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**INDIGENISING SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS
(STEM):**

Integrating Pacific Knowledge Within A High School STEM Study Program

A thesis

submitted in fulfillment

of the requirements for the degree

of

Master of Arts in Pacific and Indigenous Studies

at

Te Whare Wānanga o Waikato

by

Zyshana Kolokea Selepa Kauaula



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WAIKATO
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Ka Hua
Mo'ōlelo Pōkole: Abstract

Pacific students have low course completion rates within universities in Aotearoa, New Zealand (ANZ), resulting in poor educational outcomes in STEM-related fields. Additionally, Pacific students are underrepresented in university departments, including those in STEM fields. This research explores the reasons behind Pacific students' low representation and course completion rates in STEM, aiming to create a more supportive and conducive environment within ANZ universities.

Integrating culturally relevant educational content has been shown to improve the success rates of Pacific students. This thesis investigates the benefits of incorporating Indigenous Pacific knowledge into STEM curricula to enhance student engagement and academic performance. The research is based at the University of Waikato, aligning with the university's Pacific theme, Imua, meaning to go forward, to help Pacific students progress and thrive.

Despite the growing interest in integrating traditional Indigenous knowledge into education, most research in this area has been limited to small projects and case studies. This thesis provides an in-depth examination of an Indigenous methodology that acknowledges culture, identity, and worldview, aiming to offer a more profound understanding of the factors affecting Pacific student development in STEM fields. Ultimately, this research aspires to contribute to the development of a new model of STEM learning that better supports Pacific students by addressing their cultural needs and backgrounds.

Keywords: STEM, Pacific peoples, knowledge, culture

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Ka Papa Wehewehe ‘Ōlelo: Glossary

Ahupua‘a: Traditional Hawaiian land division that extends from the mountains to the sea, including the land and resources within that area.

Aloha ‘āina: A Hawaiian term meaning “love of the land,” referring to a deep connection and responsibility to care for the land.

Fale: A traditional Samoan house or building structure, often open-sided and used for communal living.

Imua: A Pacific term meaning “to move forward” or “to advance,” often used to encourage progress and strive ahead.

Iwi: Refers to a tribe or a large group of people descended from a common ancestor in Māori culture.

Kahua: A Hawaiian term meaning “foundation” or “base,” often used metaphorically to refer to the foundational principles or groundwork of something.

Kapa: A traditional Hawaiian cloth made from the bark of the wauke (paper mulberry) tree. It is beaten, softened, and decorated with natural dyes and designs.

Kilo: The practice of observation in Hawaiian culture, particularly in the context of environmental and celestial monitoring.

Kuleana: A Hawaiian term meaning “responsibility” or “privilege,” referring to individuals' roles and duties in their community and the land.

Kura: A Māori term for school or educational institution.

Kūpuna: Hawaiian for elders or ancestors, recognized for their wisdom and experience.

Lu‘u Piha: A Hawaiian term referring to full immersion, often in the context of learning or spiritual practices.

Manaakitanga: A Māori concept similar to hospitality, encompassing caring for, respecting, and providing for guests and others.

Mātauranga Māori: Māori knowledge and wisdom encompassing traditional knowledge systems, practices, and worldviews.

Mātauranga Pasifika: Pacific knowledge and wisdom, representing the collective traditional knowledge systems, practices, and worldviews of Pacific peoples.

Mo‘okū‘auhau: A Hawaiian term meaning “genealogy” or “ancestry,” often used to trace familial lineage and heritage.

Pilina: A Hawaiian term meaning “relationship” or “connection,” often referring to the bonds between people, land, and spirituality.

Rangatahi: A Māori term for youth or young people.

Tangata Moana: A term referring to people of the sea, often used to describe Pacific Islanders with a deep connection to the ocean.

Tangata Whenua: A Māori term meaning “people of the land,” used to describe the indigenous people of New Zealand.

Te Tiriti o Waitangi: The Treaty of Waitangi, an agreement signed in 1840 between the British Crown and various Māori chiefs, established New Zealand's legal and political foundation.

Umu: A traditional Samoan earth oven used for cooking food. It involves heating stones over a fire, placing food on the rocks, and covering it with banana leaves and soil to trap the heat.

Waka: A traditional Māori canoe used for transportation, fishing, and warfare. Waka can vary in size from small river canoes to large sea-going vessels capable of carrying many people.

‘Ike: Hawaiian word for knowledge or understanding, often used to describe a deeper, more intuitive form of knowing.

‘Ohe Kāpala: Bamboo stamps used in traditional Hawaiian kapa (bark cloth) making. These stamps are carved from bamboo and used to create intricate designs on the fabric.

Nā Hua Hō‘ailona: List of Abbreviations

ANZ: Aotearoa, New Zealand

FoE: Family of Excellence; Future of Excellence

GPS: Global Positioning System

HECS: Health Engineering Computer Science

INPEACE: Institute For Native Pacific Education and Culture Empowering

IUU: Illegal, Unreported, and Unregulated

KAI: Kauhale Analytics & Intelligence

MM: Mo‘okū‘auhau Methodology

NHPI: Native Hawaiian, Pacific Islander

NOAA: National Oceanic and Atmospheric Administration

NZQA: New Zealand Qualification Authority

PCFMC: Pacific Coastal Fisheries Management and Compliance

PTK: Pacific Traditional Knowledge

RPEIPP: Rethinking Pacific Education Initiative for Pacific Peoples

SPFSC: South Pacific Form Seven Certificate

USAID: United States Agency for International Development

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Ka Ha‘alele
Mokuna ‘Ekahi: Chapter One
Ka Ho‘olauna a me Ke Kahua: Introduction and Background

1.1 Ku‘u Ho‘olauna: An Introduction Of Self

Before we *lu‘u piha* (dive fully) into this research, I must begin by introducing myself in a proper form. For many Indigenous communities, introducing ones, lands, winds, seas, rivers, mountains, and tribes establishes respect and a *pilina* (connection) to not only those they are being introduced to but also to their *kahua* (foundation). For this reason, this thesis will start with my origin of birth and of place, my *mo‘okūauhau* (genealogy):

‘O Kalawaianui Nakoa ke kāne no Waialua, Molokai
Noho pū ‘o ia me kekahi,
Hānau ‘ia ‘o Pa‘akaula Kalawaianui Nakoa, he kāne.
‘O Pa‘akaula Kalawaianui Nakoa ke kāne no Waialua, Molokai
‘O Kailioi Naone ka wahine no Kahakuloa, Maui
Noho pū lāua,
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‘O David Kalawaianui Nakoa ke kāne no Kahakuloa, Maui
‘O Malia Uwelo ka wahine no Makena, Maui
Noho pū lāua,
Hānau ‘ia ‘o Josephine Ho‘olea Nakoa, he wahine.
‘O Josephine Ho‘olea Nakoa ka wahine no Pu‘unēnē, Maui
‘O David Kaho‘ohanohano Makua Kalohi ke kāne no Ka‘ū, Hawai‘i
Noho pū lāua,
Hānau ‘ia ‘o June Leilani Kalohi, he wahine.
‘O June Leilani Kalohi ka wahine no Honolulu, O‘ahu
‘O Kuresa Nasau ke kāne no Olosega, Tokelau
Noho pū lāua,
Hānau ‘ia ‘o Zena Kahealani Selepa Nasau, ka hiapo, he wahine.
‘O Zena Kahealani Selepa Nasau ka wahine no ‘Aiea, O‘ahu
‘O Clifford Kanihonui Kauaula ke kāne no Kalihi, O‘ahu
Noho pū lāua,
Hānau ‘ia ‘o Zyshana Kolokea Selepa Kauaula, he wahine.
‘O wau nō, ‘o Zyshana Kolokea Selepa Kauaula;

*'O O'ahualua ku'u moku a puni,
'O Wai'anae ku'u moku o loko,
'O Ka'ala ku'u malu ulu niu,
'O Palikea ku'u malu ulu kiawe,
'O Kaiāulu ku'u makani aheahe,
'O Ulehawa ku'u wai kahe,
'O Nānākuli ku'u 'āina aloha.*

Ola.

I am Zyshana Kolokea Selepa Kauaula, and I come from a long line of ancestors who were warriors, navigators, chiefs, poets, artists, and farmers. I am deeply grateful for my ancestors' sacrifices to get me where I am today. This research is dedicated to them and their contributions. My writing delves into exploring the identity of people from Pacific cultures, like myself. I have collected this knowledge from scholarly findings and from my elders, family members, friends, and teachers who have imparted it to me. My research draws on my life experiences and educational background, specifically focusing on the well-being of Native Pacific communities and their relationship with academic research. My interest in this research stems from my life journey, which has helped me gain vast knowledge and personal growth.

The research illustrates the connection between traditional Indigenous and Pacific knowledge and their lived experiences. Although some may think Indigenous research needs to be more scientific, this thesis will demonstrate the significance of cultural understanding and life experiences, as seen through my personal story. I want to acknowledge the contributions of those before me who have conducted similar research and helped shape my work. I am solely responsible for any errors or deletions in my research and am accountable for the knowledge my teachers and *kūpuna* (ancestors) have given me¹. I hope that by presenting this research, I can encourage and support Indigenous research in the future.

1.2 Ke Kahua: Background Context

Understanding the integration of Indigenous Pacific knowledge within STEM-related fields is critical for fostering Pacific student development at the University of Waikato. My exploration into this topic revealed a significant gap: the lack of focus on prioritizing Indigenous knowledge and methodologies within current educational frameworks. This realization stemmed from discussions with peers and a

¹ Hence the reason 'ōleo Hawai'i is integrated into this thesis, specifically in each heading.

growing interest in decolonizing educational structures to incorporate Indigenous knowledge and principles.

The root of this research emerged from the need to address the systemic exclusion of Indigenous methodologies in academia. It seeks to explore how Indigenous Pacific knowledge can be integrated into STEM education to support Pacific students' academic and personal development. This integration is not merely an addition to existing curricula but a transformative approach that validates and incorporates Indigenous epistemologies.

Cultural methodologies and epistemologies will be employed throughout this study to support the findings. These include but are not limited to the Ka'ao Framework and Mo'okū'auhau Methodology, which provide culturally grounded structures for conducting and interpreting research. These methodologies ensure that the research aligns with Indigenous knowledge systems and cultural values, offering a robust foundation for analysis and contributing to a more equitable educational landscape.

