. There is a reasonable likelihood that the study's results could be reproduced and applied in another setting.

The reliability of the quantitative data used in this research is challenging to measure because the testing was conducted only in one akomanga, within the same kura. Therefore, there was limited test-retest reliability. In acknowledgement of this limitation due to the size of the research, steps were taken to increase the reliability of the quantitative data. The design of the test was based on well-established testing methods, with the questions involved in the test being peer-reviewed by the supervisors of this research. The test was also piloted with

ākonga of a similar age and reviewed before being used in the learning intervention. This helped ensure that the questions were clear and understandable to the target audience. The test was also purposefully designed to be delivered on a Kahoot!, a programme that the akomanga were familiar with as they used it regularly in their learning. Features such as the time limit, points and leaderboard were removed to reduce competitiveness and allow for the time needed to understand the questions and potential answers. A combination of these factors were used to enhance the improvement of the reliability of the quantitative data used in this research.

The trustworthiness of the qualititative methods used in this research include the criteria of credibility, transferability, dependability, confirmability (Shenton, 2004)

3.6.2 Credibility

This is the qualitative equivalent of internal validity. According to Lincoln (1985), a qualitative study is credible when it presents an interpretation or description of an experience in a way that individuals who have had that experience would recognise it in the description.

A potential threat to the credibility of this study is researcher bias stemming from preconceived notions. As Shenton (2004) suggests, researchers must acknowledge their potential influence on the research process. Any pre-existing beliefs the researcher holds about the study topic or the researcher-participant relationship can significantly affect the study's credibility. This was minimised by an awareness of this, along with constant self-review throughout the research process. The methods employed in this research are well-established, having produced credible results in past research. My thesis supervisors also reviewed the ongoing research process, having a small pilot with the questions for the interview and conversations about the questions in their design with my supervisors, who are much more experienced researchers. Finally, I was very familiar with the setting and subjects, so I was able to tailor the learning more closely to what might work for the ākonga and avoid what is potentially less likely to work for them specifically.

3.6.3 Transferability

Transferability is analogous to external validity and refers to the extent to which research findings can be generalised to other contexts (Shenton, 2004). The concept of "thick description" involves providing detailed and comprehensive accounts of the time, place, and context in which the study takes place. This allows readers to assess the plausibility of the conclusions drawn.

To enhance transferability, I have included detailed information about both the process and the data. This encompasses the number and location of the participating organisations, the number of participants, the data collection methods, and the period during which the data was collected. By doing this, I aim to ensure that the study's findings align well with the data from which they were derived.

3.6.4 Dependability

Dependability is often viewed as the qualitative counterpart to reliability. A dependability audit can confirm the quality and validity of the inquiry process. As Shenton (2004) indicates, reliability relates to the consistency of research findings, and it is crucial throughout the stages of interviewing, transcribing, and analysing data. In this study, the research process has been clearly outlined, and the research problem has been contextualised through a literature review. This outline of the study's processes allows a future researcher to repeat the work, even if the results may not be identical. By reflecting on and examining the research process as it unfolded, I have ensured a high level of dependability.

3.6.5 Confirmability

Auditing and tracking can establish confirmability, which serves as a qualitative alternative to objectivity. By tracing data back to its source, we can ensure that interpretations are coherent with the original data. According to Guba and Lincoln (1985), as cited in Shenton (2004), confirmability is achieved when data can be traced to the original source, and the process of synthesising the data to reach conclusions can be verified. Procedures that support confirmability include triangulation, acknowledging the researcher's beliefs and assumptions, and recognising the study's methodological weaknesses. As mentioned in Chapter 1, I have a background in climate change education and action. I have been part of and organised actions in the climate change movement. As part of confirmability, I have continuously reflected on

my beliefs and understandings around climate change. Ensuring that the learning involved in this intervention is based on the most up-to-date scientific consensus. I also made sure that the kaiako involved in the learning intervention understood the climate change concepts covered in the learning intervention, not assuming that she may have an understanding of any concept covered.

3.6.6 Ethical Considerations

Ethical considerations are crucial for researchers in any study. Decisions about ethics should be made during the research design phase, throughout the execution, and during analysis and reporting (Guillemin & Gillam, 2004).

The starting point of ethics in this research was conversations with supervisors of potential ethical issues and areas to be aware of throughout the research stages. This was formalised in a proposal to the University of Waikato Human Research Ethics Committee, where approval is needed to start any research. Once ethics approval was secured (see Appendix E), the next step was to obtain informed consent from the tumuaki, kaiako, ākonga, and whānau of the ākonga. This informed consent included information about the research, presented in plain and understandable language tailored to the specific group. That information and statement outlined the purpose and nature of the research, as well as what their participation involved. The informed consent of ākonga themselves was gained through all the information being read to them, and questions could be asked then or at any point after. Whānau also had the opportunity to review the information and ask any questions they may have had before signing the consent forms. All participants were informed during the process that their names would be kept anonymous, and the data obtained through testing and interviews (if they participated in one) would be stored securely and accessed only by the researcher and their supervisors.

The process outlined above was followed for this research. Before data collection began, approval was obtained from the University of Waikato Human Research Ethics Committee. Informed consent was obtained from the respondents, who received a statement explaining the purpose and nature of the research, as well as the implications of their participation. A signed copy was obtained from the tumuaki, kaiako, ākonga, and whānau of the ākonga involved in the research. All data have been stored securely, and anonymity has been kept throughout the research. All participants voluntarily chose to participate in this research.

Researchers must ensure that participants are protected, preventing any harm that may result from participating in the research (Guillemin & Gillam, 2004). The kura, kaiako and ākonga involved in this research had their names kept anonymous; when data were collected in the form of testing, the names were removed completely. The kaiako and four ākonga involved in the interviews got to self-select a pseudonym. Due to the content of the learning, which can be alarming and confronting, ākonga knew they were able to kōrero with the kaiako or myself at any point about this and had the opportunity to leave the learning intervention if they no longer wished to partake.

Finally, a cultural ethics aspect present in this research was that the content of the learning had significant aspects of te ao Māori woven throughout. As an educator and researcher, I was aware of and constantly reflected on my positioning as a non-Māori/Tangata Tiriti (Treaty Partner). I recognised from the outset of the research that this is something I felt I must be mindful of throughout this research. As Tangata Tiriti, centralising mātauranga Māori in the learning intervention for this study, I was very careful to sit and listen to whakaaro (thoughts, opinions, ideas, plans) and mātauranga from Māori educators such as the tumuaki of the kura and members of the local iwi (tribe), one of whom holds the education portfolio for the iwi and the other a recognised historian, that we have as advisors at the kura. The pūrākau used in this intervention was chosen by the local hapū (subtribe) to use at the kura due to the importance in the local region and to assist in the learning in a localised manner. Whaea Tupou who was the kaiako involved in teaching the learning intervention helped to provided insight to any questions I had from a Tongan, and wider Pasifika lens for the learning intervention. One of my supervisors identifies as Māori and Tongan, and she provided cultural guidance both from an academic lens and in the learning intervention when asked. These levels of guidance across the different facets of the research helped to provide me, as Tangata Tiriti, with insight and knowledge that I could not have due to my heritage and position.

3.7 Chapter Summary

This chapter has outlined the research methodology utlilised in this study. The chapter began by outlining the research question that guided the study. It continued by exploring the methodological framework of a pragmatic paradigm, which served as the foundation of the research. This research employed both qualitative and quantitative data sources, including pre- and post-multiple-choice tests, kaiako engagement data, and accompanying conversational notes, as well as two interviews (one with the kaiako and the other with a group of four ākonga). The research design section outlined the sample and setting, the processes for data collection and analysis, and the potential limitations of this research. Finally, the validity, reliability and ethical considerations were discussed. The next chapter presents the research findings.

Chapter 4 Findings

4.1 Introduction

This chapter presents findings from data collected from an ākonga (learners) group interview, an interview with a kaiako (teacher) and her reflections on student engagement, and data collected from a pre-test and post-test completed by 17 year five and six ākonga.

The data are presented as the students' understanding of climate change concepts, kai and its relationship to climate change, and selected concepts of mātauranga (knowledge) Māori before and after the learning intervention. The data also include a representation of the views and beliefs of both kaiako and ākonga around climate change learning at primary school and their experiences of the learning intervention designed for this research.

I have made a conscious decision that any quotations made by the ākonga and kaiako who participated in this research have been italicised to bring attention to their whakaaro (in this context: thoughts and opinions). This decision was made to bring mana (in this context: respect and authority) to their whakaaro and to enable their voices to be heard.

4.2 Ākonga and kaiako learning and teaching experiences of climate change concepts

4.2.1 Ākonga learning about climate change

The ākonga interviewed as members of the group interview clearly emphasised their positive experiences of learning about climate change in a local and Indigenous context. Many ākonga spoke with pride about the knowledge they had gained throughout the learning, especially when compared to their prior knowledge at the start of the intervention. Prior to engaging in this learning, many of the ākonga indicated low levels of understanding about climate change (see Figure 2). Less than half of the akomanga (47%, n=17), when asked 'What is climate change?' in a multi-choice question with four options, were able to answer correctly (see Section 3.4.1), choosing 'there is a difference in the average weather pattern'. In addition, when asked further specific questions about the causes and effects of climate change, only 38% of the class could correctly answer the question 'Climate change leads to:' when given four possible answers, and only one ākonga could correctly answer with four options, 'What

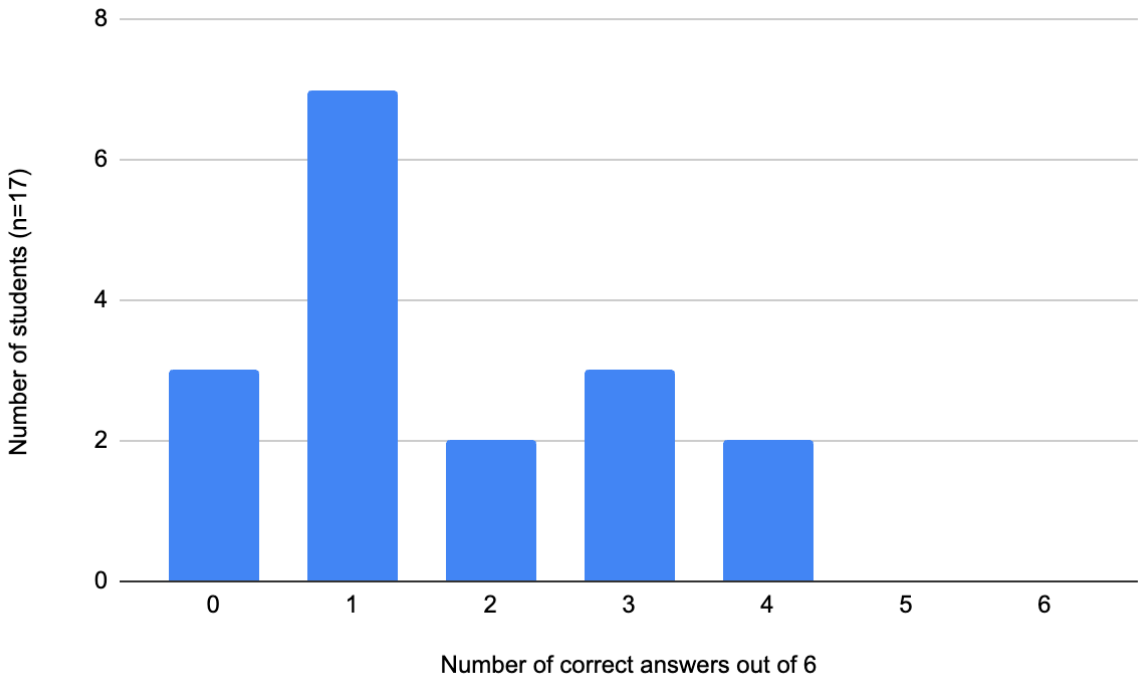
is the main contributor to climate change in Aotearoa?' which was 'farm animals burping and farting'.

When discussing their previous knowledge of climate change and whether they believed they better understood its concepts after the intervention, Kerim said, "*Of course. I literally knew nothing about it [climate change] ten weeks ago, and now I know a lot more.*" Others echoed this sentiment in the focus group. Manaia stated:

> *Yes! At the start I used to think that climate change was when trees got cut down. Then as we learnt about it, I started to understand more and more. At the end of it, I was really proud because I got a much higher score, which showed me that I learnt more.*

Figure 2

Student knowledge about climate change prior to the intervention

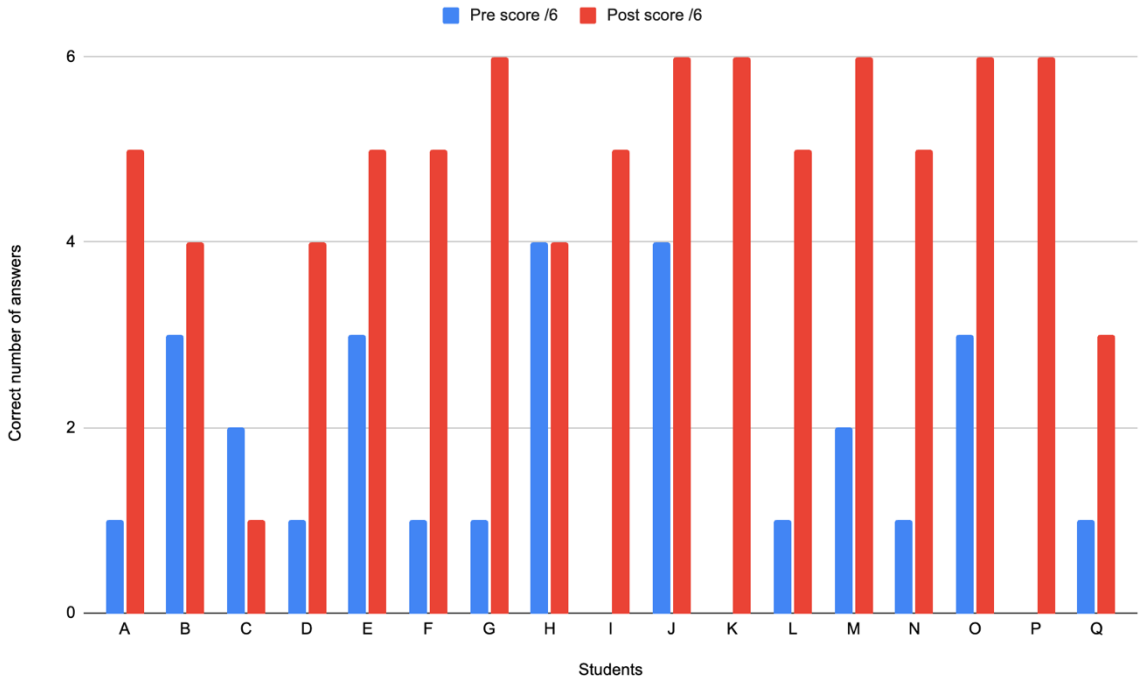


The data comparing pre- and post-learning within the akomanga shows that most learners indicated greater understanding of climate change concepts after the intervention (see Figure 3). Upon further analysis of the climate change knowledge data, it becomes apparent that a single ākonga (ākonga C) experienced a slight decrease in understanding, decreasing from two out of six correct answers to one out of six correct answers. One ākonga (ākonga H)

showed no change in the number of correct answers achieved, scoring four out of six in both the pre- and post-tests. All other ākonga who took both the pre- and post-tests showed much improvement (see Figure 3).