1.2.1 Ke Kahua: Pō'aiapili Noi'i: Research Context

While data on Pacific students enrolled in HECS are absent, studies show that students and young people of Pacific Peoples' heritage living in New Zealand remain low and underrepresented in STEM and health-related courses (Sika-Paotonu *et al.*, 2020). This underrepresentation indicates that more students from Pacific backgrounds should be pursuing STEM and health courses. Understanding the reasons behind this trend is essential, as careers in health and STEM fields require engagement in science and health-related subjects throughout high school and higher education (*ibid.*, 2020).

Several factors contribute to this underrepresentation, including a lack of culturally relevant curriculum, limited access to resources, and systemic barriers such as discouragement from family members, systemic racism, and microaggressions (Espinosa *et al.*, 2022). Addressing these issues is vital; increasing the participation of Pacific students in STEM fields can lead to more diverse perspectives and innovation in these industries. Potential strategies to improve this situation include integrating Indigenous knowledge into the STEM curriculum and conducting follow-up studies to understand students' motivations to pursue STEM careers (*ibid.*, 2022).

A report examining Native Hawaiian and Pacific students in Hawai'i sheds light on the underlying factors contributing to their low enrollment in STEM fields (Kerr *et al.*, 2018). Similar to the

challenges observed in ANZ, Native Hawaiians and Pacific Islanders (NHPI) are recognized as among the least acknowledged ethnic groups in the United States regarding representation in STEM fields (ibid., 2018). This indicates that the lack of Pacific representation extends beyond the local scope of this research. As a result, NHPI students are working to dismantle barriers by advocating for integrating culturally relevant lessons and training (ibid., 2018). This primarily involves enhancing or adapting the curriculum to reflect better island contexts, and such modifications may include incorporating problems or scenarios grounded in Pacific cultural perspectives (ibid., 2018).

The findings of this report underscore a significant issue: the absence of alignment between science education and Pacific cultural practices means that despite efforts to assimilate into the dominant educational system, the relevance of Western science curriculum to the local culture and environment remains limited (ibid., 2018). This statement underscores the challenge of making education meaningful and relevant to students from diverse cultural backgrounds by pointing out the limitations of a one-size-fits-all approach, specifically in science education. It also reveals that Indigenous peoples continue to navigate conflicts between representation and the Western style of teaching. Per McAllister *et al.* (2022), “previous research has highlighted the under-representation of Māori and Pacific people in universities results from systemic exclusion and failure to serve, rather than a lack of ability” (p.118).

Consequently, it is unsurprising to notice differences in how STEM subjects are taught across various institutions, particularly considering their relevance and alignment with Pacific cultural contexts. As shared above, one clear way to maintain and generate interest in STEM subjects is to include regionally relevant content (Chesal *et al.*, n.d.). Relevant content should encompass materials and examples that resonate with Pacific people and their cultural heritage. Cultivating relationships and connecting academic content and the local community can significantly enhance the learning experience (Yu, 2017). If the content fails to establish these connections, it can be challenging for Pacific people to grasp the importance and applicability of STEM subjects in their lives. Chesal *et al.* (2024) articulate this issue well:

Education programs developed by overseas experts are commonly criticized for including examples, case studies, and topics with no relevance to the Pacific, hindering understanding by referencing places or systems unknown to students and teachers. One learning resource, for example, referenced a windmill to explain a science concept — the problem being that neither the teacher nor the students had seen a windmill in their lived experience.

Therefore, educational programs must incorporate regionally relevant content reflecting Pacific students’ lived experiences and cultural contexts. By doing so, STEM education can provide

opportunities for students to connect to the community's content and then back to their own lives, resulting in increased student academic engagement and achievement and pathways to meaningful and fulfilling careers. This approach will encourage future generations to follow and ensure the Pacific can retain expertise in STEM (Yu, 2017; Chesal *et al.*, 2024).

1.2.2 Ke Kahua: Ke Ko'iko'i o Ka Noi'i: Significance of the Research

The underrepresentation of Pacific individuals in STEM fields is a complex issue rooted in systemic barriers. This research addresses these challenges through several primary objectives:

First, it investigates the factors contributing to the underrepresentation of Pacific individuals in STEM fields. This involves thoroughly examining the systemic and contextual elements that hinder Pacific students' participation and success. Identifying these factors is crucial for addressing the root causes of this disparity.

Next, the research explores Pacific students' challenges in STEM education and proposes effective strategies for overcoming these barriers. Understanding these unique difficulties and offering practical solutions aims to create a more supportive and inclusive environment for Pacific students.

Furthermore, the study seeks to integrate Pacific knowledge into STEM curricula. By developing and proposing models that incorporate cultural perspectives and traditional knowledge, the research aims to make STEM education more relevant and accessible for Pacific students. This integration fosters a learning environment that values diverse ways of knowing.

Finally, the research aims to enhance Pacific students' academic and personal development in STEM fields. This involves creating a framework that supports their sense of belonging and empowerment. Establishing support systems and educational practices that enhance students' overall experience and success is vital for fostering a supportive environment for Pacific students in STEM education.

By addressing these objectives, the research hopes to improve representation and enrich the STEM educational landscape with diverse cultural perspectives, leading to a more inclusive and dynamic field.

1.2.3 Ke Kahua: Wehewehena Ko'iko'i: Key Concepts

This section defines key concepts essential for understanding the ideas discussed in this research. By clarifying these terms, we establish a consistent vocabulary that will be used throughout the thesis. This clarity is crucial for accurately conveying the significance of integrating Indigenous Pacific

knowledge into STEM education and ensuring that the educational implications of this research are fully understood. The five core concepts defined here include Pacific people, Pacific traditional knowledge, Aotearoa New Zealand, and the University of Waikato.

1.2.2.3 Ka Po‘e Pākīpika: Background of Pacific People

“Pacific peoples” is the overarching term for diverse ethnic groups native to islands across the Pacific. In this thesis, when utilizing the term “Pacific peoples,” I am referring to Indigenous peoples from the vast Pacific. In ANZ, this word is commonly used alongside the terminology “Pasifika,” for which the government describes migrants from the Pacific regions and their descendants (Tapasā, n.d.). However, this study will only utilize the umbrella term “Pacific peoples.” Throughout this research, “Pacific people” primarily refers to Pacific students, their families, and their communities. Although this study will speak mainly about Pacific students, it will also consider students of other nationalities, ethnicities, and backgrounds. In addition, the study will share how students come from diverse cultures and places; that is what Pacific people are.

1.2.2.4 Ka ‘Ike Ku‘una Pākīpika: Pacific Traditional Knowledge

“Lulamu ko nyanyio kale nyo me saiva”

(p.3)

Nunn *et al.* (2024) share a Solomon Islands proverb that refers to knowledge that comes from ancestors. The proverbs explain that the knowledge bestowed upon by ancestors will continue to live on from generation to generation. This reflects the importance of preserving traditional knowledge like Pacific Traditional Knowledge (PTK). PTK is directly focused on Pacific people’s knowledge and understanding. It includes cultural expressions such as oral traditions, music, narratives, visual and performing arts, rituals, and cultural practices (Salī, 2020). These expressions of Pacific knowledge also extend to Pacific people’s connection to land and environments. In fact, in a journal by Rachelle Dickie (2005), the author states that “the Pacific Islands and their people survive within a reciprocal relationship held with the land and are a perfect representation of an interdependent existence” (p.1). Concerning PTK, the author continues to share that the expansive “amount of knowledge is held in nature and those who work the closest with it...For all these, an intense relationship with, and knowledge of, the surrounding land was necessary” (ibid., p.1-7). This underlines the interconnectedness between Pacific peoples and their environment while underscoring the importance of recognizing and valuing Indigenous perspectives on the environment and natural phenomena within the context of PTK. They learn much about the world from observing the land and its surroundings.

In addition to the interconnectedness of Pacific peoples with their land and traditional knowledge, it is essential to recognize that PTK encompasses centuries of accumulated wisdom passed down through oral traditions. Many Pacific cultures rely heavily on oral traditions, passing down knowledge through chants, music, dance, and storytelling (Salī, 2020). Storytelling has long been the primary method for relaying information in Indigenous societies, as traditional knowledge was typically unwritten (Lilomaiava-Docktor, 2020). Today, PTK is increasingly being integrated into scientific approaches; many researchers are looking for ways to connect Indigenous knowledge with mainstream Western sciences (University of Waikato, 2023). For example, an article related to PTK shares that “traditional knowledge in the Pacific explains the causes and manifestations of natural phenomena and identifies the best ways to respond...Here, we describe such knowledge relating to animals, plants, water, and sky – and show how these beliefs make scientific sense” (Kumar *et al.*, 2024). In general, PTK in academic disciplines is not a means of privilege but is equally included and respected when combined with Western knowledge. As an example, in Kerstin Kopf’s report, *The Turn Toward The Indigenous* (2015), it is shared that “British theoretical physicist David Peat respectfully merges his understanding of Indigenous knowledge with his knowledge...arguing that Western ideas of quantum physics and Indigenous holism have more common premises and ideas than are generally assumed” (p. 188). Such an opinion suggests there are more similarities between Western ideas of STEM and Indigenous holistic perspectives than realized. It further highlights the potential for common ground and mutual enrichment between PTK and Western knowledge.

1.2.2.5 ‘O Aotearoa: Background of Aotearoa New Zealand

This research focuses specifically on the Pacific people of Aotearoa, New Zealand. The abbreviation “ANZ” will be used throughout the thesis for Aotearoa, New Zealand. Occasionally, the term “Aotearoa” from Te Reo Māori will also be used to acknowledge the land’s Indigenous name and highlight the significance of national names (University of Waikato, 2021). Over the past years, Pacific Island peoples have established themselves as a significant and permanent community within the societies of ANZ (Earle, 1995). The bonds between “Tangata Whenua (Indigenous people of the land) and Tangata Moana (Pacific people) have existed for millennia before the signing of Te Tiriti o Waitangi” (Ministry for Pacific Peoples, 2001, p.3).

According to the latest census data, over 442,632 people identify as part of the Pacific Peoples ethnic group, making up 8.9% of New Zealand's population in 2023 (Radio New Zealand, 2024; Stats NZ, 2024). This is an increase from 381,642 in 2018, reflecting significant growth in the Pacific

population. The median age for Pacific people is 25, highlighting a youthful demographic crucial for New Zealand's future (RNZ News, 2024).

Regarding education, there has been an increase in the enrollment of Pacific young people in health-related degrees. Recent data shows that in 2021, 420 Pacific young people aged between 18 and 24 were enrolled in either the Bachelor of Medicine and Bachelor of Surgery or Bachelor of Nursing degrees, representing about 1.1% of the Pacific young population in this age group. This is a slight increase from 2010, when 320 Pacific young people were enrolled in these programs, accounting for 0.85% of the population (Stats NZ, 2023).

Pacific young people are still underrepresented in these critical health education pathways despite these improvements. The overall enrollment rate for young people aged 18 to 24 in New Zealand was 2.5% in 2021, suggesting that Pacific young people face unique barriers that must be addressed through targeted support and initiatives (Stats NZ, 2023).

Moreover, compared to other ethnic groups, the enrollment rate for Māori and Pacific young people in these programs was 1.8% in 2021, highlighting a disparity that needs to be addressed through targeted support and initiatives (Stats NZ, 2023). This is especially significant considering that Pacific people make up 8.9% of the population in New Zealand (RNZ News, 2024). These comparisons underscore the ongoing need to enhance educational opportunities and support systems for Pacific young people to improve their representation in the health workforce.

1.3 Ka Po'e a me Ke Ko'i'ko'i: Target Audience and Significance

In Aotearoa, equity requires more Indigenous Pacific people to pursue STEM-related fields and careers. As previously mentioned, ANZ is home to 381,642 Pacific people, and over 8% of the population identifies as being of Pacific origin (New Zealand Ministry of Foreign Affairs and Trade, n.d.). Out of these statistics, the health sector is only enriched by 3.3% of Pacific nurses, 1.8% of doctors, 10.8% of carers, and 39 Pacific providers that support the health system (Pacific Aotearoa Status Report, 2020). Moreover, the number of Pacific people across ANZ is at a low, where:

21 Pacific people are studying for the Master of Nursing degree, and about 180 are undertaking postgraduate training in Nursing. We also estimate that 27 Pacific doctors are undertaking clinical training as specialists, with approximately 16 as general practitioners and 11 as other specialties. At least four Pacific people are undertaking clinical placements in the allied health professions. (Pacific Perspectives, 2013, p.10).

As a student, I have recognized the significance of STEM education for all students in enhancing their academic achievements. Moreover, as an Indigenous student, I have also observed that many students from an Indigenous background struggle to navigate through STEM-related fields and often feel challenged in these areas. This demonstrates the importance of Indigenous science, which incorporates Indigenous knowledge and perspectives into science. The University of Waikato has yet to provide an Indigenous STEM course. Such a course could foster the interest of Indigenous students in STEM-related fields and serve as a foundation for opening a new gateway for students. So far, Indigenous STEM learning is not a requirement at any university. Even though there are STEM-related courses and organizations that universities have partnered with, an Indigenous STEM course has yet to be in sight. Through this research, we aspire to build a system to find common ground and bridge the gap between Western STEM teachings and Indigenous *'ike* (knowledge). Indigenous students must be genuinely seen, heard, and respected in these academic fields to achieve equity.

Furthermore, it is worth noting that *Mātauranga Māori* (Māori knowledge) is also closely related to *Mātauranga Pasifika* (Pacific Knowledge). As stated in the University of Waikato and Pacific at Waikato, Pacific Strategic Plan, “Māori and Pacific people share a common heritage of voyaging, wayfinding, knowledge, and learning, by which they settled Moananuiākea/the Pacific Ocean in one of the greatest feats in human history” (Pacific Strategic Plan, 2021, p.2).

Mokuna ‘Elua: Chapter Two **Ki‘ina Hana: Methodology**

2.1 Ho‘olauna: Introduction

This methodology chapter details the research design and methods used to investigate the integration of Indigenous Pacific knowledge into STEM education. Central to this study is the Ka‘ao Framework, which provides a culturally grounded structure for conducting and interpreting the research. Supplementary methodologies include the Mo‘okū‘auhau Methodology, emphasizing genealogical continuity and relationality. These methodologies ensure that the research aligns with Indigenous knowledge systems and cultural values, providing a robust foundation for analysis.

The study employs a secondary research approach, focusing on existing studies and research to explore integrating Indigenous Pacific knowledge into STEM education. By leveraging these existing resources, the study aims to understand current practices and comprehensively identify areas for further integration. In addition, the Ka‘ao Framework and Mo‘okū‘auhau Methodology ensure that the research design remains culturally relevant and respectful of the communities it aims to serve.

2.2 Kūkulu Noi‘i: Research Rationale

Previous sections have highlighted the significance of Pacific individuals’ underrepresentation in STEM fields, the systemic challenges they face, and the necessity of integrating Indigenous knowledge into STEM education. This rationale will now delve into why this research is crucial and how it aims to address these pressing issues.

This thesis is essential because, in my positionality as an Indigenous student, I have experienced firsthand the feeling of not being seen and represented in university, particularly in STEM-related courses. From that experience, I have been determined to ensure that other Indigenous and Pacific students do not have to face the same challenges. This research explores integrating Indigenous Pacific knowledge into STEM education to create a more inclusive and supportive environment for Pacific students.

2.3 He aha Ka Hihia?: What Is The Problem Statement?

Pacific students in academia face systemic challenges resulting from broken promises within the education system. Conflicts between Indigenous cultural practices and Western-style education have always existed, compelling native peoples to conform to the dominant system (Kerr *et al.*, 2018). However, Kerr *et al.*’s bold statement reflects a harsh reality. From personal experience, there were always conflicts between being Indigenous and attending Westernized institutions, requiring

adjustments to that way of learning. This made it clear that true equality for Indigenous students was not being achieved. Another account reveals that “despite the supposed equality, Pacific students continue to underachieve in the educational system compared to Pākeechā and Asian students” (Nash, 2000, p.69). This discrepancy highlights the ongoing inequities and the need for an education system that genuinely supports and reflects the cultural contexts of Pacific students.

The research problem addressed in this thesis centers on the necessity for an Indigenous-focused STEM course at The University of Waikato to bolster Pacific student representation in STEM fields. Many students from Indigenous backgrounds face challenges navigating STEM-related fields due to a lack of basic cultural competency and cultural safety within academic environments (McAllister *et al.*, 2022). Furthermore, the prevailing education system frequently disregards the knowledge and contributions of Pacific people and other Indigenous communities, exacerbating their under-representation in STEM fields...Universities often neglect the identities and experiences of Pacific students, disregarding perspectives and phenomena that fall outside of Eurocentric worldviews (ibid., 2022). Therefore, universities must foster inclusive environments within STEM-related fields (ibid., 2022).

The proposed Indigenous-focused STEM course will encompass subjects such as mathematics, biology, chemistry, and physics, all approached through the lens of Indigenous knowledge and practices. The primary objectives are strengthening Pacific student enrollment and retention in STEM fields, elevating their academic achievements, and cultivating a nurturing learning environment that honors and integrates Indigenous cultures. As articulated by McAllister *et al.*, “We hope that our stories show Pacific students that they are not alone and that we continue to challenge universities to do more and to do better today, not in a promised yet non-existent future” (ibid., p. 130).

This discrepancy is highlighted in the *2020 Action Plan for Pacific Education*, which outlines a vision for ensuring Pacific learners thrive in education, advocating for inclusive, equitable, and culturally responsive systems. The plan emphasizes embedding indigenous knowledge and practices within the curriculum to foster a sense of belonging and identity among Pacific students (Ministry of Education, 2020). Moreover, the Rethinking Pacific Education Initiative for Pacific Peoples by Pacific Peoples (RPEIPP) has proven the effectiveness of incorporating indigenous knowledge systems and cultural competencies into higher education. This initiative has significantly improved Pacific students’ academic and leadership skills, ensuring they are well-prepared to succeed globally and within their communities (Nabobo-Baba, 2012).

In the long term, the Indigenous-focused STEM course aims to create a more diverse STEM workforce, promote social justice, and enrich the STEM field with diverse perspectives and knowledge systems by integrating cultural practices, concepts, and diverse worldviews into high-quality education (Pacific Perspectives, 2013).

2.4 Te Whare Wānanga o Waikato: The University of Waikato

The University of Waikato stands out among the eight universities in Aotearoa New Zealand, all of which rank within the top three percent globally and offer a broad range of subjects including arts, sciences, commerce, engineering, and health sciences (Universities New Zealand, n.d.). Known also as Te Whare Wānanga o Waikato, this university serves as the primary focus of this research.

Data from The University of Waikato (2024) shows that Pacific student enrollment has increased to 747, equivalent to full-time study. Additionally, Waikato has gained recognition for its Computer Science program, with its thriving Department of Computing and Mathematical Sciences elevated to a School (The University of Waikato, n.d.).

The 2023 University of Waikato Annual Report indicates that Māori and Pacific students comprise 26.4% of the university's student body (University of Waikato, 2023). However, precise data regarding the total number of Pacific students enrolled in the university's Te Wānanga Pūtaiao—Division of Health, Engineering, Computing, and Science (HECS) remains unavailable. Furthermore, Health Workforce New Zealand and the Ministry of Health have also struggled with discerning the influx of Pacific students in health degrees, stating: “We were unable to determine how many students completed degrees leading to careers in allied health professions” (Pacific Perspectives, 2013, p. 9). This highlights the importance of examining this division's Pacific student enrollment rate to assess their success in STEM-related fields.

2.5 Nā Pahuhopu: Aims and Approach

This research explores how Indigenous Pacific knowledge can be integrated into STEM education to support Pacific students' academic success and cultural identity. This approach involves a literature review, reflections on an operating STEM program, and designing an ideal Indigenous Pacific STEM program for high school students transitioning into STEM tertiary study.

2.6 Nā Mea Waiwai: Principles and Values

This research is grounded in principles and values that honor the Indigenous Pacific worldview, such

as mo‘okū‘auhau (genealogical continuity), relationality, and the importance of language. These principles challenge the dominance of Western knowledge systems and highlight the value of Indigenous perspectives in education. The Ka‘ao Framework and Mo‘okū‘auhau Methodology are central to this approach, ensuring the research respects and incorporates Indigenous knowledge and cultural values (Wilson-Hokowhitu, 2019).

As a researcher, approaching this study with humility and kuleana (responsibility) is vital. This perspective acknowledges the privilege of conducting research within Indigenous communities and the duty to handle this knowledge with care and respect. By embodying aloha (love, compassion), I strive to foster an environment of mutual respect and understanding, recognizing that shared knowledge is a gift that must be treated with the utmost reverence.

Incorporating the value of self into this research involves recognizing and embracing my identity as an Indigenous researcher. This self-awareness allows for a more authentic and grounded approach to the research, ensuring that my cultural heritage and personal experiences inform the study. Reflecting on my journey and the challenges faced as an Indigenous student, I aim to create a research framework that is both empathetic and empowering for Pacific students.