Figure 3

Pre-Test Understanding vs Post-Test Understanding of Climate Change Knowledge



Post-intervention data indicates 86% of ākonga could correctly answer from a four possible answer multi-choice question, ‘What is climate change?’ compared to 47% in the pre-test. Correct answers to, ‘Climate change leads to:’ where the correct answer was, ‘more rain in some places and less rain in other places’ increased from 38% to 59% and for ‘What is the main contributor to climate change in Aotearoa?’ increased from 5% to 68%. (see Table 2)

Table 2

Comparison of Correct Answers on Climate Change Concepts in Pre- and Post-Test

Question (see Appendix B for full questions)	Pre-test Answers Correct Percentage (n=17)	Post-Test Answers Correct percentage n=17)
What is climate change?	43%	86%
Which of the following is contributing most to climate change?	29%	73%
What is the main contributor to climate change in Aotearoa?	5%	68%
Climate change leads to:	38%	59%
The greenhouse effect means that:	14%	73%
Which of the following is NOT a greenhouse gas?	10%	68%

4.2.2 Ākonga learning experiences of greenhouse gases

Greenhouse gases was one of the climate change concepts explored during the learning intervention. Prior to engaging in the learning, the ākonga indicated limited knowledge of the concept of greenhouse gases. Only a very limited number of ākonga could accurately explain the concept of what a greenhouse gas was. Furthermore, Whaea Tupou mentioned in discussions at the end of the first week of learning that some of the ākonga felt "*the test was speaking in another language*", referring to the names of the different greenhouse gases.

Ākonga completed some initial learning that included watching previously chosen YouTube videos (see Appendix F) and explored some cards designed by NASA (National Aeronautics Space Administration (NASA, 2025) (see Appendix G) which highlighted the different greenhouse gases and further discussed the concepts of greenhouse gases as a class. To consolidate their learning, ākonga were divided into small rōpū (groups) and were tasked to record a short, funny or catchy clip to teach a person about a greenhouse gas. Some rōpū incorporated aspects of the pūrākau (verbal narratives that encode knowledge), and all rōpū were able to portray the key information about the greenhouse gases from the NASA fact

cards and YouTube videos they used for information sources. The clip-making provided a successful learning experience for the ākonga. Whaea Tupou highlighted this in her interview, saying, "*They just got so creative, and they had fun. It actually did [help imbed it] because after that, we got greenhouse gas just like that (click of fingers)".* In the kōrero shared by members of the focus group, Manaia said *"I thought making the videos [greenhouse gas videos] was really cool, and it helped me a lot to learn about the gases. It was fun*."

When compared, the pre-test and post-test data demonstrate increased understanding about greenhouse gases for ākonga. For the question, 'The greenhouse gas effect means?', only three ākonga answered correctly in the pre-test, whereas in the post-test, this rose to 73% (N=17). In a four possible answer multi choice question, 'Which of the following is NOT a greenhouse gas?', with the correct answer being oxygen, only 10% ākonga answered correctly in the pre-test. In contrast, post-test data showed that 68% of ākonga answered correctly. The data and comments from kaiako and ākonga suggest that ākonga had a positive learning experience when looking specifically at greenhouse gases.

4.2.3 Ākonga learning experiences of emissions

The concept of emissions was a completely new concept to the ākonga who partook in the learning intervention. Whaea Tupou confirmed that before the learning intervention, as far as she knew, none of the ākonga had any teaching or learning experiences at kura on emissions. Initially, ākonga had difficulty in understanding the scientific, and perhaps unknown word, emission(s). This is reported on further in sub-heading 4.2.5. However, the kaiako engagement data report that during the learning, the ākonga found the concept of emissions fascinating. Using emissions data supplied by the New Zealand Ministry of Environment, ākonga, alongside their kaiako, explored the emissions profile of Aotearoa. Ākonga were able to make connections from the data to the kaupapa (topic/theme) of their learning.
In her interview Whaea Tupou reported:

> *I feel like when we dived a bit deeper with the emissions, that they kind of went like woah! So I asked them why do you think the agriculture industry is the biggest emitters? And they were like because we have the farming data, but no one had explicitly told them that.*

Ākonga then used this farming data to make links to the pūrākau, comparing the concept of modern-day farming to the hunting and traditional crop growing that they had established

was probably typical in the setting of the pūrākau. They decided that the latter would have a smaller emissions profile.

High levels of engagement appear to impact positively on test results, as data from the pre-test and post-test shows improved understanding. When considering the question that focus on emissions in the four possible answer multi-choice question, 'What is the main contributor to climate change in Aotearoa?', data from the pre-test and post-test shows gains in understanding. In the pre-test, only 5% ākonga answered correctly whereas in the post-test, 68% of ākonga answered correctly. In the four possible answer multi-choice question, 'How can climate change affect the availability of food?' with the correct answer being 'It can decrease the amount of food grown due to weather conditions', 48% of ākonga answered correctly in the pre-test. In contrast, 73% of ākonga answered correctly the post-test.

In her interview, Whaea Tupou reported one ākonga spoke to her during the learning around emissions, saying, "*I want to go home and tell my mum that we need to stop driving around and eating as much meat*". This ākonga seemingly understood the link between human actions, emissions and their effects on the world around her. This learning impacted her to the extent that she wanted to take this knowledge home and share it with her whānau (family).

4.2.4 Teaching and learning through the use of science experiments

The use of simple science experiments in the learning intervention, able to be done in the akomanga with limited scientific supplies, was reported as a highlight for many ākonga. The experiment that gained the most attention was one designed by National Institute of Water and Atmospheric Research (NIWA) to visually show the greenhouse gas effect to ākonga in real life (NIWA, n.d.). The experiment used a desk lamp, two recycled glass jars, two thermometers, baking soda and vinegar. For the experiment, the two sealed jars with vinegar and a thermometer already placed in them are placed under the desk lamp for 10 minutes, the temperature is recorded, then baking soda is added to one of the jars and quickly sealed again. After another 10 minutes the temperatures of both jars are recorded again, showing the jar with the baking soda heated up the most. This is due to the reaction between the vinegar and the bicarbonate of soda releasing carbon dioxide, a greenhouse gas, which absorbs infrared radiation (in this case the heat from the lamp). NB: heat is also released by the chemical reaction, so make sure the reaction has finished before reading the temperature. There was a lot of excitement and engagement during this experiment, as highlighted by several data

sources. Whaea Tupou rated the akomanga as ‘very positively engaged’ (The highest on the Likert scale due to this experiment). She stated, *“[The ākonga] loved the science experiment, super engaged learning all the ākonga wanted to repeat experiments and do more! All the different levels of ākonga hooked in. Helped to concrete the concept of greenhouse gas effect in a visual way. Lots of ‘Aha!' moments*.”

In her interview, Whaea Tupou reflected on the fact that in her experience as a primary school kaiako, there were fewer chances to do ‘science experiments’ compared to within high school science. This may be due to several factors such as resources, kaiako experience or confidence. She said: “*With the science experiment, they don’t do that often… we did the science experiment, which they’ve never actually seen, and they love the reaction.*” She went on to say, “*My boys really enjoyed it the most.”* During the time of the experiment at the kura, this was one of the moments where ākonga would come out to find me while on active supervision at lunch and excitedly explain what was happening and state how this *“actually shows the greenhouse gas effect to our eyes Matua*”. This further speaks to and supports the perceived engagement levels of ākonga while learning through practical science experiments. Similarly, in the focus group interview, the rōpū collectively placed the science experiment card high on the list of six options when asked to rank them. They said it was something new, and they did not get to do science experiments very often. Manaia finished by saying, “*The jar experiments helped me to see it [greenhouse gas effect], it helped me to picture it better. To actually see it*.”

Data suggest the use of science experiments in the ākonga’s learning not only increased engagement levels but also contributed to an overall increase in understanding of greenhouse gases and the greenhouse gas effect. As mentioned in subheading 4.2.2, the pre-test and post-test data showed a gain in understanding.

4.2.5 The difficulty of teaching content-specific kupu (words)

During the learning, a theme emerged from both the kaiako and the ākonga that some of the kupu were difficult to understand. The kupu highlighted were often specific scientific names for concepts associated with climate change. Whaea Tupou spoke about the complaints at the start of the intervention, during the pre-test, that “*the test was written in another language, and they didn't have a clue what the questions were asking*.” While the test was written in either English or known Māori kupu, one can understand the potential feelings of ākonga. For

many ākonga, this was the first time they had been exposed to scientific words of any nature, according to Whaea Tupou and casual remarks from ākonga in the study. Emissions was a specific example of a kupu that was difficult to teach and learn. Whaea Tupou said when asked about any barriers to learning, "*Well, emissions, well the word itself, it really, really threw them off. Like they just went: what the? What is this? What are we learning? They just completely... just blanked out.*" In conversations with Whaea Tupou and her comments in her engagement reports and interview, she repeatedly noted how many of the ākonga could understand the concept of emissions but struggled to link that concept to the specific scientific kupu. Whaea Tupou commented concerning this line of thought, "*They were just like, what is the emissions? And I was like we did this last week and then we changed it… we broke down the word and then they kind of got it.*"

None of the ākonga mentioned the difficulty of learning scientific kupu in the focus group. This was potentially due to the lack of a direct line of questioning about this, or perhaps that at the time of the focus group the ākonga were comfortable in their understanding of the kupu and its meaning, as the focus group interview was done after the intervention.

The four possible answer multichoice question 'What is the main contributor to climate change in Aotearoa?' speaks to the concept of emissions in a local context, with the correct answer being 'Farm animals burping and farting'. In the pre-test, only 5% of ākonga answered correctly. In the post-test, 68% of ākonga answered correctly. One could interpret this data in different ways. There is an improvement in ākonga understanding of the emissions profile in Aotearoa. This data supports Whaea Tupou's comments about how ākonga understood the concept but struggled with the scientific words, as there is no direct use of the term emissions but focuses on the concept. Alternatively, one could say that 68% still means that almost a third of the akomanga still do not understand the concept of emissions, perhaps due to the kupu involved.

4.2.6 Kaiako experience of teaching climate change concepts

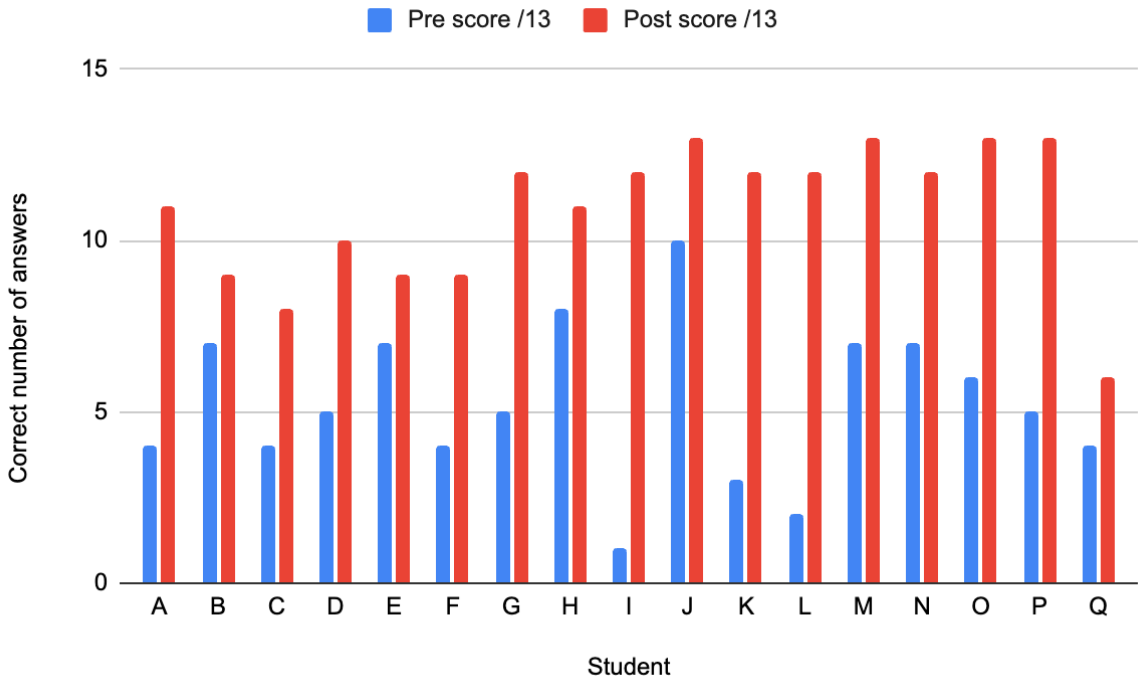
Whaea Tupou was completely open before the learning intervention started, and in initial conversations at the start of the planning process revealed she had limited prior knowledge about climate change. After discussing the research and its aims, she was happy to be the kaiako for the learning intervention and had the philosophical approach of learning alongside the ākonga. This encompassed the Māori concept of ako, which translates to teach and learn.

Throughout the learning intervention, she spoke of her enjoyment of teaching the kaupapa and how it combined some mātauranga Māori and climate change learning. This was highlighted in reflective notes from Whaea Tupou's weekly engagement data, where she often spoke about enjoying teaching an aspect of the learning, whether that be the use of science experiments, learning through the pūrākau or watching the ākonga make videos to explain a scientific kupu. During her interview, Whaea Tupou stated, "*It was really good. There were so many different concepts that I had to go back and rewrite or read... I actually genuinely didn't even know anything about it until we had to teach it... But it was really, really good. I really enjoyed it.*"

When analysing the data for both climate change and food in relation to climate change questions (see Figure 4), ākonga achieved an average increase of correct responses from 5/13 in the pre-test to 11/13 in the post-test. These data suggest an increase in understanding of climate change related learning amongst the different ākonga. The data shift was likely to be influenced by an akomanga being guided by a kaiako who was very open about her lack of knowledge in many different areas of learning. At the end of the interview, Whaea Tupou said, when asked if teaching climate change concepts was still achievable, even if you did not have the background knowledge, she replied: "*Yeah, if I can do it (laughs) then anyone can do it! And I had no knowledge of it before.*" Anecdotally, for many kaiako, a significant barrier to teaching climate change is the lack of knowledge and self-confidence. The experiences of this kaiako and the akomanga involved in the research suggests that guidance through resources and the mindset to learn alongside learners, both ākonga and kaiako can have engaging learning experiences that increase understanding of climate change concepts specific to an Aotearoa context.

Figure 4

Pre-Test Understanding vs Post-Test Understanding of Climate Change and Food in Relation to Climate Change Knowledge



4.2.7 The perceived dangers of teaching climate change

At the conclusion of the interview, Whaea Tupou shared her perceived concerns of how climate change may be taught through her experiences as a learner in the Aotearoa and Tongan education system and as a kaiako. She spoke of the apparent surface-level approaches to the broader environmental education kaupapa, where she felt there was danger of climate change being taught simply as recycling and making sure you put paper in the recycling bin at kura. She added, "*That is what many of the ākonga initially believed climate change was.*" She further explained "*through teaching this learning over the term, I can see how that is problematic, and it doesn't really cover the actual concepts of climate change. Just a very small part of the possible solutions*." This whakaaro perhaps links to the pre-test data (see Figure 2) where there was low initial understanding by the ākonga in the climate change section of the test. Less than half of the ākonga could correctly answer the question 'What is climate change?' and only one of the ākonga could correctly identify the main contributor to climate change in Aotearoa. Their lack of exposure to learning about climate change, other than some learning about recycling and how that is a 'solution' may have contributed to this.