Approaching this research with humility means acknowledging the limitations of my understanding and being open to learning from the communities I engage with. It involves actively listening, valuing the insights of others, and being willing to adapt and grow. Kuleana emphasizes the responsibility of using this research to benefit the community. It is about ensuring that the outcomes of this study contribute positively to the educational experiences of Pacific students and help dismantle systemic barriers.

The principle of aloha is integral to this research, fostering a sense of love, compassion, and interconnectedness. By embracing aloha, I aim to build relationships based on trust and respect, recognizing the interconnectedness of all beings. Relationality, as a core value, emphasizes the importance of relationships and community. It involves understanding the research process as a collaborative journey, where the contributions of all participants are valued and honored.

2.7 Ke Ki‘ina Hana Mo‘okū‘auhau: Mo‘okū‘auhau Methodology Integration

The Mo‘okū‘auhau Methodology emphasizes genealogical continuity and relationality, essential concepts in Hawaiian epistemology. This methodology connects researchers to their ancestors, land,

and the broader cosmos, providing a holistic approach to knowledge creation and dissemination (Wilson-Hokowhitu, 2019).

Integrating the Mo‘okū‘auhau Methodology into the Ka‘ao Framework is essential because it ensures that the research process remains deeply rooted in Indigenous epistemologies, enhancing the cultural relevance and authenticity of the findings. This integration acknowledges the interconnectedness of knowledge, identity, and place, reinforcing the significance of cultural heritage in shaping educational practices and outcomes. By embedding Mo‘okū‘auhau within the Ka‘ao Framework, the research honors the continuity of ancestral wisdom and promotes a holistic understanding of Pacific student experiences in STEM education.

2.7.1 Ka Pu‘uwai: The Heart

This research is guided by the Mo‘okū‘auhau Methodology (MM). *Mo‘okū‘auhau*, translated as genealogical lineage, embodies multifaceted significance. It is a genealogical record and an in-depth exploration of one’s familial and personal history (Kumukahi, n.d.). Exploring *mo‘okū‘auhau* is like unraveling the story of one’s ancestors, linking one to one’s roots. It’s more than just names and dates; it’s about understanding who you are, where you come from, and how you’re connected to others and your culture (ibid., n.d.). The Mo‘okū‘auhau Methodology is an approach that draws upon the Hawaiian cultural values, practices, and knowledge system of *mo‘okū‘auhau*. It shares the efforts to decolonize methodology by incorporating cultural context and participating in research on the researcher’s terms (Wilson-Hokowhitu *et al.*, 2018). For example, a case study called *Reviving Buried Ideas of ‘Āina Through Mo‘olelo, Mo‘okū‘auhau, and Aloha ‘Āina* integrates Wilson-Hokowhitu’s methodology and shares that:

Beyond being a simple ancestral pedigree, mo‘okū‘auhau encompasses a deep significance in the Hawaiian language, referring to human connection to spiritual and geographic elements. The succession of our ancestors, as outlined in genealogy, and the mana within their bones buried in the land create a foundation that establishes our identity as connected to our places. Genealogical lineage also asserts political power; mo‘okū‘auhau asserts ancestry and our rights and responsibilities (Elkington, 2018, p.5).

After considering the importance of *mo‘okū‘auhau*, as outlined in the block quote above, it becomes evident that this Indigenous methodology holds immense value in connection to land² and shaping identity. This perspective aligns with the efforts of the MM, which seeks to decolonize research methods and empower research with Indigenous perspectives. With this understanding, MM was chosen as it has the application to examine this research on PTK in STEM fields appropriately. In

² As mentioned in the previous section ‘Ike Ku‘una Pākīpika: Pacific Traditional Knowledge, land connection is vital in Indigenous, Pacific cultures.

contrast, “in a Western research approach, the action and participatory approach come forward as critical research” (Biin *et al.*, 2021, p.9). Thus, MM is intended to capture the essence of Indigenous, Pacific, and Kanaka ‘Ōiwi scholarship, serving as a vehicle for expanding consciousness (Wilson-Hokowhitu *et al.*, 2018). Intertwining with the *Ka‘ao framework*³, the MM helps face challenges fronted by traditional development paradigms. Many of these challenges include using development theories that tend to reproduce Western thinking (University of York: Department of Education, n.d.). Furthermore, the Ka‘ao framework, developed by Taupōri Tangarō, transforms the student experience while creating alignments between university services, programs, and life passions (UH Maui College Professional Development, 2022).

2.7.2 Ka Ho‘omau: Genealogical Continuity

Mo‘okū‘auhau as a methodology is about our connections and relationships to places and the natural world, as well as our past, present, and future people. This understanding is ancestral and intergenerational, extending from our long lineage of understanding and knowing.

Adding the Mo‘okū‘auhau methodology to the Ka‘ao Framework enriches the approach by ensuring that genealogical continuity and relationality are integral to the research process. The Ka‘ao Framework, which structures the research into stages reflective of a journey, benefits from the incorporation of Mo‘okū‘auhau as it deepens the cultural and historical context of the study. This combination allows for a more comprehensive exploration of Pacific students' experiences, emphasizing their ancestral connections and the impact of these connections on their educational journey. By intertwining these methodologies, the research documents current experiences. It honors the past and looks toward future generations, creating a dynamic and culturally resonant approach to studying Pacific student development in STEM.

2.7.3 Ka Pilina: Relationality

Relationality involves recognizing and honoring the relationships between people, land, and the spiritual realm. This methodology emphasizes the interconnectedness of all elements in the research process and acknowledges the guidance of ancestors embodied in the natural world.

Integrating the concept of relationality from the Mo‘okū‘auhau methodology into the Ka‘ao Framework further enriches the research approach. The Ka‘ao Framework benefits from this integration by emphasizing the interconnectedness of all research elements and the importance of

³ The Ka‘ao Framework will be further acknowledged in later chapters.

relationships in the research process. This approach ensures that the research is not isolated but considers the broader context of relationships between people, land, and the spiritual realm. By incorporating relationality, the research honors the guidance of ancestors and the natural world, fostering a more holistic and interconnected understanding of Pacific students' experiences in STEM. This integration reinforces the cultural relevance and authenticity of the research, providing a comprehensive framework that respects and values Indigenous knowledge systems.

2.7.4 Ka Mole: Foundations

Mo'okū'auhau Methodology is grounded in Hawaiian values and ethics. Research must be conducted with honor, responsibility, and respect for cultural values and practices. This involves engaging with community leaders, seeking guidance, and ensuring the research benefits the community. Ethical considerations include maintaining confidentiality, obtaining informed consent, and ensuring the research process is transparent and respectful (Wilson-Hokowhitu, 2019).

Integrating the foundational principles of the Mo'okū'auhau Methodology into the Ka'ao Framework strengthens the research's ethical grounding. The Ka'ao Framework, when combined with Mo'okū'auhau's emphasis on honor, responsibility, and respect, ensures that the research process is not only academically rigorous but also culturally sensitive and ethically sound. Engaging with community leaders and seeking their guidance enhances the credibility and relevance of the research while maintaining confidentiality and obtaining informed consent to uphold the ethical standards necessary for working within Indigenous communities. This integration ensures that the research is beneficial to the community and conducted in a manner that honors their cultural values and practices.

2.7.5 Nā Ponolia: Practical Applications

In practice, the Mo'okū'auhau Methodology involves several key steps that ensure the research process is respectful and culturally grounded. These steps include community engagement, genealogical research, data collection, data analysis, and dissemination, aligning with Indigenous ways of knowing and ensuring the research process is culturally relevant (Wilson-Hokowhitu, 2019).

By incorporating these practical applications into the Ka'ao Framework, the research process is structured to be both methodologically sound and culturally appropriate. Community engagement ensures that the research is relevant and beneficial to the participants, while genealogical research grounds the study in a rich historical and cultural context. Data collection methods that respect Indigenous knowledge systems and cultural practices ensure the integrity of the information

gathered. The data analysis phase, guided by the principles of relationality and interconnectedness, provides a holistic interpretation of the findings. Finally, disseminating the research results in a manner that honors the participants' contributions and shares knowledge in a culturally respectful way ensures that the benefits of the research extend beyond the academic community to the wider Pacific community.

2.8 Ke Ki'ina Hana Ka'ao: Ka'ao Framework: The Structure of the Methodology

The Ka'ao Framework is the central methodology guiding this research. It structures the research process into four stages: hua (seed/beginning), ha'alele (departure), huaka'i (journey), and ho'ina (return), each representing a phase of the research process that aligns with Indigenous storytelling and knowledge transmission.

2.8.1 Ka Hua: The Beginning

The hua stage involves defining the research questions and objectives, grounding them in Indigenous knowledge and cultural values. This phase sets the foundation of the study, ensuring that the research objectives align with the cultural context and needs of Pacific communities.

2.8.2 Ka Ha'alele: The Departure

The ha'alele stage focuses on initial data collection from existing literature. During this phase, the researcher immerses themselves in the data, gathering insights while leaving behind preconceived notions and engaging with the literature openly and respectfully.

2.8.2.1 Ka Hō'ili'ilina 'Ikepili: Data Collection Methods

The methodology of this research is informed by the extensive literature review conducted in Chapter Three. This literature review provided critical insights into existing studies and reports on integrating Indigenous Pacific knowledge into STEM education. By identifying gaps and highlighting successful practices, the review has helped shape this study's research questions and objectives.

2.8.2.1.1 'Ikepili No Ka Mo'olelo Nā'ana: Information On Literature Review

A comprehensive literature review was conducted to gather information on existing STEM programs, the integration of Indigenous knowledge, and culturally responsive education. This review provided a foundation for understanding the current landscape and identifying areas for further research.

2.8.2.1.2 Ke Ana Mana‘o No Ka Papahana: Reflections on an Operating STEM Program

Reflections on the FoE program, an existing STEM initiative, were used to gain practical insights into integrating Indigenous knowledge. This involved analyzing program activities, student engagement, and the effectiveness of culturally responsive teaching practices.

2.8.2.1.3 Kālailai No Nā Mea Kuko‘ia: Designing an Ideal Indigenous Pacific STEM Program

Based on the findings from the literature review and reflections, an ideal Indigenous Pacific STEM program was designed. This program aims to support high school students transitioning into STEM tertiary study and university students, incorporating cultural and academic elements to enhance their learning experiences.

2.8.3 Ka Huaka‘i: The Journey

The huaka‘i stage represents the ongoing data analysis process, reflecting the dynamic and iterative nature of the research journey. Continuous reflection and adaptation are crucial during this phase as the researcher navigates the complexities of integrating Indigenous knowledge with STEM education.

2.8.4 Ka Ho‘ina: The Return

The ho‘ina stage involves synthesizing and disseminating the findings to the academic community and stakeholders. This ensures that the research benefits those involved and respects the principle of reciprocity, highlighting the importance of returning the knowledge gained to the community.

2.9 Ka Huaka‘i: Ke Kālailai ‘Ikepili: Data Analysis

Data analysis will involve qualitative techniques to synthesize findings from the literature and secondary data gathered from previous research studies, educational programs, and governmental reports. Thematic analysis will identify and analyze patterns and themes in the qualitative data. This process includes coding the data, identifying significant themes, and interpreting the findings in the context of the research questions. Using thematic analysis, the study aims to provide a comprehensive understanding of integrating Indigenous Pacific knowledge into STEM education, ensuring the findings are culturally relevant and grounded in the collected data. This approach allows for a thorough understanding of existing practices and their effectiveness.

2.9.1 Ka ‘Oloke‘a Ka‘ao ma ka ‘Ikepili: Ka‘ao Framework Integration in Data Collection

The Ka‘ao Framework will guide the data collection process, ensuring it aligns with Indigenous perspectives and knowledge (Hawai‘i Community College, n.d.). The stages of the Ka‘ao Framework in data collection are:

- **Hua:** Formulating research questions and criteria for literature review that reflect Indigenous perspectives and knowledge.
- **Ha'alele:** Engaging with the literature respectfully and establishing a comprehensive understanding of existing research.
- **Huaka'i:** Continuously refining the analysis based on ongoing feedback and observations from the literature.
- **Ho'ina:** Sharing preliminary findings with the academic community and stakeholders to validate the data and ensure it resonates with their experiences.

2.9.2 Ka 'Oloke'a Ka'a ma ke Kālailai 'Ikepili: Ka'ao Framework Integration in Data Analysis

By integrating the Ka'ao Framework into both data collection and analysis, the study ensures that the research processes are culturally grounded and aligned with Indigenous knowledge systems. The Ka'ao Framework will also guide the data analysis process:

- **Hua:** Initial categorization of data based on Indigenous related research.
- **Ha'alele:** Deepening the analysis by exploring the departure points or contrasts within the data.
- **Huaka'i:** Engaging in an iterative analysis process, continuously developing and refining insights.
- **Ho'ina:** Interpreting the results in a way that honors the participant's cultural contexts and sharing these interpretations with the community.

2.10 Kū i ka Lula Maika'i: Ethical Considerations

While this research does not involve direct interaction with human subjects, it is conducted with a deep respect for Pacific cultural values and practices. The research design incorporates cultural values from the outset, ensuring that the study is culturally sensitive and respectful. Building trust and respectful relationships with the literature and existing research is crucial throughout the process. Continuous reflection and addressing ethical considerations are integral, and disseminating findings honors the principle of reciprocity, benefiting the community. The Ka'ao Framework guides this process by embedding these principles at every stage.

2.11 Ke Kaupalema (Wehewehe Pōkole): Limitations (Brief)

This research acknowledges potential limitations, including challenges in data collection, the generalizability of findings, and any biases that may arise. These limitations are recognized to provide context and transparency for the research scope and methods and will be further discussed in

the conclusion chapter.

2.11.1 Ke Ko'iko'i o Ka 'Ōlelo: Importance of Language

Language plays a crucial role in this research, serving as a vehicle for expressing and preserving Indigenous knowledge. By incorporating Pacific languages and terminologies, the research not only honors cultural heritage but also enhances the relevance and accessibility of the findings for Pacific communities. I am unapologetically using Indigenous language throughout this thesis to assert the significance of cultural identity and epistemology. This intentional choice underscores the importance of linguistic diversity in academic discourse and recognizes the power of language in shaping and conveying Indigenous worldviews. By doing so, the research respects but revitalizes Pacific languages, contributing to the broader movement of language preservation and cultural resilience.

2.12 Ka Pani: Summary

This chapter thoroughly details the research design and methods for integrating Indigenous Pacific knowledge into STEM education. The Ka'ao Framework is the central guiding structure, ensuring the research aligns with Indigenous knowledge systems and cultural values. The Mo'okū'auhau Methodology supports these efforts by emphasizing genealogical continuity and relationality.

The chapter outlined the four stages of the Ka'ao Framework—hua, ha'alele, huaka'i, and ho'ina, each playing a crucial role in structuring the research process. The Mo'okū'auhau Methodology emphasized the importance of genealogical continuity and relationality, guiding the research through engagement with the community, genealogical research, and culturally respectful data collection and analysis.

Ethical considerations have been embedded throughout the research process, ensuring cultural sensitivity and respect. While acknowledging potential limitations, this chapter has provided a robust and culturally attuned methodology for examining the integration of Indigenous Pacific knowledge into STEM education.

By employing the Ka'ao Framework and Mo'okū'auhau Methodology, this research not only aims to enhance the educational experiences of Pacific students but also supports the development of a STEM curriculum at the University of Waikato that is culturally relevant and inclusive. These frameworks help address the unique challenges faced by Pacific students, fostering an educational environment that respects and integrates their cultural heritage. This approach aims to create a more

engaging and supportive learning experience, ultimately contributing to Pacific students' academic success and empowerment in STEM fields. This strong foundation sets the stage for the subsequent analysis and findings, further exploring the impact and effectiveness of these culturally grounded methodologies.

Ka Huaka'i
Mokuna 'Ekolu: Chapter Three
Mo'olelo Nā'ana: Review of Literature

3.1 Mo'olelo Nā'ana Hua Mua: Initial Literature Review

One common theme I have found while researching is Pacific representation. As previously stated, the underrepresentation of Pacific individuals in STEM fields is a multifaceted problem beyond statistical differences. This research delves into and scrutinizes the hidden factors contributing to this phenomenon, focusing on recognition, cultural obligations, and the infusion of Indigenous knowledge.

The first area of emphasis of this review is the underrepresentation of Pacific people in STEM-related disciplines. Statistical data from ANZ universities highlight a significant gap among Pacific academics and professors (Ministry of Education, 2020; Universities New Zealand, n.d.). A significant contributing factor to the underrepresentation is the education system's failure to acknowledge the historical contributions of Pacific people to STEM (Smith, 2012). This initial section explores the implications of this omission and its impact on the representation of Pacific individuals in academic and professional STEM spaces. Additionally, this section examines the challenges Indigenous students face in balancing cultural responsibilities with scholarly pursuits (Thaman, 2003). The literature stresses the need for customized programs and supportive structures to address these challenges and promote academic success (Airini *et al.*, 2010). A prevalent feeling among Pacific students pursuing STEM fields is that they are undervalued and in the minority in educational spaces (Samu *et al.*, 2009). This section synthesizes research and personal narratives to shed light on the dynamic and psychological elements of underrepresentation.

Despite national and institutional policies that advocate for including Indigenous knowledge, this literature review assesses the gradual integration of Pacific knowledge systems into science faculties. The absence of Pacific cultural values and structures within the education system is a significant issue contributing to underrepresentation (Health Workforce Advisory Board, 2020). Successful learning for Pacific students depends on integrating their languages, cultures, and values into the educational environment (Pacific Perspectives, 2013; Yu *et al.*, 2017). Literature consistently highlights the necessity of creating a supportive environment within the education system (Easthope-Harper, 2018). Recognizing and integrating Pacific knowledge and perspectives into STEM fields is crucial for achieving equitable representation (Knopf, 2015; Ministry of Education, 2020).

Pacific people have a long history of STEM and a solid and living legacy in these fields (Easthope-Harper, 2018). However, many gaps and areas still need further investigation and more inclusion in STEM fields and careers for the people of the vast Pacific. This proposal presents a compelling argument for integrating PTK learning methods into Western academia. It emphasizes the crucial role of culturally based learning in university courses, particularly exploring the rich and diverse Indigenous Pacific knowledge in STEM fields. The discussion will delve into the various forms of this knowledge and its numerous benefits for the different Pacific communities in the Pacific islands and ANZ. The ultimate objective is to provide a detailed and comprehensive understanding of how PTK can significantly enhance the educational experiences of all students, particularly those with Pacific heritage, while emphasizing the need for a more inclusive and diverse academic environment (Health Workforce Advisory Board, 2020; Pacific Perspectives, 2013; Yu *et al.*, 2017).

3.2 Ho‘olauna: Introduction

“Our stories grow the evidence that Māori and Pacific people are excluded from New Zealand universities.”

(McAllister *et al.*, 2020, p. 129)

The saying above from the 2020 report, *Seen but Unheard: Navigating Turbulent Waters as Māori and Pacific Postgraduate Students in STEM*, captures the feelings experienced by Māori and Pacific students in New Zealand universities. This literature review explores this underrepresentation in STEM fields, examining historical and current barriers and emphasizing the integration of PTK into educational frameworks. This review will analyze the systemic issues within educational institutions contributing to this underrepresentation and discuss the importance of integrating PTK into STEM education. Understanding the significance of these challenges is crucial for developing effective academic strategies. Existing research indicates that “Pacific students in ANZ face numerous barriers, including the lack of culturally relevant support and resources” (Enari, 2021, pp. 63-64). These unmet needs “significantly impact their engagement and achievement in academic settings, particularly in STEM disciplines” (*ibid.*, p. 64).

There is a growing emphasis on merging Western and Pacific research styles to address these gaps and create more inclusive and supportive educational environments. This integration is essential for fostering a sense of belonging and improving academic outcomes for Pacific students (*ibid.*, p. 62). By recognizing and valuing Pacific cultural perspectives, educational institutions can better meet the needs of these students and promote more excellent representation in STEM fields.

Due to these challenges, other vital questions arise, such as: What are the primary factors contributing to the underrepresentation of Pacific individuals in STEM fields? How do Pacific students experience and navigate STEM education challenges in Western academic institutions? What are the best practices for integrating Indigenous knowledge into STEM education? How can educational institutions develop inclusive and culturally responsive STEM curricula to support Pacific students? This research will attempt to answer these questions.

This literature review will examine the historical context and current state of Pacific representation in STEM, followed by an analysis of the systemic barriers and challenges. It will then explore the importance of culturally relevant education and integrating Indigenous knowledge. Finally, the review will present case studies and examples of successful initiatives that have addressed these issues, providing a comprehensive understanding of the steps needed to foster equitable representation and success for Pacific students in STEM.