In summary, the findings of this research showed that the learning of climate change concepts during this learning intervention was overall successful in terms of gaining a greater understanding of climate change concepts and engaging ākonga. Almost every ākonga showed growth in understanding, with only two ākonga not growing their understanding. Data from both interviews and engagement comments indicate that some ākonga experienced difficulties learning scientific words but were highly engaged in scientific processes, such as practical experiment. Whaea Tupou highlighted that, despite her limited knowledge of climate change, with the right resources, she was able to teach ākonga about climate change concepts successfully. This highlights the mindset of ako, or teaching and learning simultaneously. The next section of the findings chapter focuses on the weaving of mātauranga Māori in the learning intervention.

4.3 The weaving of Mātauranga Māori through ākonga and kaiako learning and teaching experiences

One central aspect of the learning intervention design was the weaving of specific, localised mātauranga Māori into the learning and teaching experiences throughout the intervention. The use of mātauranga Māori helped create a learning environment where ākonga Māori were better able to see themselves reflected in their learning. It was also an important aspect in the design of learning and the learning content, honouring Te Tiriti o Waitangi, the founding document of modern-day Aotearoa New Zealand. Honouring Te Tiriti o Waitangi is a legal requirement for education in Aotearoa. The mātauranga Māori used in the learning was focused mainly on pūrākau, maramataka (Māori lunar calendar), and Atua (God/deity). These were chosen carefully in collaboration and guidance with a local hapū that has a relationship with the kura.

Table 3

Comparison of Correct Answers on mātauranga Māori in Pre- and Post-Test

Question (see Appendix for full questions)	Pre-test Answers Correct Percentage (n=17)	Post-Test Answers Correct percentage n=17)
How can using maramataka help with growing and collecting kai?	52%	89%
What happens to Whāngai Mokopuna when he isn't fed well?	48%	37%
How did Whāngai Mokopuna grow to be a strong and large taniwha?	67%	72%
One important lesson we could learn from the pūrākau Whāngai Mokopuna is:	48%	36%
Which of these Atua are mostly related to the growing of vegetables?	24%	59%
Which of these Atua are mostly related to the animals of the water we eat?	57%	68%
What does it mean to be a kaitiaki for Papatūānuku?	52%	68%

4.3.1 Ākonga Māori seeing themselves in their learning

In large and seemingly complex learning areas such as climate change, it can be important to ground the learning in a local, relatable and potentially more understandable way. For the learning intervention, in the kura where the intervention took place, the learning stemmed from one centralised pūrākau, which was co-selected with the guidance of a member of the local hapū who sits on the hapū's board as an education representative. Within this framework, the learning intervention was co-designed by the researcher, kaiako and ākonga. Learning about climate change concepts and how that can affect kai and water was formed around the Rangitāne pūrākau 'Whāngai Mokopuna' (see Chapter 3.5.2 for summary and

themes of the pūrākau). This process ensured that any form of learning had the potential to bring te ao Māori (the Māori worldview) concepts to a central position across all forms of learning in a non-tokenistic manner.

During the focus group interview, the ākonga who whakapapa Māori, conveyed that it was important to them to see their culture and identity in their learning at kura. When asked, "Do you think that it is important to have te ao Māori ideas in your learning at kura?" Manaia said, "*We can't just forget about the part of us that is most important*.". She argued that one cannot leave out culture in learning, and it is important for the learners to see themselves in their learning. Kerim responded by focusing more on the language and kupu used in learning, saying, "*If nobody knows the language, then the language is not a thing; it just becomes forgotten*.". The insights here highlight the importance of using his language in everyday learning, no matter the language medium. In addition, Bartholomew remarked, "*Yes, it is always good to learn about your culture*." These sentiments were agreed on by all the ākonga involved in the focus group, no matter their whakapapa.

Whaea Tupou also strongly believed that ākonga Māori seeing themself in their learning was important, saying, "*They [ākonga Māori] should be able to see themselves in a classroom space, no matter what space you are in.*" Whaea Tupou elaborated that she believed it is effective pedagogy to have mātauranga Māori woven into everyday learning, not just at the side in separate lessons, saying, "*For Māori learners, for Pākehā learners, I could not think of any bad reasons why we should not be doing this. I think every school should be doing this.*"

This dialogue, gathered through interviews and focus groups, suggests that having ākonga Māori see themselves reflected in their learning is viewed as important by both ākonga and kaiako in education.

4.3.2 Honouring Te Tiriti o Waitangi in the Aotearoa Education System

As discussed in Section 1.4, Te Tiriti o Waitangi is the founding document of Aotearoa and has four articles which have direct impacts and implications for the education system in Aotearoa. Using mātauranga Māori, such as the learning that comes from pūrākau, in English-medium education is an authentic and meaningful way that educators can honour Te Tiriti o Waitangi through protecting and perhaps revitalising taonga (treasure)**.** The weaving

of pūrākau throughout the learning is a way that the education system, no matter the whakapapa (in this context: genealogy) of the kaiako or ākonga, can honour Te Tiriti o Waitangi. It places mana on an Indigenous knowledge system, showing ākonga and whānau Māori the importance placed on their knowledge.

When interviewed, Whaea Tupou spoke of her beliefs as a kaiako of the importance of honouring Te Tiriti o Waitangi. She spoke of partnership and honouring Te Tiriti o Waitangi as part of her role as a kaiako. Throughout her interviews, data reflect this is a central thought in her process for designing learning. Whaea Tupou stated:

> *But I highly, highly, highly, highly believe that it should be the norm [to use pūrākau and other forms of mātauranga Māori], and it doesn't matter if it's an English medium or kura kaupapa, you know... because that is how we honour Te Tiriti o Waitangi, and that's our job and our partnership with the Indigenous people of Aotearoa, and I'm not even Māori.*

She went on to say, in relation to the way the learning intervention was designed, that, "*I think every school should be doing this. That's how we honour Te Tiriti o Waitangi.*"

There are many ways that kaiako, no matter their whakapapa or position within the education system in Aotearoa, can honour Te Tiriti o Waitangi. The evidence from this research suggests that apart from being a legal requirement, as seen in the Education Act 2020 and the standards set by the Teaching Council of Aotearoa New Zealand (Education Council of Aotearoa New Zealand, 2017), it is important to educators and ākonga.

4.3.3 Steps to use local mātauranga Māori in a tika (in this context: correct) way

The following steps were taken to ensure local mātauranga was used in a tika manner. A localised curriculum has been and is continuing to be developed by the kura. This curriculum development has been designed collaboratively with the local hapū, and supported by the kura's community. The Tumuaki (principal) has factored the localised curriculum in staff appointments, and the use of trusted providers of professional development are just some of the factors to ensure the curriculum works for the ākonga of the kura.

Whaea Tupou spoke from her perspective as a kaiako and team leader of the importance of doing things correctly, not rushing into this learning and providing learning that is te ao Māori centred, authentic and localised:

> *We didn't just get here overnight. We spent a lot of time with Rangitāne and we spent a lot of time doing our own learning in order to help our kids, alongside our local iwi, which... we still are working with, our local iwi, we're not just [picking a random pūrākau] and it had to, like, with Whāngai Mokopuna, the narrative had to be sent to our Rangitāne connect, and she approved it, and then it came back to us. It took us two terms, and then now we're finally doing it. But that was the background mahi for all of us involved in order to get to this position, even before it could get be taught to the kids, it went through the right people, through Rangitāne, they suggested this one. It was like, given to us, so it could be a good learning pūrākau and then we had to go and learn it, understand it. We travelled through Whāngai Mokopuna's footsteps and did some learning around those locations. So there was a lot of background stuff for us in order to even do this.*

Systems put in place from a Board of Trustees level down have led to a point where the kura can provide learning from a te ao Māori perspective, including the use and centralising of mātauranga Māori such as pūrākau with consistency and fidelity. These deliberate acts of thinking and planning may have contributed to higher levels of engagement in learning, as noted in Whaea Tupou's engagement data throughout the learning intervention.

4.3.4 The use of pūrākau to help guide learning experiences

Using the Rangitāne pūrākau 'Whāngai Mokopuna' as the basis for learning was a significant step in grounding te ao Māori as a central component of the learning for this research. The pūrākau acted as the hands that wove the three primary aspects of learning together: climate change, kai and te ao Māori. Whaea Tupou highlighted this by effectively pulling these components together throughout the day-to-day delivery of learning, often bringing small aspects of learning back to the pūrākau to link them all together. She said, "*it wasn't just for climate change. It became handy for all our curriculum activities. We were able to kind of connect the two [climate change and the pūrākau] without even realising that we were doing it.*"

By its very nature, climate change is a large subject that can often focus on the global perspective. The pūrākau 'Whāngai Mokopuna' is a local (to the kura) pūrākau, and this can help to support the learning and provide relevance and meaning for ākonga. Hearing about the different parts of the pūrākau and how it was based along an awa (river) that flowed alongside the area they lived in may have helped the overall learning engagement for the ākonga. Whaea Tupou was asked if she believed it was beneficial that it was a local pūrākau. She responded, "*Yeah for sure, the kids could connect to the location… so it was just they could engage with it, and they knew what they [the pūrākau] was talking about.*" Data suggest the ākonga were engaged by the pūrākau. It was one of the key contributing factors that led to a rating of five, 'very positively engaged' week, the highest option available to Whaea Tupou on the engagement Likert scale, in the week of learning that focussed specifically on the pūrākau. She commented during that week that *"[Ākonga were] interested in the pūrākau, wanted to go to the different locations to see the taniwha's impacts*." Whaea Tupou also commented that from her teaching perspective when using the pūrākau for guiding learning, "*I feel like for me it was a lot more engaging*". These data suggests that connections made in the pūrākau about the value placed on the environment, such as the awa, which provides kai for the people and taniwha in the pūrākau, relate to climate change learning about the relationship between climate change, the environment, and food sources.

When considering the comments from participants of this research, both kaiako and ākonga, as well as data comparing pre-learning intervention knowledge and post-learning intervention knowledge there appears to be the potential that the use of pūrākau made the learning more engaging and may have helped to increase understanding of climate change aspects and its effect on kai. When asked if she would teach using pūrākau as a base for your teaching again, Whaea Tupou responded, "*Yeah for sure. I think we've proved that this term, that like we've done really well.*". Kerim, an ākonga interviewed in the focus group, highlighted that to him, "*It was really interesting to learn from the story pūrākau*." In the question, 'How did Whāngai Mokopuna grow to be a strong and large taniwha?', in the pre-test, 67% (n=17) of ākonga answered correctly that 'Tupatunui and the iwi fed him the best kai', whereas in the post-test, 78% answered correctly. The slight increase in correct responses in the pūrākau and kai question helps to show that through the pūrākau ākonga were able to gain greater understanding of the pūrākau itself as well as of one of the nutrition concepts that was a focus of the kai aspect of learning. This question relates to the concepts in the pūrākau that focuses on the value of healthy kai and the benefits or problems associated with not eating well.

Tupatunui always fed the taniwha well in the pūrākau, whereas the young people became lazy and only feed the taniwha scraps which made the taniwha unwell and sick. Whaea Tupou was able to make these links for ākonga in aspects of learning around kai. Responding to the interview question, 'Do you think using the pūrākau helped them to understand more about bits of climate change in their learning?' Whaea Tupou responded, "*Yeah. I'd say that because we proved it with our test as well… We were able to link in the te ao Māori concepts of Papatūānuku… we connected the two together.*".

4.3.5 The weaving of Atua in the learning experiences

As with other te ao Māori concepts, Atua, the traditional Māori gods, were woven through the primary learning focuses: climate change, kai and te ao Māori. Atua are commonly referenced, in a non-religious tone, in the kura where the learning intervention took place, from use in learning to emotional regulation. It therefore made sense to incorporate some aspects of different Atua in the learning intervention, and this aspect was added in the initial planning stages of the intervention. Whaea Tupou added links throughout the intervention where the connections between climate change and kai may help ākonga to understand the concepts better. She said, "*We were able to link in the te ao Māori concepts of Papatūānuku (Atua of the earth). We were able to link to Rongo mā Tāne (*Atua of the kūmara and cultivated food*), and we connected the two together with climate change.*". There were many examples of where the intervention could link climate change concepts within the different realms of Atua. One example of this was in the interview with Whaea Tupou, in which she stated,

> *How is it affecting Tangaroa's children? What are we doing as human beings to affect that? How are we affecting Ranginui (Atua of the sky)? How it goes up [greenhouse gases], that concept of climate change. So they would always just go, "Tawhirimātea (Atua of the wind and storms) is windy today", but then now they're like, Oh actually if it's more than 30 years [of weather], we actually know it could be climate change because... [alluding to the difference between weather and climate].*

In the test question that focussed on Atua (in both the pre-test and post-test), there was an increase in understanding of which Atua represented what from a te ao Māori perspective. In the question, 'Which of these Atua are mostly related to the growing of vegetables?', the expected answer was Rongo mā Tāne. In the pre-test, 24% of ākonga answered correctly, whereas 59% answered correctly in the post-test. In the question, 'Which of these Atua are

mostly related to the animals of the water we eat?' the expected answer was Tangaroa (Atua of the sea and fish). In the pre-test, 57% of ākonga answered correctly, while 68% answered correctly in the post-test (see Table 3). Tangaroa is a relatively well-known Atua, spoken about at the kura and potentially at home, so one can see, as the data may suggest, there is a greater awareness of this Atua in the pre-test. Weaving Atua into the learning may have helped ākonga connect concepts and deepen their understanding of climate change.

4.3.6 The weaving of maramataka in the learning experiences

The concept of maramataka was introduced to ākonga in relation to growing one's own kai and the māra kai (garden) at the kura. Maramataka, in a simplistic explanation, is the lunar cycle and the effect that the moon has at different stages of the cycle developed through countless scientific observations from tangata Māori. It is important to note that maramataka was not fully explored and was primarily looked at from a planting, harvesting, fishing and hunting perspective. For some of the ākonga, it seemed that it was their first time exploring the concept of maramataka. Initially, many ākonga found it challenging to comprehend the complexities of maramataka, though Whaea Tupou observed a lot of interest. Whaea Tupou noted in the engagement data, "*First look at maramataka and there is a lot of interest but a complex idea.*". After more time exploring maramataka, many ākonga appeared to better understand it, and it seemed they were engaged with the concept and how it related to other aspects of learning. As Whaea Tupou explained, "*The maramataka stuff, the kids, they came and sat with me when we were eating lunch. An ākonga goes 'can you tell me a bit more about this?'. Like he genuinely wanted to know more.*" Whaea Tupou explained that this was not characteristic of that ākonga and was excited to see them interested in the learning.

Data suggest that ākonga better understood maramataka after the learning intervention. In the test question, 'How can maramataka help with growing and collecting kai?', the expected answer was, 'It helps predict the best time grow and collect kai'. In the pre-test, 52% of ākonga answered correctly, while 82% answered correctly in the post-test (see Table 3). Furthermore, from conversations in the focus group, it seems that some of the ākonga could make connections between maramataka, growing one's own kai and climate change. Manaia mentioned in the focus group, "*I could see how maramataka can link to climate change, growing vegetables is important and that helps*". Lucy said, "*Maramataka and how the dates*

worked from the last full moon, it helped us to decide when to plant food", when replying to what parts of learning helped you better understand climate change.