In addressing the barriers to representation and the need for inclusive educational strategies, one critical approach that emerges is culturally inclusive teaching. This approach has shown promise in creating supportive and engaging learning environments for Indigenous and Pacific students. The following section delves into the principles of culturally inclusive teaching and its significance in STEM education.

3.3 Nā Kulekela Ho‘ona‘auao: Educational Policies

Understanding the historical and contemporary educational policies in ANZ is crucial for addressing the underrepresentation of Pacific Peoples in STEM fields. Historically, these educational policies have often marginalized Indigenous knowledge and practices, prioritizing Western educational paradigms. For instance, Western educational institutions have discounted Indigenous knowledge and nurtured the belief that non-Western cultures “contribute nothing to the development of knowledge, humanities, arts, science, and technology” (Knopf, 2015, p.181). This underscores the importance of challenging these narratives and promoting the value of Indigenous knowledge in education.

In STEM education, addressing the needs of Indigenous communities has emerged as a critical imperative. Government funding initiatives, such as those highlighted by the University of Hawai‘i at Mānoa (2022), underscore the importance of allocating targeted resources to Indigenous students to mitigate disparities in access to quality education. Additionally, community-based STEM

education programs⁴, exemplified by initiatives focusing on Pacific college students (Sika-Paotonu *et al.*, 2020), have demonstrated efficacy in fostering interest and participation in STEM disciplines. However, the success of such initiatives depends on incorporating culturally responsive pedagogies and curriculum development strategies (Yu *et al.*, 2017), emphasizing the significance of integrating Indigenous knowledge systems into STEM education frameworks. By recognizing and valuing cultural context within STEM learning environments, stakeholders can enhance academic outcomes and cultivate a sense of cultural identity and empowerment among Indigenous learners.

Government policies outlined in the *2020 Action Plan for Pacific Education* provide insights into efforts to “improve educational outcomes for Pacific learners, emphasizing inclusivity and equity in STEM education” (Ministry of Education, 2020, p.5). Additionally, forecasts of healthcare workforce “demands among Pacific communities emphasize the importance of investing in STEM education tailored to Pacific learners” (Pacific Perspective, 2013, p.8). Policy analyses provide insights into how educational policies affect Pacific People’s access to quality education and equitable opportunities in STEM fields. They guide advocacy for policy reforms prioritizing cultural responsiveness and equity (Earle, 1995).

Integrating insights from research, policy analyses, and workforce forecasts is essential for developing evidence-based strategies to address the underrepresentation of Pacific Peoples in STEM fields and foster their participation in the STEM workforce.

3.4 Ka Pilina Mo‘omeheu: Culturally Inclusive Teaching

Culturally inclusive teaching is an educational approach that recognizes the importance of including students’ cultural references in all aspects of learning. This method seeks to empower students by valuing their cultural heritage and integrating it into the educational process. It is particularly significant in STEM education, where traditional teaching methods may not always resonate with Indigenous and Pacific students.

Easthope-Harper (2018) highlights the impact of culturally inclusive teaching on student engagement and success, emphasizing that students are more likely to excel when they see their cultural backgrounds reflected in the curriculum. Grande (2014) supports this in the *Handbook of Critical and Indigenous Methodologies*, which provides a comprehensive overview of how integrating cultural knowledge and perspectives can transform educational practices and outcomes. The

⁴ Further details on the programs and initiatives to be discussed later in the thesis and will provide a comprehensive understanding of the strategies aimed at achieving these objectives.

handbook shares that this approach builds on cultural responsiveness and relevance concepts, emphasizing acceptance and inclusion...It encourages pedagogy that explicitly supports aspects of learners' languages, literacies, and cultural traditions (ibid., 2024). The Ministry of Education (2020) describes culturally inclusive teaching as a method that seeks to sustain the diversity of languages, literacies, and cultures, countering current pressures that lead to monolingual and monocultural schools.

Culturally sustaining pedagogy helps ethnically and linguistically diverse students develop cultural competence, academic success, and critical consciousness (Ministry of Education, 2020). This pedagogy goes beyond mere acceptance; it actively supports and perpetuates students' cultural practices and knowledge, ensuring their cultural identities are preserved and valued within the educational system.

3.2.1 Nā La'ana o Ka Pilina Mo'omeheu: Examples of Culturally Inclusive Teaching Practices

Several successful culturally inclusive teaching practices demonstrate the effectiveness of this approach. Integrating traditional ecological knowledge with modern scientific concepts allows students to see the relevance of their cultural heritage in contemporary STEM fields. Some of these examples will be further examined later in this literature review.

One example is using traditional navigation techniques, such as those employed by the Polynesian Voyaging Society, to teach astronomy and environmental science⁵ principles. By linking these practices to the curriculum, students can better understand the scientific concepts being taught and see their cultural practices as valuable sources of knowledge (Polynesian Voyaging Society, n.d.).

The *Ola Manuia: Pacific Health and Wellbeing Action Plan 2020-2025* by the Ministry of Health (2020) includes examples of culturally responsive practices in health education, which can be adapted for use in other STEM fields. This plan emphasizes the importance of integrating cultural perspectives into health education to improve the well-being of Pacific communities.

In one of my previous studies, I focused on connecting a Hawaiian universe to STEM. Like other Indigenous cultures, a Hawaiian universe consists of our *pilina* (relationship) with the elemental realm. Once students comprehend the cycles and rhythms of our universe, they will understand that everything around us has a function. Hence, if Pacific students are to succeed in STEM subjects, it is a must to intertwine their cultural belonging within academics. Once this integration has begun,

⁵ Examples of culturally Inclusive Practices will be further explained later in literature.

students will be naturally motivated to excel, carrying forward the legacy of their ancestors and paving the way for future generations.

An example of this can be seen in a student's reflections from Ōtorohanga College, who noted how integrating culture with STEM education has made learning more relatable and impactful. It has taught students much and helped with their school work, making everything easier...They appreciate that it incorporates culture, allowing them to relate their everyday life to what their ancestors used to do (The University of Waikato, 2022).

3.3 Ka Ho 'oponopono 'ana i nā Pilikia Ho'ona'auao: Addressing Systemic Barriers

Addressing systemic barriers is another critical issue. Indigenous students often face systemic barriers in education, such as a lack of support. For Pacific students, many teachers locate the problem of underachievement within the students themselves. This is what Bishop et al. (2009) call "deficit theorizing," which involves believing this underachievement is a product of poverty and unsupportive family lives. This perspective is a significant barrier to educational achievement (Bishop et al., 2009, as cited in Easthope-Harper, 2018, p. 5). According to Nieto (2003), teachers must critically reflect on their teaching, thinking, and practices, as this reflection can be used to create culturally relevant teaching practices. Personal reflection is necessary to see oneself as an agent of change (Nieto, 2003, as cited in Easthope-Harper, 2018, p. 5). By addressing these systemic barriers and shifting away from deficit theorizing, educators can better support Indigenous students and foster an environment that promotes their academic success.

Systemic barriers significantly hinder the participation and success of Pacific students in STEM fields. These barriers include deficit theorizing, lack of support, and cultural disconnects within educational institutions (Ministry of Education, 2021). Deficit theorizing refers to the perception that Pacific students are less capable or prepared for STEM fields due to their cultural backgrounds. Such assumptions can lead to lower expectations and limited opportunities for these students, perpetuating a cycle of underachievement (ibid., 2021). Additionally, many Pacific students report feeling unsupported or marginalized within their academic environments. Professors have noted that these students often need more support, impacting their confidence and academic performance (Easthope-Harper, 2018).

The school curriculum often needs to adequately include Pacific cultural elements, leading to a disconnect for Pacific students and reducing the relevance and engagement of their education (Ministry of Education, 2021). Furthermore, there often needs to be more connection between the

cultural contexts of Pacific students and the Western-centric educational paradigms prevalent in many institutions (Ministry of Education, 2021). This gap can make it difficult for students to see the relevance of their cultural knowledge in STEM fields.

Although Pacific people face barriers, it is not impossible to overcome them. Many strategies have been developed to support this. These strategies include increasing cultural competency, enhancing support systems, promoting inclusive curricula, and building community connections.

Increasing cultural competency is a crucial strategy. Educational institutions must provide training for faculty and staff to better understand and support the cultural backgrounds of Pacific students. The *Action Plan for Pacific Education 2020-2030* outlines initiatives for professional development that focus on cultural competency, ensuring educators are equipped to support diverse learners effectively (Ministry of Education, 2020). By enhancing cultural competency, educators can create a more inclusive environment that acknowledges and values the diverse cultural backgrounds of Pacific students.

Enhancing support systems is another vital strategy. Creating robust support systems like mentorship programs and culturally relevant academic resources can help Pacific students navigate their educational journeys. The *Pūhoro STEM Academy* is a prime example of a successful mentorship program supporting Māori and Pacific STEM students through personalized mentorship and community engagement (New Zealand Qualification Authority, 2023). These support systems provide students with the guidance and resources they need to succeed academically and personally.

Promoting inclusive curricula is also essential. Integrating Indigenous and Pacific perspectives into STEM curricula can make learning more relevant and engaging for these students. The *STEM Learning Through a Samoan Lens* initiative demonstrates how incorporating traditional Samoan practices into STEM education can enhance student engagement and understanding (Education Gazette, 2022). By making the curriculum more inclusive, educational institutions can help Pacific students see the relevance of their cultural knowledge in modern STEM fields.

Building community connections is another essential strategy. Encouraging collaboration between educational institutions and Pacific communities can foster a more inclusive and supportive academic environment. The *Tolooa Program*, supported by the Ministry for Pacific Peoples, illustrates the effectiveness of community-based initiatives in supporting Pacific students through scholarships, mentorship, and cultural programs (Ministry for Pacific Peoples, 2023). These community connections provide a network of support that helps students feel valued and understood.

The New Zealand Qualification Authority (NZQA) suggests several actions to support culturally inclusive teaching. These include building stronger relationships with Māori and Pacific students, reducing or eliminating class streaming, and focusing on teaching about STEM and STEM careers in ways that match students' career aspirations. Additionally, crucial steps include improving support structures, encouraging change among colleagues, developing more relevant learning resources, and setting higher expectations for Pacific success (NZQA, 2023).

In conclusion, while Pacific people face significant barriers in STEM education, these challenges are not insurmountable. Educational institutions can create an environment where Pacific students can thrive by increasing cultural competency, enhancing support systems, promoting inclusive curricula, and building community connections. These strategies support academic success and foster a sense of belonging and empowerment among Pacific students.