In her interview, Whaea Tupou said, "*I feel like with the maramataka, it links in with climate change.*" However, she spoke about how she would have liked to spend more time exploring the maramataka during the intervention. She felt like there was more to learn in this area. *"[The ākonga are] interested in maramataka and might do some more learning in this area in Term Four*" (Engagement data), contributing to a 'very positively engaged in week 10', the highest option available to Whaea Tupou on the engagement Likert scale. Based on the comments and gain in understanding, it appears that the ākonga enjoyed learning about the te ao Māori concept and that they and their teacher wanted to learn more. One of the ākonga in the focus group asked if they could keep a copy of the maramataka cycle dial so that she could help her dad with fishing for her whānau. Manaia said "*I'm trying to convince my dad to start fishing … So I want him to have that [maramataka chart] so that he can use that to fish.*" (Interview).

In summary, the findings of this research suggest that the weaving of mātauranga Māori into climate change education positively increased engagement and contributed to enhanced understanding throughout the learning intervention. The kaiako and ākonga involved in the interviews all expressed their views on the importance of incorporating te ao Māori into all forms of learning. The use of mātauranga Māori, in the form of pūrākau, maramataka, and Atua, helped guide the learning while grounding the learning intervention in a localised form of learning. In the next section of the findings chapter, the exploration of the relationship between kai and climate change is explored.

4.4 The exploration of kai, its nutrition, what this looked like traditionally in Aotearoa and the impacts of climate change

4.4.1 Comparisons between modern kai and traditional Māori kai

Part of the learning intervention focused on exploring what tangata (people) Māori ate before or at the point of arrival of Pākehā (New Zealand European) settlers. Exploration of what was eaten in that era was ākonga-lead research, with support from Whaea Tupou. Ākonga used internet sources and books to piece together possibilities of what Māori ate. Across the different data sources, it would suggest that the ākonga found this exploration fascinating.

When interviewed as part of the focus group, Bartholomew said, "*I really liked learning about the different types of kai. I found it really interesting to see what Māori ate*". During the same focus group, Lucy said, "*It was really interesting to see what Māori ate*", agreeing with Bartholomew. From a kaiako's perspective, Whaea Tupou noted in the engagement scale data, "*Loved the slide about kai and Māori before Pākehā*" This exploration helped to contribute to a four out of five on the Likert scale, which assessed engagement of the ākonga from a kaiako's perspective.

After their initial exploration into what tangata Māori ate before or at the point of arrival of Pākehā settlers, ākonga began to compare the difference in that diet with what they ate currently. Whaea Tupou spoke about the interest and connections that ākonga made between kai, lifestyles and potential climate impacts. She said in her interview:

> *We looked into kai, like they explored a whole different concept of that, because they made that comment about how it's, so the difference between just traditional kai and modern kai is that they went and actually hunted for it... Whereas modern kai, we go and buy it from the supermarket, and we don't know all of the impacts that they've done behind the scenes to get to that point! There were so many connections.*

Notably, some students could verbalise connections between the different types of food we use to fuel our tinana and ways that may impact our world. In week five, Whaea Tupou mentioned in her engagement comments that ākonga "*Made comments on processed food and Māori hunter-gathering from ākonga. Making the connects between this and grocery stores. Some ākonga making connects to climate change concepts from here.*"

4.4.2 How we fuel our tinana (body) can have an impact on climate change

The perceived visible interest mentioned in Whaea Tupou's engagement records and comments during her interviews about ākonga's learning of comparisons between traditional Māori ways of fuelling one's tinana and modern ways, (as mentioned in Section 4.3.1), led to interest in the impacts of the way we fuel our tinana and the connections that this has to our environment and the climate. The ākonga then built on their prior knowledge to explore the impacts of food on climate change. This exploration of the relationship between fuelling our tinana and the impact on the climate was explored in many ways, including looking at emissions profiles in Aotearoa and making possible connections to the food we eat, exploring food supply lines, and the impact that eating seasonally and locally may have on someone's

emissions profile. More specific examples of ākonga learning about the connections between fuelling one tinana and the climate are explored below in Sections 4.3.3-4.3.5.

Whaea Tupou mentioned her observations of understanding in her weekly engagement reports that some ākonga "*Understood the links between food and climate change impacts.*". Lucy, during the focus group interview with ākonga, said, "*The atmosphere is like a fluffy blanket, but if there is more gases then it gets hotter and hotter. That can affect things like a drought, and we could not have food and even starve*." This comment suggests she was able to make connections between the climate and kai, and vice versa.

Quantitative data indicate that ākonga engagement in learning has potentially contributed to higher levels of understanding of the links between what we eat and drink and the impacts on the climate and environment. In the pre-test, for the question, 'What drink has the least impact on climate change?', 24% (n=17) ākonga answered correctly from the four multi-choice answers, with 'water' being the correct answer. Following the learning intervention, 64% of ākonga answered the same question correctly in the post-test. For the question, 'What food category has the least impact on climate change?' 14% of ākonga answered correctly from the four multi-choice answers in the pre-test, where 'Eating food that is in season and locally grown' is the correct answer. In the post-test, 59% of ākonga answered the same question correctly (see Table 4).

Table 4

Comparison of Correct Answers on Food in Relation to Climate Change in Pre- and Post-Test

Question (see Appendix B for full questions)	Pre-test Answers Correct Percentage (n=17)	Post-Test Answers Correct percentage n=17)
How can climate change affect the availability of food?	48%	73%
What drink has the least impact on climate change?	24%	64%
What food category has the least impact on climate change?	14%	59%
Which food choice is better for the climate?	57%	86%
To help slow climate change, is it better to put food scraps in the:	71%	91%

What impact does food waste have on climate change?	33%	73%
Which way of growing food is better for the climate?	48%	77%

4.4.3 Food supply line concepts and emissions

One of the concepts explored while learning about how we fuel our tinana and its impact on climate change was the concept of supply lines of kai and how that may impact our climate. The supply line concept was initially planned as a small exploration. However, once the ākonga became familiar with how this concept worked, they wanted to explore it for longer, so Whaea Tupou and the ākonga broke down all the different stages they could find in the supply line of a mandarin. Whaea Tupou said in her interview, "*We even went back and watched a YouTube video on how you would even process a mandarin. So, they went "there are machines, there is this" like because they had no concepts of what you know [the supply chain to get a mandarin in a supermarket]. They just thought you just pick it and put it in the store.*". Once ākonga understood some of the processes involved in the supply line of different types of kai, Whaea Tupou helped ākonga make possible connections to the impact on the climate. She looked for simplistic and understandable places to link emissions into the supply line, from the initial place, such as a farm, travel time for the food, to the processing of it. Whaea Tupou commented on this part of the learning intervention by saying:

> *I feel like they knew it, but it took me to explicitly say, go back, tracking back along [the supply chain]. Like, how does that all impact? So they kind of have that information there for some for the ones who [were able to make the connections in their heads]. So it was just like connecting the dots for them going, actually, just looking [at] the background of how that actually impacts the environment... The process of the people getting it from the machine, bagging it. So you know, all of that, the steps to get it to there, that's it. That creates that emissions profile for that mandarin.*

The perceived interest and engagement in this topic area may have helped increase understanding of the relationship between kai and the climate. Exploring the direct impact of this relationship and helping to see the broader picture of Aotearoa's emissions profile and its connection to kai. In the multi-choice tests, for the question "What is the main contributor to climate change in Aotearoa?", only one of the ākonga answered correctly prior to the

intervention. The correct answer was “Farm animals burping and farting.” In the post-test, 68% (N=17) of ākonga answered the same question correctly.

4.4.4 Local and seasonal eating

While learning about how they fuel their tinana and the relationship between this and climate change, the ākonga spent time investigating the potential impacts of eating local and seasonally on the climate and the environment. It became apparent to Whaea Tupou that many ākonga did not know that kai from their local supermarkets was not necessarily grown or produced in Aotearoa. Therefore, they started at that point, exploring food sources at the supermarket: grapes from North or South America, bananas from Ecuador, meat imported from overseas, and some different fruits and vegetables from our neighbours across the Pacific. Using the knowledge they had built on or acquired from learning about the supply chain in the learning intervention, ākonga could start to make connections between the climate and eating locally. In her interview, Whaea Tupou said, “*Getting the mandarin from Napier versus getting a mandarin from America. They instantly just went why would you use all that fuel like that, so they already made the connection [eating locally sourced kai].*” Ākonga could make connections between the use of fuel in transport and distances that different forms of kai may have to make to get to their supermarkets and that difference in supply lines may negatively impact the climate compared to the food items grown locally.

Ākonga had limited understanding of the concept of seasonality and kai. Not all fruits and vegetables can grow year-round, which impacts several things, from needing to import certain types of kai to changing the price of the food item. When out in the māra (garden) kai at kura with Mrs Green (the kura’s retired learning assistant and gardener), learning about growing kai themselves, (more detail in Section 4.3.5), some ākonga learned for the first time that different seeds get planted at different points in the year depending on the seasons and the associated climate. This learning was brought back into the akomanga and used in connection with growing locally to help develop a broader picture of how we fuel our tinana can impact the climate.

In learning about local and seasonal eating and the supply line of some kai, ākonga may have developed a better understanding of the impact that kai has on the climate and the environment. Data suggest that there was a positive impact on the ākonga’s understanding of these concepts. In a multi-choice test, the ākonga were asked the question, “Which food

choice is better for the climate?" In the pre-test, only 14% (n=17) of ākonga answered correctly, selecting "Eating food that is in season and locally grown" as the correct option from the four choices provided. In the post-test, 59% of ākonga answered the same question correctly.

4.4.5 Being in the māra kai at kura and learning about the whenua

There was an initial assumption from both Whaea Tupou and Mrs Green that perhaps the year five and six ākonga would not be engaged or enjoy spending time in the garden due to the lack of older ākonga presence in the māra kai at break times. There was some initial hesitation from ākonga in the māra kai and the learning around this part of the topic, perhaps due to the reluctance to get their hands dirty or perhaps due to any time spent in the māra kai while at school. However, for many of the ākonga, it was one of the highlights of the learning intervention. Bartholomew said, "*I enjoyed being able to eat different parts of the māra kai*" when reflecting on his time with Mrs Green in the māra kai. Whaea Tupou believed that it was the being outside and hands-on that drove engagement: "*Again, that was that physical, being outside... at the start, they were like "Oh, children do that; we don't want to do that", and then they came back saying that was fun!*".

The time spent in the māra kai focused on a few key objectives related to the learning happening in the akomanga. These objectives were to learn what was in the māra kai and why we must grow vegetables and fruits at specific points of the year, how to grow and look after the whenua, a practical look at maramataka, and planting their own crop of vegetables. In the last half of the learning intervention, Mrs Green spent time with small groups in the māra kai, providing hands-on learning experiences for the ākonga to learn relating to the aforementioned objectives. Ākonga all planted corn, starting from seeds and nursing them in the akomanga in a sunny spot until the ākonga and Mrs Green planted them in the māra kai. "*I really enjoyed being able to grow corn from a seed.*" said Kerim when speaking in the focus group about his experiences in the māra kai. Whaea Tupou added about growing their own kai: "*They loved tracking their corn in class, they were like "Look Whaea!" [as they tracked its progress each week]*".

A combination of in-class and practical hands-on learning was used to explore different ways to look after the whenua and how this may impact the climate and environment. Ākonga briefly learnt about the positive impacts of organic and regenerative agriculture on the

climate. They saw examples of what this form of agriculture looks like from a te ao Māori lens by exploring Pourewa Māra Kai from a hapū based in Tāmaki Makau Rau by watching a video tour of the māra kai. In the māra kai at kura, they helped to look after the whenua by weeding, removing pests, and giving back to the whenua by using compost to enrich it. "*I really enjoyed yeeting [chucking] snails and slugs into the bin!*" Kerim exclaimed, speaking about removing pests from the māra kai in the focus group interview. Lucy said as part of her kōrero about time in the māra kai, "*We learnt about the compost and found that interesting how it helps in the garden.*". Manaia also agreed, saying, "*It was really cool to see new things that I've never seen before, like putting compost in.*". This combination of learning in the akomanga and hands-on learning in the māra kai may have helped contribute to increased engagement for ākonga in their learning. This engagement flowed out of kura and back to the homes of some akomanga. Whaea Tupou commented on week nine's engagement levels: "*Ākonga are sending lots of pictures from home of their māra kai and sharing these with the akomanga. Showing a level of engagement with the learning content.*"

The time spent learning about māra kai and caring for the whenua appears to have contributed to higher levels of engagement, which likely enhanced the understanding of ākonga in this learning area of the intervention. In several areas focused on māra kai and the whenua, in the multi-choice tests, there were increases in understanding across ākonga. In the question 'To help slow climate change, is it better to put food scraps in the?' There were four possible answers, and the correct answer was: 'compost.' In the pre-test, 71% (n=17) ākonga answered correctly. In the post-test, 91% of ākonga answered correctly. When asked: 'What impact does food waste have on climate change?' the correct answer was, 'Food waste that goes into the rubbish releases greenhouse gas'. In the pre-test, 33% of ākonga answered correctly whereas in the post-test, 73% of ākonga answered correctly. In the final question directly asking about growing kai, the question asked: 'Which way of growing food is better for the climate?' The correct answer was 'Farms that use natural systems'. In the pre-test, 48% of ākonga answered correctly. In the post-test, 77% of ākonga answered correctly (see Table 4).

4.4.6 Cooking and eating kai

In the initial planning stages of the learning intervention, some of the ākonga were part of a short focus group interview. This focus group were given a brief overview of the learning intervention and asked if they liked the sound of any parts of it, did not think parts of it were

interesting and if they had any further ideas to contribute to the learning intervention. Every single ākonga involved wanted to know if they could cook and eat some kai once they learned that some of the learning would be based on kai. Early in the intervention, a nutritionist visited the ākonga and spoke about the foundations of nutrition, eating and drinking healthily and how to look for healthy food in supermarkets. This learning helped to contribute to a foundation of knowledge about healthy eating. Whaea Tupou mentioned in the engagement scale data that: "*Nutritionist visit, good links to learning intervention and complements kai aspect of learning. Strong Foundations*.". After further learning during the term-long intervention, ākonga designed a meal that they could cook at kura that was healthy and had a lower impact on the climate. The akomanga made a brunch with a 'healthy pancake' recipe, fresh fruit from local farms in Aotearoa and homemade kumara hashbrowns. They also had chilled water, with some fruit cut up into it to add flavour. These food and drink choices may have demonstrated some aspects of the learning throughout the intervention when they learned about healthy foods to eat and balance in eating different types of kai and what type of kai and drinks are less impactful on the climate. Quantitative data focusing on the above areas suggested an overall improvement in understanding by ākonga. In the question, that focused on the drink and food that had the least harmful impact on the climate both questions showed shifts of around 40% improvements in understanding, as related more in-depth in earlier sections.

Many of the ākonga were visibly excited to be cooking in the kura kitchen, preparing food and flipping pancakes. Bartholomew commented, "*I really loved the food*", and all the other ākonga in the focus group agreed with his comment. Half of the students in the akomanga began their day by working in the māra kai, assisting Mrs Green in planting the corn seedlings they had grown throughout the term in their akomanga. The other half spent their time preparing food in the kitchen. After some time, the groups rotated activities and then finally finished the learning intervention by joining together to share the food with each other, Mrs Green and Whaea Tupou. Manaia and Lucy said in the focus group, "*The part we most enjoyed was kai, especially the cooking today!*".

4.5 Chapter Summary

This chapter presented an analysis of how a Rangitāne pūrākau helped increase engagement and deepen the understanding of climate change in an akomanga of Year five and six ākonga within a kura in the lower North Island of Aotearoa. Quantitative data from pre- and post-tests suggest that there were gains in ākonga comprehension of core climate change concepts, including the definition of climate change, the role of greenhouse gases, and emissions (see Table 5). Qualitative data gathered from an ākonga focus group and kaiako interviews revealed that ākonga were engaged and had positive learning experiences. This was notably apparent during practical activities, such as science experiments, clip-making, and hands-on experiences in the māra kai. These activities appeared to collectively enhance their understanding of climate change and environmental concepts.

A central finding was the impact of weaving mātauranga Māori, specifically the Rangitāne pūrākau, Atua, and maramataka, into the learning intervention. This weaving of mātauranga Māori may have helped nurture a stronger sense of cultural identity for ākonga Māori in their learning, aligning with the principles of honouring Te Tiriti o Waitangi, while also serving as an effective pedagogical tool to connect often abstract climate change concepts to local, relatable contexts. The ākonga's knowledge of mātauranga Māori concepts involved in the learning intervention grew from average correct answers (n=7) in the pre-test of 50% to 61% in the post-test (see Table 5). The exploration of kai through a combination of mātauranga Māori and Western lenses, examining traditional versus modern ways to fuel your body, supply chains, and local/seasonal eating, further helped to deepen ākonga understanding of human impacts on the climate and environment. The ākonga's knowledge of the relationship between kai and climate change grew from average correct answers (n=7) in the pre-test of 42% to 75% in the post-test (see Table 5). Whaea Tupou's experience, which began with limited knowledge but a desire and enjoyment of learning alongside ākonga, emphasised the feasibility of implementing culturally responsive and engaging climate change education, moving beyond superficial approaches.

Table 5

Comparison of Correct Answers in Full Pre- and Post-Test

Question	Pre-test Answers Correct Percentage (n=17)	Post-Test Answers Correct percentage n=17)
What is climate change?	43%	86%

Which of the following is contributing most to climate change?	29%	73%
What is the main contributor to climate change in Aotearoa?	5%	68%
Climate change leads to:	38%	59%
The greenhouse effect means that:	14%	73%
Which of the following is NOT a greenhouse gas?	10%	68%
Average correct answers for climate change questions:	23%	71%
How can using maramataka help with growing and collecting kai?	52%	89%
What happens to Whāngai Mokopuna when he isn't feed well?	48%	37%
How did Whāngai Mokopuna grow to be a strong and large taniwha?	67%	72%
One important lesson we could learn from the pūrākau Whāngai Mokopuna is:	48%	36%
Which of these Atua are mostly related to the growing of vegetables?	24%	59%
Which of these Atua are mostly related to the animals of the water we eat?	57%	68%
What does it mean to be a kaitiaki for Papatūānuku?	52%	68%
Average correct answers for mātauranga Māori questions:	50%	61%
How can climate change affect the availability of food?	48%	73%
What drink has the least impact on climate change?	24%	64%

What food category has the least impact on climate change?	14%	59%
Which food choice is better for the climate?	57%	86%
To help slow climate change, is it better to put food scraps in the:	71%	91%
What impact does food waste have on climate change?	33%	73%
Which way of growing food is better for the climate?	48%	77%
Average correct answers for food in relation to climate change questions:	42%	75%

Chapter 5 Discussion

5.1 Introduction

In this chapter, the findings of the research are discussed in detail and conclusions for the study drawn. My research question (as below) determines the layout of this chapter.

In what ways can Rangitāne pūrākau (verbal narratives that encode knowledge) engage and further the understanding of Year five and six ākonga (learners) in learning about climate change within a kura (school) in the lower North Island of Aotearoa (New Zealand)?

This research question is discussed initially as two distinct components: engagement and understanding. These components are examined in relation to the use of pūrākau to support the teaching of climate change. Both these aspects of the discussion are compared with previous research.

Discussion of the research question is followed by research limitations, conclusions, impacts, and further recommendations for future research.

5.2 Student Engagement

5.2.1 Culture Counts

An ākonga, aged 10, said to me in their group interview, "*We can't just forget the part of us that's most important.*" A profound statement from an ākonga in year five at primary school. Lucy, who is of whakapapa (in this context: genealogy) Māori, was responding to a question about whether she believed it was important to incorporate te ao Māori (the Māori worldview) ideas into our learning at kura. Findings revealed similar sentiments were shared by other ākonga and the kaiako (teacher) in the group interview and kaiako interview, some who identify as Māori, others as Tangata Tiriti (Treaty partner). These thoughts and beliefs personify the educational research from Bishop and Glynn (2003) and more recently Riwai-Couch (2022) whose research into successful educational outcomes for ākonga Māori notes not only the importance of academic achievement but of all aspects of hauora (health and wellbeing), including awareness of language, identity and culture. The importance of culture and identity, as highlighted by ākonga and the kaiako in this research, can be directly related

to increased engagement in learning (Bishop & Glynn, 2003; Macfarlane & New Zealand Council for Educational Research, 2004).

In the learning intervention, the use of specific mātauranga (knowledge) Māori, such as pūrākau, the integration of Atua, and exploration of maramataka (Māori lunar calendar), brought culture and Indigenous knowledge to the forefront of the learning context of climate change. Often climate change education is presented as a somewhat siloed and strictly scientific one (McKenzie et al., 2023; Monroe et al., 2019; Nepraš et al., 2022). The integration of te ao Māori allows for a more expansive, integrated and holistic approach to teaching climate change concepts. This approach encompasses social, emotional, cultural, and action-oriented dimensions alongside scientific understanding. Such an approach, researchers argue, enables climate change education to be more personally relevant and meaningful for a broader range of ākonga (Monroe et al., 2019; Nepraš et al., 2022). When aligning the understanding of specific climate change research into more meaningful and relevant learning for a broader range of ākonga to the research by Berryman et al. (2018), Bishop and Glynn (2003) and Riwai-Couch (2022), the findings of this research, through the observations of an experienced kaiako, suggest that having a culture-centred approach in climate change education can increase engagement in learning.

The explicit inclusion of te ao Māori as a central strand for the learning intervention created a learning experience where ākonga could see themselves and see the mana (status and authority) placed on mātauranga Māori. Several data points, including interviews, engagement scales by the kaiako, and improvements in understanding as shown in pre- and post-testing, suggests that the inclusion and centralisation of te ao Māori has supported engagement in learning, and contributed to improved understanding.

5.2.2 The integration of mātauranga Māori into learning to increase engagement

Throughout the learning intervention, many learning experiences centred on mātauranga Māori concepts. Data gathered from interviews and notes on engagement show that the inclusion of mātauranga Māori concepts has a positive effect on the engagement levels of ākonga in this intervention. This was shown in the observations of engagement made by the kaiako and further in comments in the kaiako's conversations about the engagement ākonga had in their learning using the pūrākau. In line with this, research on engagement in education more broadly reinforces the concept of seeing one's culture and identity within learning as a

contributor to increased engagement in education (Berryman et al., 2018; Riwai-Couch, 2022). This relates directly to the use of mātauranga Māori in the learning intervention and its contribution to the increased engagement in learning by ākonga within the akomanga. While there were a high number of ākonga Māori in the akomanga, research shows that what is effective for Māori ākonga is effective for all learners in Aotearoa, but this is not necessarily true in reverse (Bishop & Glynn, 2003).

In the learning intervention, an example of mātauranga Māori and climate change education being effectively woven together to create an environment that increased engagement levels was within the learning regarding emissions. In the learning intervention, the concept of emissions was entirely new to the ākonga who participated, as confirmed by their kaiako. Using the data from the emissions profile of Aotearoa supplied by the New Zealand Ministry of Environment alongside the pūrākau, the kaiako and ākonga compared modern-day farming, with traditional hunting and crop growing which they determined was likely to be a typical way of gaining kai (food) to feed whānau in the context of the pūrākau time setting. They concluded that traditional practices would likely have a smaller emissions profile. In this section of learning, the ākonga, with guidance from their kaiako, were able to manipulate data and relate this to the pūrākau. Their excitement and engagement were evident, as findings show that the teacher observed the use of a local pūrākau to be beneficial in terms of connection to location and allowing comparisons between modern and past kai production and consumption habits.

By considering the concept of mana ōrite (equality) in the learning intervention, and attempting to create this between two knowledge systems, demonstrating the value of mātauranga Māori alongside with the Westernised statistics that the ākonga and kaiako were engaging with may have contributed to increased engagement in learning by ākonga within the akomanga. As Hipkins et al. (2022) explained, mana ōrite can be an important factor for engagement levels, as it means ākonga Māori are seen as ‘knowers’, ‘understanders’, and ‘doers’ within their own knowledge system, which can complement and enhance everyone’s learning. A similar trend was found in international research by Turner and Wilks (2022), where the use of verbal narrative by Aboriginal Elders, through lived experiences, was a powerful tool to increase engagement in learning, enabling learners to connect to the local area with knowledge from the narratives, which helped them to activate their prior knowledge and build empathy towards the land. In a high school, in Aotearoa, the head of the science

department used pūrākau to enhance science education for ākonga (Russell, 2024). This approach helped students better understand their local area and provides different perspectives on relevant scientific concepts, leading to increased engagement in their learning.

A further experience in this learning intervention also centralised the integration of mātauranga Māori. This involved the exploration of maramataka by the kaiako and ākonga. Maramataka was explored in the context of when to plant and gather kai, both in the māra kai (food garden) and for activities such as fishing. Many ākonga were interested in the concepts, with some even wanting to discuss maramataka in their own time, which Whaea Tupou said was not a usual characteristic displayed by some of the ākonga. These ākonga were clearly engaged in the application of the maramataka in relation to food, and asking questions and seeking further information is indicative of their engagement in the topic. In addition, ākonga were sharing their new knowledge outside of school with their whānau and explaining the use of maramataka. There is limited research on the application of specific Indigenous knowledge concepts, such as maramataka, currently available. However, in an article about the use of maramataka in kura across Aotearoa, anecdotal notes from kaiako or tumuaki (principal) suggest that there are many positives to integrating maramataka into learning in kura, including increased engagement (Heke, 2022).

This study shows potential for how mātauranga Māori integrated into climate change education could engage primary school ākonga in Aotearoa. There appears to be precedence, which has been replicated in differing age groups across multiple countries (Heke, 2022; Russell, 2024; Turner & Wilks, 2022), showing that the integration of Indigenous knowledge systems, in this learning intervention case mātauranga Māori and specifically pūrākau and maramataka, have positive impacts on engagement and potentially their understanding of the learning.

5.2.3 Hands-on learning in the māra kai

An unexpected finding from the learning intervention was the level of engagement from the ākonga in the kura's māra kai. When initially planning the learning intervention, Whaea Tupou was not sure about the potential enthusiasm from the ākonga in the māra kai, as it was perceived as 'for the juniors' by the older ākonga. However, I was very interested in trialling its involvement in the learning intervention due to the clear links to learning around kai. The

literature review also noted the importance of being outdoors in the environment and the corresponding positive impact on engagement levels in environmental education (Bleazby et al., 2023; Bolstad & Durie, 2024; Reynolds, 2020; Turner & Wilks, 2022).

In Bolstad and Durie's (2024) case studies, a theme was identified regarding the need for time spent in a māra or outside in the environment while learning about climate change. They identify this as a chance for ākonga to be in a space connecting to whenua (land), partaking in informal conversations with others that may not necessarily have happened in an akomanga (classroom). Connecting learning to whenua was significant and enjoyable for many learners in the various case studies explored by Bolstad and Durie (2024), and it held particular significance for Māori ākonga. Therefore, when ākonga spoke to both Whaea Tupou and me about how they enjoyed their time in the māra kai and asked about when they get to go back, it was a direct confirmation of research presented in the literature review. Thereafter, a strong connection emerged between māra kai sessions, in-class climate change conversations, and connections drawn from the pūrākau.

Findings from conversations with Mrs Green, a kura gardener volunteer, and interviews, and engagement scales by the kaiako, showed a potential correlation between the time spent outside connecting with whenua and others, and its positive impact on engagement levels across learning, both inside and outside the akomanga.

5.3 Student Understanding

5.3.1 Learning alongside ākonga while teaching

From the outset of the learning intervention, Whaea Tupou made it clear that she had a limited understanding of climate change and its associated impacts on the environment. She expressed being slightly nervous about teaching the concepts to ākonga and wanted to ensure she was able to teach all the parts of the learning intervention effectively. This anxiety associated with teaching climate change is common among kaiako, often linked to a lack of knowledge and confidence (Beach, 2023; Eames, 2017). The learning intervention was therefore designed as a plan that could be unpacked as a series of learning experiences, stemming from the three main concepts (climate change, the pūrākau, and kai) with attached resources. The intervention was designed to enable the kaiako to learn alongside the ākonga, rather than her being the sole source of knowledge. Before each week started, Whaea Tupou

would review the plan, explore the lessons, and watch any attached video clips. This enabled her to have a solid foundation for the lessons ahead. From the onset of teaching in the intervention, Whaea Tupou was very open with the ākonga and said she may not be able to answer all their questions. She highlighted that together they would explore different sources of knowledge and hopefully find their answers. This openness, combined with the learning intervention design and resources, created a positive learning environment where a kaiako can teach climate change education whilst growing their own understanding.

The teaching and learning approaches were based on elements of co-constructivism, collaborative learning and aspects of teaching as inquiry. These pedagogical tools were used to create an environment where the spotlight moves from the kaiako as the source of knowledge and is, in turn, brought into a more collaborative, ākonga-centred approach where kaiako and ākonga work together to create knowledge and develop skills (Culture Counts, n.d.). The learning concept of 'ako' literally means 'to teach and learn' (Bishop, 2011). This Māori concept of learning centres on the kaiako not needing to be the source of all knowledge but rather, they should create environments for learning where students can actively engage in the conversation. Bishop (2011) explains that this learning concept, when used effectively, is beneficial to ākonga Māori in education. In this learning intervention, Whaea Tupou reported spending time learning alongside the ākonga, not having all the answers and exploring concepts together, while being supported by the learning intervention planning. This proved to be an effective combination, which I believe was one of the contributing factors to a deeper understanding of climate change concepts for ākonga. The 89% (N=17) average increase in understanding of climate change concepts by ākonga points to an effective learning intervention.

The findings of this research, supported by other studies such as Bishop (2011) and Culture Counts (n.d.), suggest that kaiako do not need to be the centre of knowledge and be at the front of the class teaching. Instead, an effective manner of teaching is to co-construct learning with their ākonga, allowing for an environment where ākonga and kaiako can explore the learning together and share their own valid knowledge and findings (Bishop, 2011). This can contribute to increased understanding in their learning for ākonga. Perhaps, with the support of culturally responsive practical teaching resources for climate change education and a mindset of learning alongside ākonga, some of the challenges kaiako face with teaching

climate change education due to a lack of confidence and knowledge could be alleviated (Beach, 2023).

5.3.2 Potential benefits of practical science experiments

A notable aspect of the learning intervention findings was the enthusiasm of the ākonga for the science experiment and the apparent increase in understanding it afforded. In notes from the weekly engagement scale reports and interviews, Whaea Tupou mentioned that, in her experience, primary school ākonga receive less time to participate in scientific experiments and may have less access to science equipment than older learners. In reality, to complete the practical experiment for this learning intervention, many pieces of equipment for the scientific experiment had to be borrowed from a local high school science classroom.