3.4 Ka Ha‘alele: Pō‘aiapili Mō‘aukala: Historical Context of Pacific Contribution to STEM

Historically, Pacific people have contributed significantly to STEM fields through navigation, environmental management, and traditional medicine. These contributions demonstrate a profound understanding of scientific principles that predate many Western discoveries (Elkington, 2018; Wilson-Hokowhitu, 2019; Ministry of Health, 2020). This historical context highlights the importance of integrating these traditional practices into contemporary STEM education to address current underrepresentation and foster a more inclusive learning environment.

For Indigenous people, *‘ike* and science are written onto the landscape (Irvine, 2021). For example, STEM is evident in everyday life. As Irvine (2021) illustrates, “Our cultural experience is placed in the geography of our everyday lives and in the ecology of the diverse relationships that take place within and between places” (p. 8). Furthermore, it is crucial to recognize that Pacific contributions to STEM are integrated into their way of life. Irvine (2021) points out that *kilo* (observing) practice extends far beyond traditional classroom settings, such as teaching in a lab or under a microscope. This approach allows students to “learn science naturally, often without even realizing they are engaging in scientific learning” (p. 20). These historical contributions showcase the profound legacy of Pacific peoples in STEM, laying a crucial foundation for integrating Indigenous knowledge into contemporary STEM education.

3.4.1 Ke Ko'iko'i o Ka 'Ike 'Ōiwi: The Importance of Indigenous Knowledge

Ma Ka Ho'ona'auao STEM: In STEM Education

Building on the understanding of traditional knowledge and practices discussed in the previous section, it is essential to further explore the definition and significance of Indigenous Knowledge within the context of STEM education. Indigenous Knowledge refers to the traditions and practices of specific regional, Indigenous, or local communities. These knowledge systems encompass a deep understanding of the environment, social practices, and cultural values passed down through generations. In the context of STEM, Indigenous Knowledge provides alternative perspectives and approaches to scientific inquiry, enriching the field with diverse methods and understandings.

Yu *et al.* (2017) emphasize the benefits of incorporating Indigenous Knowledge into STEM education. They highlight how Indigenous Knowledge can enhance critical thinking, foster a deeper connection to the environment, and provide culturally relevant education that resonates with Indigenous students. Integrating traditional knowledge into modern science acknowledges the value of Indigenous perspectives and promotes a more holistic understanding of scientific concepts (*ibid.*, 2017).

Ma Ke Akeakamai o Kēia Au: In Modern Science

One successful example of integrating traditional knowledge into modern science is the Kaulele project under the Institute for Native Pacific Education and Culture Empowering (INPEACE). This project weaves Hawaiian science and cultural practices with STEM exploration, translating ancestral knowledge into hands-on, interactive, science-based experiences (INPEACE, 2021). Incorporating STEM-based activities into cultural legacies can be challenging, but it is crucial for fostering a connection between Indigenous knowledge and modern science. As an Indigenous researcher, I believe integrating STEM with traditional art forms can create a wealth of activities centered around STEM and culture. Creative expression in STEM is critical for developing innovation, problem-solving, logical thinking, and invention skills.

Traditional cooking techniques like *umu* (underground oven), wayfinding through navigation, and other Indigenous activities such as plant analysis, *kapa* (cloth) studies/designs, fishpond/terrace construction, star and moon studies, storytelling, and composing music can all be integrated into STEM education. These activities engage students and strengthen their connection to their cultural heritage (Exploratorium, 2023).

The *Kaulele project*, focused on the traditional Hawaiian practice of making *kapa*, exemplifies integrating Indigenous knowledge with STEM. In this project, students participated in an interactive

exhibit where they learned the science behind *kapa*, a traditional Hawaiian cloth. They explored various stations that taught them about the fermentation process of *kapa*, the tools used in its creation, and the designs and printing techniques with *‘ohe kāpala* (bamboo stamp).

The exhibit also included storytelling elements, such as the story of Māui Snaring The Sun, and activities like identifying native Hawaiian plants through puzzles and observing the fermentation process of *kapa* (cloth). This hands-on experience made learning fun and relevant, strengthened students’ fine motor skills, and deepened their connection to their cultural roots (INPEACE, 2021).

Understanding the theoretical importance of integrating PTK into STEM education sets the stage for exploring specific traditional practices that exemplify this knowledge. The following sections will detail examples of traditional knowledge and practices, such as navigation, canoe building, and environmental management, illustrating the depth and richness of Pacific contributions to STEM fields.

3.4.2 ‘Ike Ku‘una a No‘eau: Traditional Knowledge and Practices

Ka Ho‘okele: Navigate

Traditional knowledge allows Pacific people to view STEM learning through an Indigenous lens. Indigenous⁶ People have been trailblazers in wayfinding and land stewardship. Epeli Hau‘ofa’s piece *Our Seas Of Islands* reminds Indigenous peoples that they possess all the tools their ancestors provided to succeed in Western society, particularly STEM fields. Hau‘ofa emphasizes the empowerment and responsibility that comes with this heritage:

We are the sea; we are the ocean; we must wake up to this ancient truth and together use it to overturn all hegemonic views that aim ultimately to confine us again, physically and psychologically, in tiny spaces that we have resisted accepting as our sole appointed places and from which we have recently liberated ourselves. We must not allow anyone to belittle us again and remove our freedom (Hau‘ofa, 1993, as cited in Naepi, 2020, p. 3).

Indigenous ancestors navigated the vast Pacific for thousands of years by sensing subtle environmental changes. This skill, honed through generations of experience, fostered a profound connection with and appreciation for their surroundings (Elkington, 2018; Wilson-Hokowhitu, 2019). These historical practices of navigation and exploration demonstrate the scientific and technological skills inherent in Pacific cultures. In support, Wilson-Hokowhitu (2019) states, “While discovery and exploration are always practices linked with Western science and colonialism, our ancestors were also discoverers and explorers. The worldwide voyage of Hōkūle‘a and Hikianalia is but one

⁶ This term is used here as an inclusive reference to native people, encompassing Pacific individuals.

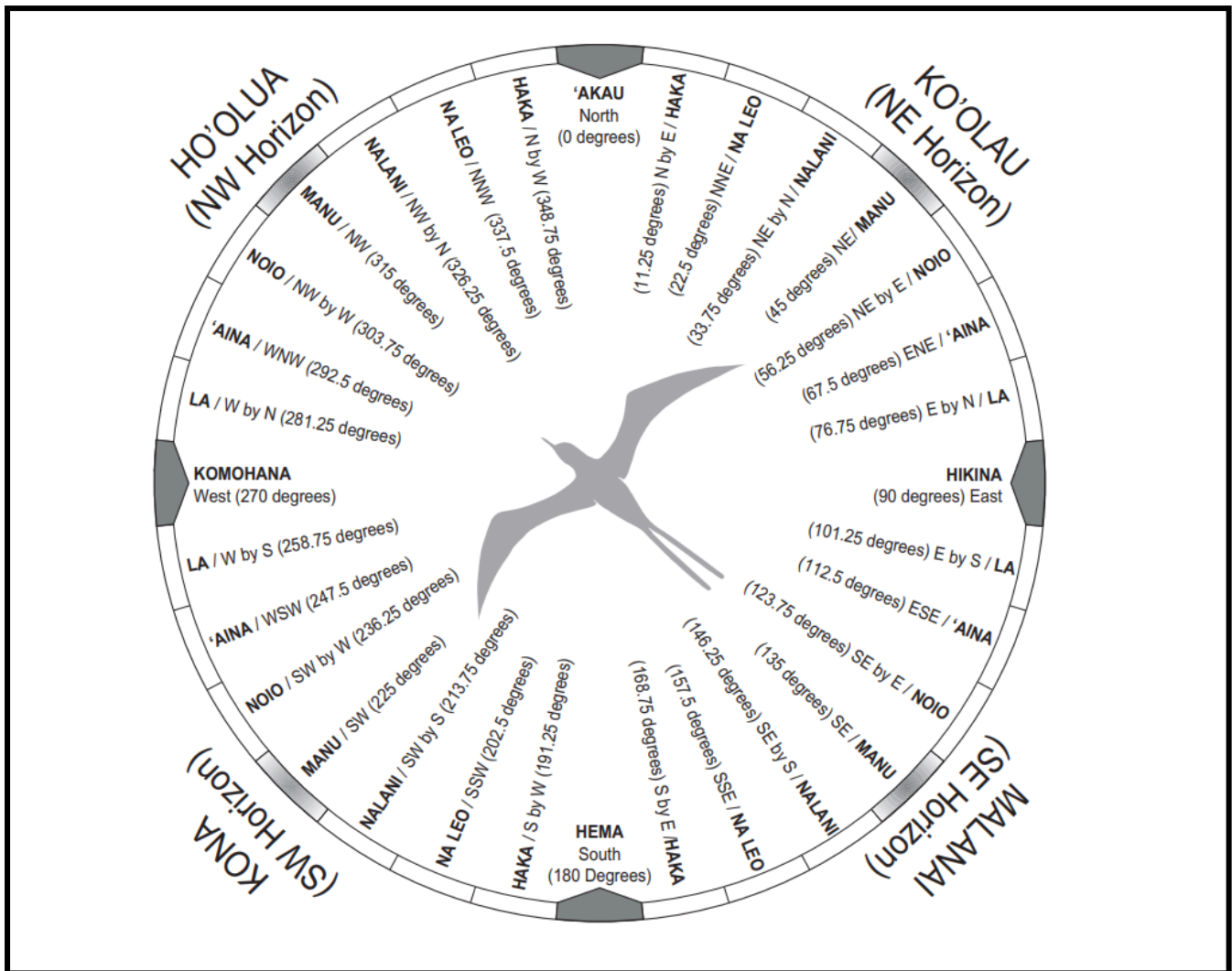
example” (p. 62). In nearly all Indigenous cultures, navigation utilized traditional Pacific methods of non-instrument navigation for wayfinding (Polynesian Voyaging Society, n.d.). Traditional navigation in the Pacific inherently involves skills such as critical thinking, strategic planning, and keen observation. These practices align closely with STEM principles, demonstrating the sophisticated knowledge systems developed by Indigenous navigators. Before the advent of the compass, sextant, clocks, and the modern satellite-dependent Global Positioning System (GPS), Pacific Islanders undertook open-ocean voyages without instruments (ibid., n.d.). Navigators used environmental cues, such as the stars, the sun, ocean swells, and other natural signs, to guide their voyages across the Pacific (ibid., n.d.).