In a large-scale study, Monroe et al. (2019) reviewed various climate change education models and teaching programmes. One of the common threads found to increase understanding of climate change concepts in this research was for ākonga to have the opportunity to interact with scientific equipment, collect data and conduct scientific experiments. This was shown to increase their interest, knowledge, and confidence in climate change science. Hipkins et al. (2022), in an Aotearoa-based article on science competencies, suggest that combining practical experiments with critical thinking provides the tools to increase understanding and navigate the sea of misinformation that ākonga encounter today. This is highly relevant to climate change education, which is often marred by large quantities of misinformation developed and distributed by parties with vested interests in maintaining industries such as fossil fuels and large-scale agriculture (Stott, 2021).

The kaiako in this study highlighted in her interview the enjoyment ākonga showed, along with their ability to articulate abstract concepts, through a science experiment. The ākonga also spoke (in their interview) of the enjoyment and support the science experiment provided in developing their understanding of the greenhouse gas effect. When triangulating these comments with pre- and post-testing data, I argue that the use of practical science experiments contributed to increasing understanding of climate change concepts.

5.3.3 The use of Pūrākau to guide learning experiences

As discussed in Chapter 2.4.2, pūrākau arise from mātauranga Māori. They are narratives containing philosophical thought, epistemological constructs, cultural codes, and worldviews

(Lee, 2009). This research, through the learning intervention, explored how the use of pūrākau as a guide for learning experiences for climate change education could contribute to increased understanding of climate change concepts. The pūrākau was used as a source of information that connected all the other sections of learning together. The first step of the learning intervention was for akonga to become became familiar with the pūrākau and to explore the different aspects of the narrative. Then, throughout the learning intervention, all learning connected explicitly back to the pūrākau. Whaea Tupou and the ākonga explored different ways of food production as a class, examining the relationship between this and climate change. The ākonga learned how different farming techniques can have either positive or negative effects on the whenua and climate. A connection was made to the pūrākau, Whangai Mokopuna, highlighting the value placed on food sources and where they come from in the narrative. Whaea Tupou and the ākonga then used this understanding as a connection to the impacts of climate change and the importance of caring for these taonga (treasures). This then led to thinking about how to look after the whenua when caring for the māra kai. During their experiences in the māra kai, they used organics such as compost to care for the whenua while growing kai from it. These many and varied connections between the pūrākau and learning experiences in the intervention helped to positively increase the understanding of the kai and climate change concepts. The improved understanding was reflected in ākonga answers to the question relating to which ways of growing food are better for the climate. The correct responses lifted from 48% in the pre-test, to 77% in the post-test. Throughout the intervention, ākonga explored different ways to fuel their bodies, connecting this to health and the impacts on the climate. Ākonga used a further connection to the pūrākau, where Tupatunui left the young people in charge of feeding the taniwha. The ākonga made connections to this aspect of the pūrākau as they learned about how to fuel their bodies healthily. Ākonga explored traditional types of kai that may have been eaten at that time, being enabled to make further connections between the pūrākau and their learning about kai. This provided an authentic and unique way to compare how they fuel their bodies with the way it was in the past. Learning that ultra-processed foods are not only often unhealthy but also typically have worse impacts on the climate than whole food equivalents was also able to be linked to the pūrakau. The ākonga could connect the different eating habits in the pūrākau and in their own lives and explore the different impacts that food choices have on the environment and climate. In the pre-test, 14% of ākonga could correctly identify which food category has the least impact on climate change. In the post-test, this number increased to

59%. The use of the pūrākau's to connect, ground and guide learning appeared to contribute to a greater understanding of climate change concepts.

The integration of Indigenous knowledge with Western knowledge can enhance understanding of concepts related to climate change and environmental education (Cajete, 2020; Datta, 2018; Russell, 2024; Olstead & Chattopadhyay, 2024; Tanyanyiwa, 2019). This encapsulates the concept of Etuaptmumk or two-eyed seeing, as developed by Mi'kmaq Elder Albert Marshall (Bartlett et al., 2012), where using both knowledge systems can help to develop stronger understandings and more holistic learning outcomes for ākonga. Indigenous narratives, such as pūrākau, have been used for millennia to codify knowledge into concise and understandable forms of information (Hikuroa, 2017; Lee, 2009). Therefore, it makes sense that the use of pūrākau, with connections to the learning content, would also be a valuable tool in modern education to help guide kaiako and ākonga in their learning. It creates opportunities for ākonga Māori to connect to learning in a way that may not be possible if Western knowledge systems are the sole providers of knowledge. The kaiako in this learning intervention suggested that Whangai Mokopuna was a valuable part of the learning intervention, allowing the ākonga to connect with a subject that was at times complex and abstract. This was particularly successful for ākonga Māori. Bishop (2011) reminds us that what works well for Māori ākonga and their learning serves all ākonga well.

The findings of this research align with other global research on the effectiveness of Indigenous knowledge systems in complementing Western knowledge systems, contributing to a deeper understanding of climate change concepts. This learning intervention demonstrated the value of the pūrākau Whangai Mokopuna in facilitating connections across multiple learning areas, serving as a touchstone for ākonga to return to in developing their knowledge.

5.4 Limitations

There are limitations of this research that must be acknowledged. This research was undertaken as part of a Master's thesis and therefore is an appropriate size and scope for the associated expectations. The learning intervention of this research took place in a single kura and in one akomanga within this kura. Due to the small sample size, the results cannot be

generalised. Given the research was conducted in Aotearoa only, its transferability is also limited.

The sample size of the ākonga partaking in the learning intervention was 21, with 17 ākonga being able to complete both the pre- and post-test. Having 17 ākonga creates a small sample size for the quantitative data, which limits the statistical reliability of the data set.

Views on engagement are almost always perceptions. Some of the engagement data collected from the learning intervention included the perception of one kaiako at the time of learning. I acknowledge that another kaiako, from another kura, may perceive engagement levels differently from Whaea Tupou, as is the nature of perception.

5.5 Conclusions, Implications and Recommendations

The findings of this research indicate that explicitly incorporating culture into climate change education can have a positive impact on ākonga's engagement levels. Creating a learning environment where ākonga can see themselves, regardless of the learning content, is of significant importance in culturally responsive practice. This enables higher levels of engagement for a broader range of ākonga.

> From this research it is my recommendation that climate change education should implement a more holistic approach to learning design, incorporating cultural perspectives in a range of ways to represent the diverse ākonga present in the kura and its community.

The findings show that aspects of mātauranga Māori such as pūrākau and maramataka have positive effects on ākonga engagement and understanding of climate change concepts and the relationships that kai has with climate change. The balancing of Western knowledge and mātauranga Māori to create noa (balance) is important at multiple levels: increased levels of engagement and greater understanding of concepts from a broader range of ākonga, and increased mana and sense of value for ākonga Māori in their akomanga and potentially wider community. A key finding from this research is that, in some cases, Western knowledge may help ākonga to see a broader global perspective. In contrast, Indigenous knowledge helps them to see local perspectives that connect to their everyday lives.

> A recommendation derived from this research is that integrating Indigenous knowledge systems, such as mātauranga Māori, in the Aotearoa context, should be implemented in climate change education programmes at a systemic level.

Time spent connecting with whenua, whether that involves working with others in the māra kai, such as in this learning intervention, or engaging in other ways relevant to that learning, can have a positive effect on ākonga engagement levels. This research, along with others of a similar nature, show that being outside and connecting with whenua creates a unique and informal space where conversations that may not happen elsewhere have the potential to flourish. These spaces and conversations create engagement that has a positive flow-on effect into the akomanga.

> It is my recommendation that, where relevant, kaiako make space in their learning to allow time for their ākonga to connect with whenua, consequently allowing for conversation to solidify abstract concepts in connection to the whenua potentially.

This research demonstrates that kaiako who may lack knowledge or confidence in teaching climate change education can effectively engage and increase their ākonga's understanding of climate change concepts when supported with practical, culturally responsive teaching resources. Perhaps this change in mindset for kaiako, along with support from practical, culturally responsive climate change education resources, can help to increase confidence in teaching this important content for ākonga.

> Two recommendations from this research are as follows. Firstly, the continued development of culturally responsive practical resources, enabling kaiako to teach climate change education more effectively. In addition, although it may be uncomfortable for some, I encourage kaiako to take the risk and teach climate change education, like Whaea Tupou, even when they are not confident, to embody the concept of ako, to teach and learn alongside ākonga.

The use of practical scientific experiments is underrepresented in primary school education. This research's findings show that when combined with other forms of teaching, science experiments contribute to an increased understanding of climate change concepts. Abstract

concepts that may be difficult for ākonga to grasp through words alone are more readily understood.

> A further recommendation of this research is for climate change education developers and kaiako to consider incorporating scientific experiments into the teaching of abstract climate change concepts, to improve ākonga understanding of these concepts.

The model of using a pūrākau to guide ākonga in their learning proved to be an effective guidance tool, both for gaining knowledge from the pūrākau and for making connections in other parts of the learning intervention. This comes from a place of foundation, where the kura involved in this study has developed over time a strong reciprocal relationship with local hapū. Meaning the pūrākau used in the research was deliberately chosen for the kura based on guidance and location of the hapū. This was a factor that contributed to both an increased understanding of climate change concepts and was mentioned by the kaiako as the part of the learning intervention that also increased engagement.

> Two recommendations come from the above aspects of this research. One being that the development of genuine, reciprocal relationships with local hapū and iwi can lead to positive engagement and increases in understanding. When kaiako and ākonga are able to learn through Indigenous knowledge systems, it adds extra depth to the learning that could not be gained otherwise. The second recommendation is that when reflecting on other successful global models for developing climate change education, some aspects are missing. The Bicycle Model on Climate Change by Cantell et al. (2019) lacks any specific aspect that highlights the important role that Indigenous knowledge systems, such as narratives like pūrākau, can play in climate change education. A recommendation for further research and development from this research is the development of a model like the Bicycle Model on Climate Change. This could be a minor adjustment such as the addition of a GPS device on the handlebars that signifies the role indigenous knowledge can play in guiding climate change or a development of a new model. A new model could be researched and developed to be more relevant to the context of Aotearoa such as a waka hourua (double hulled ocean voyaging canoe) with the tohunga (knowledge holder and expert) on board signifying the use of Indigenous knowledge systems, with narratives such as pūrākau, playing a part in climate change education.

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Appendices

Appendix A

Learning Intervention

Learning Intervention: Whāngai Mokopuna / Kai & Nutrition / Climate Change		
Start Date: Week One, Term Three	**Duration:** 10 weeks	**Level(s)** NZC Level: 2-3
Key Concepts for learning: • Pūrākau and the knowledge we can learn from them • Climate change • Kai & fueling our tinana **Overarching Kaupapa:** Using the pūrākau Whāngai Mokopuna as a guide to gain access to knowledge and learn about kai, nutrition and climate change. • What are pūrākau, why do they exist and how can they help us? • What were the main sources of kai for Māori before Pākehā arrived? • How does this compare to what we use to fuel our bodies now? • What is climate change? • How does climate change affect our kai? • Does the food we eat have an impact on climate change? • Atua, kaitiakitanga and caring for te tai ao The learning finishes with a gardening + cooking session learning to cook low impact kai to fuel their tinana and share as a class.		

Curriculum Coverage:

- Social Science
  - Understand how people view and use places differently.
  - Understand how people make decisions about access to and use of resources.
- Science
  - Investigating in Science:
    - Build on prior experiences, working together to share and examine their own and others' knowledge.
    - Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations.
  - Participating and Contributing:
    - Use their growing science knowledge when considering issues of concern to them.
    - Explore various aspects of an issue and make decisions about possible actions.
  - Ecology:
    - Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human- induced.
- P.E & Health
  - **Personal growth and development**
    - Identify factors that affect personal, physical, social, and emotional growth and develop skills to manage changes.
    - Hauora

Overarching Learning Outcomes:

- Each LEGEND will develop a basic understanding of what climate change is, what are the main things that have caused it and some of its effects on their everyday lives.
- LEGEND's will be able to identify health kai to fuel their bodies
- LEGEND's will develop a basic understanding of the relationship(s) of kai and climate change

Te Ao Māori Links:	Materials/Slides:
• Whāngai Mokopuna pūrākau • Kaitiakitanga explored through environmental lens • Manaakitanga explored through pūrākau • Maramataka explored through gardening and harvesting • Hauora links through nutrition • Kai research into what was used to fuel ones body before Pākehā arrived in Aotearoa • Kupu hau around kai & climate change	Teaching Slides: • Climate Change 101 • Exploring Kai in Aotearoa • Fueling My Tinana • Climate Change and Kai • Growing Kai and Caring for Papatūānuku Materials: • Whāngai Mokopuna Pūrākau • Freeze Frames • Kahoot Quiz • Padlet for brainstorm • Slide for sharing kai research • LEGEND Matrix for shop • Greenhouse gas cards • NZ Emissions Profile • NZ Low Carbon Eating Government Website • NIWA CC Impacts Clip

Wiki Tahi
Kaupapa Outline: **Pūrākau**: What is a pūrākau? Why are they used? Introduce the pūrākau Whāngai Mokopuna, teacher to share verbally (maybe with slides to back the pūrākau with images/key parts). After hearing the story, ākonga to learn it through their LEGEND rōpū (kagan structure TBC). **CC**: Kahoot quiz on climate change kaupapa. Learners will do it independently, with their name/initials as their login, data to be kept by Lia and if any ākonga need to be removed from data pool before data used Lia will do so. **Kai**: - **Objective**: • Touch on what a pūrākau is and why they are used. • Learn the pūrākau Whāngai Mokopuna so each individual ākonga has a good understanding of it and the themes running through it. • Gather initial data on ākonga CC understanding. **Materials/Slides**: • Pūrākau Slides? • Card for making picture prompts (4 from an A4 piece) • Kahoot CC Quiz **Outline of Ako**: Post listening to Lia retelling the pūrākau, ākonga to do an activity to learn the pūrākau and its themes -Use of LEGEND rōpū and kagan structure **TBC**. Perhaps in a follow up ako, ākonga could do an activity to share the story. This could be making a set of cards to share the pūrākau but with no words used, which could lead on to a fantastic opportunity to use freeze frames to "perform" the different key moments as a class. One rōpū could choose one of the cards, developed before, and then turn that into a freeze frame. A certain LEGEND could use a device to take pictures of each freeze frame and that could visually tell the pūrākau on your walls as a point of reference.

At a point during the wiki, ākonga to do kahoot quiz (pre learning) on CC.
Reflection on the Wiki: **What was taught?** • **Did anything not get covered?** • **Any connections in other learning to this kaupapa?** •
Wiki Rua
Kaupapa Outline: **Pūrākau:** Bring focus of pūrākau to kai, look at where kai is mentioned and what it might mean in the pūrākau food learning. **CC:** Small introduction to CC, one session, explore in rōpū. **Kai:** First explore of what kai was commonly used pre European arrival *Ruahine team doing nutrition work with a nutritionist throughout the wiki. Worksheet examples tahi, rua **Objective:** • Explore where food is of importance in the pūrākau, opening the door to the concept of kai and fueling our tinana. • Explore collective understanding of climate change • Intensive session(s) with nutritionist about: **Materials/Slides:** • Pūrākau Slides and imagery • Padlet for brainstorm • Slide for sharing kai research • Nutritionist **Outline of Ako:**

Start with a recap of the pūrākau using the visual cues from the freeze frames.
Using a prompt around food e.g. "Where was food mentioned in the pūrākau?" and "Do we think that it is important to the pūrākau?" The hope is to get LEGENDs to figure out for themselves that Whāngai Mokopuna needed healthy kai to survive and be strong/healthy, when that didn't happen he started to get sick and starve forcing him to eat the rangatahi who only feed him scapes.
This is a great point to link to kai and fueling our bodies well (nutritionist/other learning). Using rorohiko working in LEGEND rōpū do a first digital hunt for what was common kai pre European arrival for Māori people. Rōpū could use images to feedback to the class on what they found (Slide). These could then be printed off and be one half of a visual table for a wall/window comparing kai before European arrival and modern.

~~Exploring CC to focus on LEGEND rōpū who will use _____ Kagan structure to gather what they know as a small rōpū about CC. This can then be shared back to the akomanga through a Padlet, the rōpū/kaiako reading out different posts.~~

Reflection on the Wiki:

What was taught?

- Main teaching around freeze frames, kids putting a lot of effort into making them look amazing. Lia is thinking of turning them into a book through ring binders.
- Did nutrition learning with Nova and went to the shops.

Did anything not get covered?

- Exploring CC to focus on LEGEND rōpū who will use _____ Kagan structure to gather what they know as a small rōpū about CC. This can then be shared back to the akomanga through a Padlet, the rōpū/kaiako reading out different posts.
-

Any connections in other learning to this kaupapa?

-

Wiki Toru

Kaupapa Outline:
Pūrākau: The ākonga will be engaging in a cross of descriptive writing and AI generative art work. Inspired by the pūrākau and the taniwha Whāngai Mokopuna, ākonga will develop small sections of descriptive writing, to describe their own taniwha. This writing once edited and worked over with peers/the kaiako will be imputed into an AI programme and generate an image based off their descriptions.

CC: Building on from the last wiki (establishing what they may already know), start to build foundational knowledge of CC concepts using Climate Change 101 . What is CC & comparing climate to weather (one session) + Greenhouse gases (second session)
Kai: A think back and comparison which focuses on what was eaten by Māori people before Pākehā settlement and what they picked up in learning with the nutritionist in wiki rua. Then vs now visual comparison for wall.

Objective:
- Develop a shared foundation of what the climate is, establish from that climate change
- Develop an understanding of GHG and where they can come from
- Reflect on the kai that we eat every eat

Materials/Slides:
- Climate Change 101
- Slide for sharing kai research
- What we eat most weeks
- Fueling my Tinana

Outline of Ako:

Exploring CC to focus on LEGEND rōpū who will use Kagan structure (rally robin, shoulder partners) to gather what they know as a small rōpū about CC. This can then be shared back to the akomanga through a Padlet, the rōpū/kaiako reading out different posts.

This wiki as a class you will start to explore climate change concepts, use Climate Change 101 (Slides 1-6) to help guide you. Part one is focused on establishing the difference between the weather and climate + establishing a basic understanding of what climate change is. Part two for the week is focused on what the greenhouse effect is and exploring the different GHG's Climate Change 101 (Slides 7-10).

~~Then vs now comparison of kai. Using the slides created from wiki rua, create another slide to compare what we eat for our main meals/snacks on this What we eat most weeks. In LEGEND rōpū, using ____ Kagan structure, discuss what you generally have for breaky, lunch and dinner. LEGEND rōpū can be shared back to akomanga, then find visual representatives for these meals and put them on a slide. Once complete print out both slides and have a visual display of then/now for kōrero points throughout learning.~~

Reflection on the Wiki:

What was taught?

- Padlet done, with discussion
- Māori kai slides done
- CC 1-6

Did anything not get covered?

- The then vs now kai, not their own kai yet.

Any connections in other learning to this kaupapa?

- Pāngarau around measurement and the awa

Wiki Whā

Kaupapa Outline:
Pūrākau: Taniwha AI descriptive writing/art. As

CC: Consolidate last wiki learning around CC and GHG's, focus on nailing the basics for the 6 main GHG's. This will mean over the past two wiki, LEGENDs have had a chance to build a basic understanding of what CC is, what the GHG are and then moving forward to next week they will focus on the why.

Kai: Compare and contrast the kai that we eat with the kai eaten traditionally by Māori

Objective:

- Explore the connection between Atua and kai, linking this back to pūrākau
- Further develop understanding of GHG
- (re)explore the types of kai, why our body needs them and balance in fueling our tinana
- Compare and Contrast the kai that we eat with the kai eaten traditionally by Māori

Materials/Slides:

- Whāngai Mokopuna Pūrākau
- Greenhouse gas cards
- Ipapa for rōpū
- Fueling my Tinana
-

Outline of Ako:
Atua and Whāngai Mokopuna pūrākau

GHG follow up from last wiki:

Each greenhouse gas has a 'good side' and a 'bad side'. **These cards need to be printed & cut out (DW about the black card).** Link and stapled together, six total. Divide into 5 rōpū, ask each group to come up and select a double sided card.

Explain to the groups that they have time to create a 1–2 minute mini show recorded on an ipapa aimed at teaching the rest of the class about the good and the bad side of their GHG. They can get creative, make it fun.

Bring the class back together and watch each clip through apple tv on the big screen. At the end of each presentation, each group asks the class what the key learnings about their heat trapping gas were. The key learnings can be recorded on a large piece of paper along with the cards -chuck up somewhere to refer to later.

Then vs now comparison of kai. Using the slides created from wiki rua, create another slide to compare what we eat for our main meals/snacks on this What we eat most weeks. In LEGEND rōpū, using ____ Kagan structure, discuss what you generally have for breaky, lunch and dinner. LEGEND rōpū can be shared back to akomanga, then find visual representatives for these meals and put them on a slide. Once complete print out both slides and have a visual display of then/now for kōrero points throughout learning.

First session work your way through slides 1-9 (Fueling my Tinana), exploring the different types of kai that are eaten -they can all roughly be put into 3 categories from a nutritional point of view: high in carbs, high in protein, high in fats. -Also look to show the difference between ultra processed kai and lesser/unprocessed.

IMPORTANT: This should not turn into a dieting lesson etc. Present as a balance, like Nova would have: Each category has important roles to play in fueling our tinana, carbs give us energy, protein help our muscles grow, healthy fats have important roles to play in keeping our gut healthy and many other things. We can still have take outs but it's about BALANCE!

Second Session: Using the wall/window where the traditional kai vs what we eat weekly is up, explore the differences. Can they place a category on them high in carbs, high in protein, high in fats? Could go back to some images in Fueling my Tinana (slides 4-6) to help you to classify them: .

Kōrero about what they can see, what are the differences between what we eat now and what was eaten hundreds of years ago by Māori? (Akomanga kōrero, take the convo where they are going and explore)

Reflection on the Wiki:

What was taught?

- CC 101 up to slide 10
- Watched the clips severals
- Started the what we eat kai slides
-

Did anything not get covered?

- The main learning for week 4, this will be caught up in week 5, W5 will be pushed back into W6 to catch up.

Any connections in other learning to this kaupapa?

-

Wiki Rima (to be taught in W6 as catch up time due to sickness)
Week 4 caught up, week 5 bumped to week 6.

Reflection on the Wiki:

What was taught?
- All of week 4 has been caught up, week 5 learning to be focused on.

Did anything not get covered?
-

Any connections in other learning to this kaupapa?
- Freeze frames from prior learning helping for Moment in time writing.

Wiki Ono

Ricoh Tournament -New lessons / Catch up time for past missed learning

Kaupapa Outline:
Pūrākau:

CC: Science experiment to see the GHG effect with their own eyes & Where are the greenhouse gas emissions coming from in Aotearoa?

Kai: Investigate the impacts of our kai on the climate.

Objective:
- See with our own eyes the GHG effect
- To establish a basic understanding of Aotearoa's emission profile
- Investigate the impacts of our kai on the climate

Materials/Slides:
- Climate Change 101
- Creating the greenhouse gas ethic in a jar (NIWA)
- NZ Emissions Profile

Outline of Ako: SCIENCE EXPERIMENT: Creating the greenhouse gas ethic in a jar (NIWA) A fun science experiment for the LEGENDs to do to physically see the GHG effect. After building a foundation on what CC is and what GHG are/what they do, LEGENDS to build an understanding of the fact humans are the root cause of an increase in GHG in the atmosphere and to develop a basic understanding of Aotearoa's emission profile. Use Climate Change 101 to help guide you for initial conversations. NZ Emissions Profile is a pie graph that shows the data of our emissions profile between 1990-2022, (**some great pāngarau here for a problem solving activity if you wanted to over the wiki**) print out for rōpū to explore -there are some guiding pātai on Climate Change 101 to help with the conversations. Investigate the impacts of our kai on the climate. From the learning this week on Aotearoa's emissions profile the LEGENDs may have started to notice that what we eat can impact the climate both positively and negatively (AGAIN THIS IS NOT TO PREACH AND SAY EVERYONE MUST EAT VEGAN, it's about learning and thinking of BALANCE). Clearly cows and sheep (plus their products like milk etc) have a massive impact on the climate with an Aotearoa lens on. In Fueling my Tinana using whānau groups and Jot Thoughts, create brainstorm lists of kai that are linked to higher emissions (Think red meat -so beef & lamb, dairy products like milk, cheeses etc, food brought from overseas because they need to be shipped here rather than just grown down the road). Once you've established a class list, make a collaborative art piece which can highlight the kai linked to higher emissions. Make a small display for these with a title about higher emission kai. Bigger picture thinking is to have to comparative displays: one based on pre/current kai we use to fuel our tinana with and two a one that compares kai comparably higher emissions to lower ones... if you are able to combine the two of them the class should be able to see that traditional Māori kai was much lower impact that current norms etc etc.
Engagement: **5** **Loved the science experiment, super engaged** **Emission kupu is tricky, keeping forgetting for some reason. Going to the phrase where gases come from.** **Understood the links between food and CC impacts**

Wiki Whitu

Kaupapa Outline:
Pūrākau: share thinking about what impacts CC would have on traditional kai that would have been eaten in pūrākau.

CC: To gain a basic understanding of what CC leads to. Make links to the impact of climate change to kai.

Kai: Explore what kai types have smaller impacts on the climate.

Objective:
- To establish an understanding of some of the effects of CC in an Aotearoa context.
- Form links to CC and kai.
- Research and develop understanding of types of kai with smaller impacts on the environment

Materials/Slides:
- Climate Change 101
- NIWA CC Impacts Clip
- Fueling My Tinana
- NZ Low Carbon Eating Government Website

Outline of Ako:

Pūrākau: (**to be done after CC learning for the wiki**) Looking at our wall display of traditional kai, that would have been eaten by people in the pūrākau, what kai might be impacted from this list and why by CC impacts. Kagan structures= line up in letterbox number order, fold the line, discuss using rally robin.

~~LEGENDs now have a basic understanding of what climate change is, what GHG are, where they are mainly coming from in an Aotearoa emissions profile, the last bit they are going to focus on for learning about CC is what CC leads to. Using the slides from Climate Change 101 (slide14) watch and kōrero s about CC impacts (Slide 14 clip is longer 6 mins but is made by NZ scientists to explain specific impacts of CC to Aotearoa). Trying to limit the "research element" here as there is soooooo~~

~~much to consume and some of it is really difficult to understand/scary/can be misinformation. Keeping it simple and pre-selected to help with the smoothness of learning.~~
~~Once the NIWA clip has been watched and discussions had, time to wrap up key learning on CC by looking at simplistic links between the two most visible impacts of CC to our LEGENDs and their kai.~~ ~~**Flooding and droughts.**~~ ~~Simply put CC leads to more rain in some places and less rain in other places. This can lead to increases in the amounts and severity of flooding and droughts, this in term can have massive impacts on our kai.~~
~~EXAMPLES:~~

- ~~The cyclones up North took out massive amounts of crops eg kūmara which led to the huge increase in the cost of kūmara and pōhara people like us couldn't afford it any more.~~
- ~~It's not just veggies though meat can be to for example drought = low crop return = low feed for cows = less cows = less cow products = more expensive or lack of supply altogether.~~

~~VERY SIMPLISTIC explanations but it gets the whakaaro across. Use~~ ~~Climate Change 101~~ ~~(slides 14-16) to watch a couple of clips on floods and droughts to build up a solid understanding of them.~~

To complete the small wall display from last wiki, following the same process but for **food with smaller impacts on the climate.** Whānau groups research, class list, mini collaborative art to put next to the mahi toi from last wiki to have some visual comparisons for higher impact foods/lower impact foods on the climate. Slides 11/12 from Fueling My Tinana can help to guide and this NZ Low Carbon Eating Government Website

Reflection on the Wiki:

What was taught?

- Emission graph, big kōrero anaylins the pie.

Did anything not get covered?

-

Any connections in other learning to this kaupapa?

-

Wiki Waru and Iwa

Kaupapa Outline:
Pūrākau, Kai & CC:: The importance of where we get our kai from, how we look after the whenua and wai that we get it from and how this links to CC. Exploring gardening and maramataka, te ao Māori and its amazing history of kai growing.

Objective:
- Buying kai locally and in season has positive impacts on the climate.
- Build an understanding that growing our own kai has positive impacts for the climate + lots of other positives.
- Develop an understanding of the rich past Māori people have with growing kai
- Explore maramataka and how it can help us to grow and harvest/catch kai
- Investigate low impact ways of growing kai and how to look after Papatūānuku

Materials/Slides:
- Growing Kai and Caring for Papatūānuku

Outline of Ako:
From last wiki
LEGENDs now have a basic understanding of what climate change is, what GHG are, where they are mainly coming from in an Aotearoa emissions profile, the last bit they are going to focus on for learning about CC is what CC leads to. Using the slides from Climate Change 101 (slide14) watch and kōrero s about CC impacts (Slide 14 clip is longer 6 mins but is made by NZ scientists to explain specific impacts of CC to Aotearoa). Trying to limit the "research element" here as there is soooooo much to consume and some of it is really difficult to understand/scary/can be misinformation. Keeping it simple and pre-selected to help with the smoothness of learning.
Once the NIWA clip has been watched and discussions had, time to wrap up key learning on CC by looking at simplistic links between the two most visible impacts of CC to our LEGENDs and their kai. **Flooding and droughts.** Simply put CC leads to more rain in some places and less rain in other places. This can lead to increases in the amounts and severity of flooding and droughts, this in term can have massive impacts on our kai.
EXAMPLES:
- The cyclones up North took out massive amounts of crops eg kūmara which led to the huge increase in the cost of kūmara and pōhara people like us couldn't afford it any more.
- It's not just veggies though meat can be to for example drought = low crop return = low feed for cows = less cows = less cow products = more expensive or lack of supply altogether.

VERY SIMPLISTIC explanations but it gets the whakaaro across. Use Climate Change 101 (slides 14-16) to watch a couple of clips on floods and droughts to build up a solid understanding of them.

Over the two wiki, ākonga will explore the concept of how to grow and choosing the kai we eat can have a positive impact on the environment.

Each wiki ākonga will join Mrs Morely and Matua Ryan for some hands-on sessions in the gardens.
These sessions will focus on:

- What is in our kura gardens and why we have to grow certain veggies/fruits at certain times of the year
- How to grow and look after the whenua (Composting and keeping the whenua healthy)
- Planting their own veggies

Using Growing Kai and Caring for Papatūānuku slides 1-4 to guide the akomanga, explore how buying locally grown kai has positive impacts on the climate. First gain ākonga thinking about why they might think it is better for the climate to buy a mandarin grown in Aotearoa than it is to bring them over from the USA. Use the Kagan structure Jot Thoughts for the ākonga to share their ideas in LEGEND rōpū, before sharing as a class and then moving to the next slide to confirm thinking!

Following this learning, consider the positive impacts of growing their own kai: low impact on the environment, low costs compared to the supermarkets, fun and easy, helping their whānau. Slides 5-7 in Growing Kai and Caring for Papatūānuku to accompany this.

ākonga to begin to explore a small bit of the rich history Māori have with growing kai. Examples of modern day revives of this history such as Pourewa Mara Kai. Slides 8-9 to explore this on Growing Kai and Caring for Papatūānuku. This can lead into an exploration of maramataka and how it can be used for gardening and harvesting/catching kai Growing Kai and Caring for Papatūānuku. Each LEGEND could have one phase of the marama cycle and then design an A4 poster for this cycle (Alternatively could make a digital version using Canva).

As an akomanga decide on what you could make as a class to celebrate the learning over the term, incorporate some the kai explored from the pūrākau/traditional Māori kai and some of the low impact kai they have learnt about over the past wiki, with the concept of balance for something yummo! Task different LEGENDs with different parts of the shared kai: mains, sides, something yum and maybe a drink? Homemade lemonade etc. build a list and then prepare for a shop at Pak.

Reflection on the Wiki:

What was taught?

- **Watched Niwa clip, talked about impacts of CC on kai**
- **Covered basic ideas of more rain in some places, less in some droughts and flooding**
- **Seeds planting, first look at maramataka**
- **Looked at local vs international kai.**

Did anything not get covered?

-

Any connections in other learning to this kaupapa?

WEEK nine

Wiki Tekau

Kaupapa Outline:
Celebrate learning about the pūrākau, kai and climate change knowledge. Using the funding from nutritionist (and topping up from Ryan if need be) ākonga to use the recipes/shopping lists they created last wiki and buy kai at New World needed for the ākomanga shared kai. Then the following day ākonga to cook kai in horo using kitchen facilities and electric fry pans, once cooking done, ākonga to share kai and Ryan will do a short kōrero to thank everyone for partaking in learning.

Objective:

- Successfully navigate a supermarket to buy healthy kai, at an affordable price.
- Cook kai as a rōpū
- Share kai and celebrate!

Materials/Slides:

- Slides on supermarkets
- LEGEND Matrix for shop
- Transport (Kura van 10 seats, 11 more seats needed from whānau or other staff)
- Kai
- Kitchen facilities/cooking gear/plates & utensils

Outline of Ako:
Using the slides on shopping at a supermarket to recap from working with Nova (nutritionist) how to shop in a supermarket, looking for the healthy kai, shopping seasonally, how to get past the branding to find affordable kai.

Trip to the shops (SOPs) in the kura van and staff/whānau vehicle. LEGEND Matrix for trip.

On set day, where Ryan is on study release, ākonga will have a morning of cooking (Ryan + Lia) and learning skills in the garden with Karen. Half ākonga to spend the first block with Karen looking after the kura garden beds and potentially harvesting kai. The second half in the horo with Ryan and Lia doing cooking. Switch second block. After both rōpū have done both parts, shared kai as an akomanga in the horo to conclude learning intervention.

At a point during the wiki, ākonga to do kahoot quiz (post learning) on CC.

Reflection on the Wiki:

What was taught?

-

Did anything not get covered?

-

Any connections in other learning to this kaupapa?

-

Appendix B

Pre- and Post-Test

What is climate change?

A. When it is sunny in the morning and rainy in the afternoon
B. It is hotter every day
C. There is a difference in the average weather patterns
D. It is colder every day

Which of the following is contributing most to climate change?

A. Volcanic eruptions
B. An increase in the amount of greenhouse gases in the atmosphere
C. A loss of forests around the world
D. More sunlight coming to the planet

What is the main contributor to climate change in Aotearoa?

A. People driving cars
B. Farm animals burping and farting
C. Making electricity to power everything
D. People throwing away too much food

Climate change leads to:

A. More rain everywhere, leading to flooding
B. Less rain everywhere, leading to droughts
C. No real difference to the amount of rain anywhere
D. More rain in some places and less rain in other places

The greenhouse effect means that:

A. When more people build greenhouses
B. Heat is trapped near the earth's surface due to increased greenhouse gases
C. All houses should be painted green to absorb heat
D. The sun's rays are bounced away from Earth due to increased greenhouse gases

Which of the following is NOT a greenhouse gas?

A. Carbon Dioxide
B. Methane
C. Nitrous Oxide
D. Oxygen

How can climate change affect the availability of food?

A. It has no impact on food production
B. It leads to more food grown
C. It can decrease the amount of food grown due to weather conditions
D. It only affects certain types of food

What drink has the least impact on climate change?

A. Water from a tap
B. Milk
C. Fizzy Drink
D. Juice

What food category has the least impact on climate change?

A. Dairy (milk, butter, cheese)
B. Meat products
C. Fruit and Vegetables
D. Processed foods like chips

Which food choice is better for the climate?

A. Eating food that has been brought from Australia
B. Eating food that is in season and locally grown
C. Eating foods that are highly packaged
D. Eating takeaways most nights

To help slow climate change, is it better to put food scraps in the:

A. Rubbish Bin
B. Recycling
C. Compost

D. Down the sink (Food disposal machine)

What impact does food waste have on climate change?

A. Food waste doesn't have an impact on climate change
B. Food waste that goes into the rubbish releases greenhouse gas
C. Food waste can make the air smell bad
D. Food waste takes up a lot of room in the bin, so that litter happens

Which way of growing food is better for the climate?

A. Big farms that grow lots of animals
B. Farms that use natural systems
C. Farms that use chemical fertilisers to grow more food
D. Clearing forests to make room for more farming

How can using maramataka help with growing and collecting kai?

A. It helps to predict the best time grow and collect kai
B. Using maramataka always makes the vegetables grow fast
C. It says where the moon will be in the sky
D. It tells us when the supermarkets are open

What happens to Whāngai Mokopuna when he isn't feed well?

A. Nothing, he is fine eating bad kai
B. He starts to starve and feel unwell
C. He goes to find his own kai
D. He loses all his strength and shrinks

How did Whāngai Mokopuna grow to be a strong and large taniwha?

A. Tupatunui and the iwi fed him the best kai
B. He ate only the food he could find
C. Tupatunui had him on a diet of kūmara
D. He ate the food scraps that the young people gave him

One important lesson we could learn from the pūrākau Whāngai Mokopuna is

A. Growing and collecting healthy local kai close to where you are is important
B. Your elders aren't always right
C. Taniwha don't make good pets
D. All kai fuels your body the same

Which of these Atua are mostly related to the growing of vegetables?

A. Tāwhirimātea
B. Tangaroa
C. Rongo-mā-Tāne
D. Ranginui

Which of these Atua are mostly related to the animals of the water we eat?

A. Ranginui
B. Tangaroa
C. Tūmatauenga
D. Rongo

What does it mean to be a kaitiaki for Papatūānuku?

A. To read pukapuka about Papatūānuku
B. Kaitiaki is an Atua, that is a daughter of Papatūānuku
C. To look after food for your family
D. Someone who cares about and takes care of the environment

Appendix C

Ākonga Group Interview Pātai (Question)

Trigger pātai:

You've spent the last term learning about climate change and kai, what were some of the parts of your learning you most **enjoyed**?

Possible probe pātai:

If they mention about the kai and being in the garden

- Why did you enjoy this part of the learning?
- How did it help you learn?

If they mention use of Māori, mātauranga or pūrākau

- What was it you like about using this?
- How did it help you to learn?

If no mentions use of Māori, mātauranga or pūrākau

Do you think that the way we used Whāngai Mokopuna helped your learning?

Yes/no

Why do you think that? How did it help (if it did)

Trigger pātai using cards with words on them:

Out of these x things _____, _____, _____, rank them to what you enjoyed the most to what you enjoyed the least.

Possible probe pātai:

- Why did you rank this here?
- Why do you think you did/didn't enjoy that?

Trigger pātai:

Do you think you know more about CC now than you did before?

Possible probe pātai:

What makes you think that?

Tell me some things you have learnt about CC

Trigger pātai:

What parts of the learning you did this term do you think helped you to **understand** climate change better?

Possible probe pātai:

· That's interesting, how do you think that helped your learning?

Trigger pātai:

Do you think that it is important to learn about ideas from te ao Māori and have these as a focus in our learning?

Possible probe pātai:

Yes or no

· Why do you think this is what you think?

Final pātai:

Is there anything else you would like to tell me about the learning about climate change over the term?

Appendix D

Kaiako Interview Pātai

Trigger pātai:

Tell me about how you have found teaching climate change concepts this term?

Possible pātai question:

What, if anything, has been different about the way you have taught this learning intervention over the term?

Trigger pātai:

Looking at the term's learning, as the kaiako, how did you perceive the overall engagement of ākonga?

Possible probe pātai:

What makes you say this? (what's the evidence etc)

Trigger pātai:

In relation to this event _____, you rated student engagement as ____. I'm interested to know why you rated that as you did?

Possible events:

-5/5 week for engagement

-learning activity she specifically mentioned as a high level engagement point

Possible probe pātai:

· When you consider all the other intended learning within the topic, why do you consider this an important/not important event for ākonga engagement/understanding of CC?

^repeat for different events

Trigger pātai:

Do you believe that the use of pūrākau helped ākonga **engagement** with climate change concepts?

Possible probe pātai:

Why do you believe this?

Would you consider using pūrākau as the base for teaching again? -Why?

Trigger pātai:

Do you believe that the use of pūrākau helped ākonga **understanding** of climate change concepts?

Possible probe pātai:

Why do you believe this?

Trigger pātai:

Do you believe that the use of mātauranga Māori in English-medium kura is important in the learning of all ākonga?

Possible probe pātai:

Yes/no

· Why do you believe that?

Trigger pātai:

Thinking about the ākonga that you feel have increased their understanding of CC, what do you believe were some of the key aspects of the ākonga learning that enabled ākonga to grow their understanding of climate change?

Possible probe pātai:

Why do you think _____ helped to grow their understanding?

Trigger pātai:

Can you identify aspects of LEGENDs learning that may have been a barrier to increased understanding for some ākonga?

Possible probe pātai:

Why do you think this?

Final pātai:

Is there anything else you would like to tell me about the teaching and learning over the term?

Appendix E

Ethics Approval

Te Wānanga Toi Tangata
Division of Education
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THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

TE WĀNANGA TOI TANGATA
DIVISION OF EDUCATION

20/7/2024

Ryan Jackson

Division of Education Research Ethics Committee Application Approved FEDU025/24

I am pleased to advise you that your ethics application for the project entitled "In what ways can Rangitāne pūrākau engage and further the understanding of Year 5 and 6 students in learning about climate change within a kura in the lower North Island of Aotearoa?" was approved by Te Wānanga Toi Tangata Division of Education Research Ethics Committee on July 20th, 2024.

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

Kind regards

Dr Dianne Forbes
Acting Chairperson

Te Wānanga Toi Tangata Division of Education Research Ethics Committee

Appendix F

YouTube Learning Clips List

Climate and the weather

https://www.youtubeeducation.com/watch?v=0geUS_j3gis

What is the greenhouse gas effect

https://www.youtubeeducation.com/watch?v=SN5-DnOHQmE

Climate change impacts for New Zealand

https://drive.google.com/file/d/13MONUJuOS1R4aeNzdxOOcnb2c5AhFezC/view?usp=sharing

Regenerative farming

https://youtu.be/Jph18rU3bZg

Organic farming

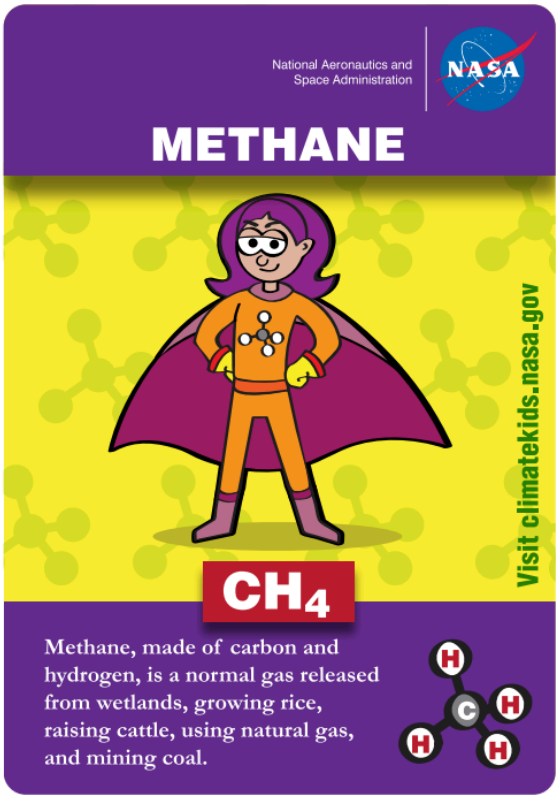
https://www.youtubeeducation.com/watch?v=2mYwqnbWhpc

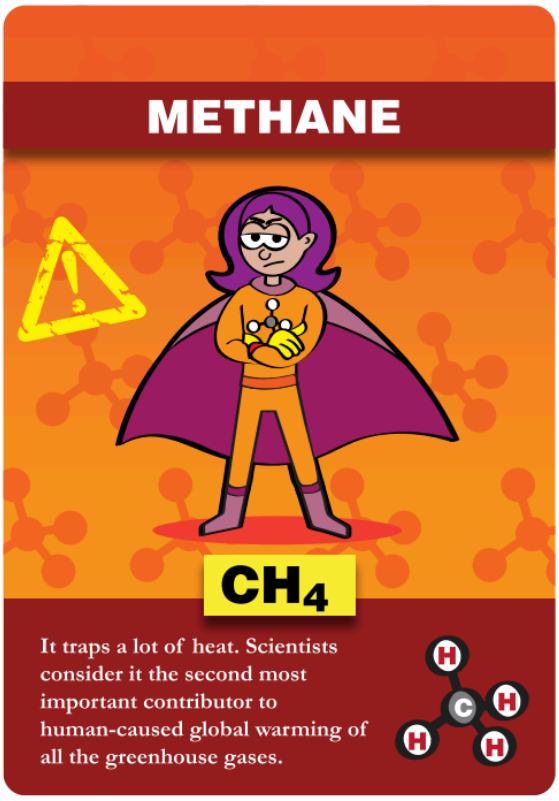
Pouwera māra

https://www.youtubeeducation.com/watch?v=-4NJBewNw6Y

Appendix G

NASA Greenhouse Gas Cards





National Aeronautics and Space Administration

NITROUS OXIDE

Visit climatekids.nasa.gov

N2O

Nitrous oxide is a natural part of the nitrogen cycle. Bacteria in soil and the ocean make it.

NITROUS OXIDE

N2O

Nitrous oxide is released by some types of factories, power plants, and plant fertilizer. It damages the protective ozone layer and is a powerful greenhouse gas.

National Aeronautics and Space Administration

CARBON DIOXIDE

Visit climatekids.nasa.gov

CO2

Made up of carbon and oxygen, CO2 is all around us naturally. It comes from decaying and living organisms, and from volcanoes.

CARBON DIOXIDE

CO2

CO2 is released when burning fossil fuels like coal and oil. It's the most important contributor to human-caused global warming.

Note. These cards illustrate different greenhouse gases, by the Earth Science Communications Team at NASA's Jet Propulsion Laboratory, 2025, NASA