Ka Ho‘okele: Navigate: Pānānā Hoku: Star Compass

One critical tool used in traditional navigation is the star compass. This conceptual tool helps navigators memorize the positions of stars as they rise and set on the horizon. The star compass is divided into houses, each associated with specific stars, helping navigators determine direction and maintain their course at sea (Hawaiian Voyaging Traditions, n.d.). This sophisticated navigation method is a testament to Pacific navigators’ advanced understanding and application of astronomical and environmental knowledge.

The star compass, illustrated in Figure 1, is an essential tool in traditional Pacific navigation, demonstrating the depth of Indigenous astronomical knowledge. Divided into thirty-two segments, or “houses,” each associated with specific stars or star clusters, the star compass aids navigators in identifying directions and maintaining their course during ocean voyages (Hawaiian Voyaging Traditions, n.d.; Polynesian Voyaging Society, n.d.). The outermost circle of the compass represents the horizon, where stars rise and set, corresponding to specific directions (Hawaiian Voyaging Traditions, n.d.). Each of the thirty-two houses marks an azimuth point around the horizon, named after the stars that rise and set at those locations (ibid., n.d.). Additionally, the zenith and nadir, representing the points directly overhead and beneath the observer, help navigators understand their position relative to the stars above and below (ibid., n.d.).

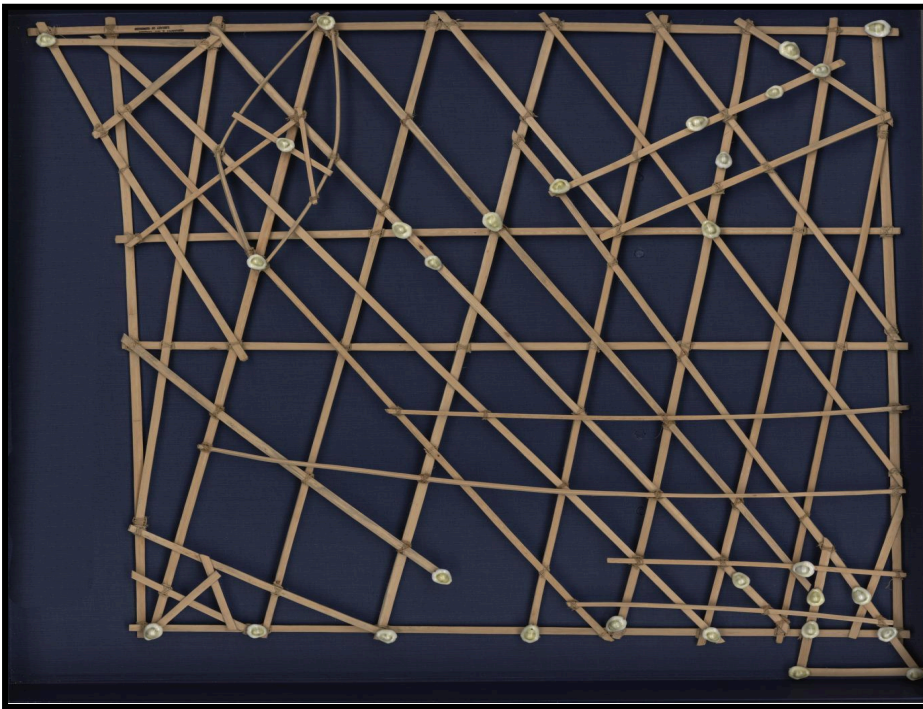
Figure 1: Hawaiian Star Compass



Note: Nainoa’s Hawaiian Star Compass © with English and numerical equivalents in degrees. The distance between compass points is 11.25 degrees; the points mark the center of houses of the same name. The distance to the sides of the house from the center, on either side, is 5.625 degrees (Polynesian Voyaging Society, n.d.). Retrieved from https://archive.hokulea.com/ike/hookele/star_compasses.html and adapted with permission, 2024.

Another notable example of traditional navigation aids is the Marshall Islands stick charts, which represent a sophisticated system of mapping ocean swells, currents, and islands (Knighton, 2020). Made from coconut strips, palm strips, and cowrie shells, these charts were not conventional maps but tools for visualizing the navigational knowledge held by master navigators known as ri-metos (ibid., 2020). The “meddo” charts depict the relative positions of islands and the direction of currents using sticks and shells, while the “mattang” charts illustrate wave refraction and reflection patterns. As seen in Figure 2, these stick charts demonstrate how mapmaking is highly contextual and tailored to the mapmakers' specific navigational needs and environmental understanding (Knighton, 2020; World History Commons, n.d.). Navigators memorized these charts and relied on their senses and ocean knowledge to guide their voyages.

Figure 2: Marshall Islands Stick Chart



Note: This stick chart, created by navigators of the Marshall Islands, uses sticks to represent ocean swells and shells to indicate the positions of islands. The intricate design illustrates wave patterns and currents, crucial for traditional Pacific navigation. This specific example is housed in the Library of Congress. Retrieved from <https://www.loc.gov/resource/g9461p.ct003132/>. Public Domain.

The intricate knowledge these stick charts represent highlights the advanced understanding of oceanography and environmental observation possessed by the Marshallese navigators. This traditional knowledge aligns with modern STEM principles, showcasing how Indigenous practices can inform and enhance contemporary scientific understanding. The star compass and stick charts highlight the sophisticated navigation systems developed by Pacific Islanders, underscoring their advanced knowledge of astronomy, oceanography, and environmental science. These traditional tools facilitated successful voyages across the vast Pacific Ocean and contributed significantly to the body of Indigenous STEM knowledge, demonstrating the integration of cultural practices and scientific principles. Other star compasses across the Pacific, such as those utilized in Māori and Tahitian cultures, continue to be used today, further showcasing these Indigenous navigation systems' enduring relevance and sophistication (Smith, 2012; Makemson, 1941).

Ka Ho'okele: Navigate: Kūkulu Wa'a: Canoe Building

Building canoes is another area where Pacific people have demonstrated exceptional skill and ingenuity. This traditional practice highlights their deep understanding of materials science and engineering and reflects their sophisticated knowledge of hydrodynamics and maritime technology (CLEARING Magazine, 2017). Constructing a canoe is as essential as navigating. According to Hoturoa Barclay-Kerr (2006), the origins of *waka* (canoes) can be traced back to the great voyaging

canoes that brought many ancestors to ANZ. The construction of these canoes was a highly skilled process, involving careful selection of materials and precise craftsmanship...In the past, canoes were used, similar to cars today. Aotearoa's waterways ran along the coast and up rivers like roads...Waka would be paddled along them, carrying people and goods (Barclay-Kerr, 2006). For canoe builders, every detail had to be precise, from the science of finding the perfect tree to use, defining the math of different parts of the vessel, to engineering the proper building techniques (CLEARING Magazine, 2017). The range of designs and building methods was vast. In double-hulled canoes, the two hulls were joined by booms and a decking...Outriggers had just one hull and a float attached to it by two or more booms...Some canoes had hulls built from planks, while others had 'dugout' hulls made from hollowed-out tree trunks (Museum of New Zealand: Te Papa Tongarewa, 2003). Moreover, one of the most rewarding aspects of using the canoe as an educational vessel is discovering and uncovering the myriad ways to integrate canoe building with the curriculum and standards that must be met (CLEARING Magazine, 2017).

For example, constructing an outrigger canoe involves precise measurements and calculations to ensure balance and stability, demonstrating an advanced understanding of geometry and the ability to measure accurately using traditional tools (Ittu, 2015). Builders must understand symmetry and balance, ensuring the canoe is adequately aligned to maintain stability in the water. This process requires calculating the volume of the canoe and understanding water displacement to provide buoyancy (ibid., n.d.). Additionally, accurate angle measurements are critical in attaching the outrigger to the main hull, and builders use their knowledge of ratios and proportions to maintain the correct dimensions and balance. These mathematical principles highlight the sophisticated knowledge systems embedded in the traditional practice of canoe building (ibid., 2015).

Furthermore, traditional canoe construction has deep cultural roots. The voyaging canoe Hōkūle'a, which launched the Polynesian voyaging revival in 1976, was built by referring to old sketches made by European explorers...Its voyage from Hawai'i to Tahiti demonstrated the power of traditional navigation methods (Exploratorium, 2023).

The construction process involves specific rituals and ceremonies to ensure the spiritual well-being of both the canoes and their builders. For instance, Hawaiian culture begins with ceremonial offerings to the forest to seek permission and blessings before taking the tree (ibid., n.d.). Traditional canoe building requires advanced knowledge of science, mathematics, and engineering. For example, constructing an outrigger canoe involves precise measurements and calculations to ensure balance and stability, reflecting an understanding of geometry and water displacement (Ittu, 2015). The

scarcity of suitable trees for canoe building has raised awareness about environmental conservation, emphasizing the importance of sustainable practices and preserving natural resources (Exploratorium, 2023). This shares that traditional canoe building in the Pacific integrates advanced STEM knowledge with deep cultural and spiritual significance, highlighting the sophisticated knowledge systems developed by Pacific Islanders and their relevance in contemporary education and environmental conservation.

Ka Mālama ‘Āina: Environmental Management

Our connection to the elements is critical in STEM. Indigenous researchers emphasize how culture mediates relationships with conceptions of and innovations in technology and technologically related disciplines, highlighting the implications for learning environments (Troxel, 2015). Pacific students can integrate that relationship into their education when learning from the elements in their environment. In a Pacific way of thinking, the relationship with STEM is grounded in *mo‘okū‘auhau*. This viewpoint of ancestral knowledge connects Indigenous people to STEM. Dr. Pualani Kanaka‘ole Kanahēle’s publication, *Ka Honua Ola: ‘Eli‘eli Kau Mai*, states that “mo‘okū‘auhau is a literary introduction to a family lineage. The family line may include humans, elements of nature, sharks, or other forms of life” (Kanahēle, 2011, p. 1). This connection shows that students can learn from natural elements and connect to their mo‘okū‘auhau while understanding the science behind them. Understanding elements such as clouds, weather systems, volcanic activity, the earth, water, trees, and birds is as essential to STEM learning as understanding time and space.

Learning about environmental management through a cultural lens is crucial for Indigenous people because, as Irvine (2021) points out, “landscapes are the storied histories, cosmogonies, philosophies, and sciences of that Indigenous knowledge which are increasingly being pushed aside by the ‘gray uniformity’ of globalization and its progenitor, European colonization” (p. 9). This perspective underscores the integration of traditional ecological knowledge into modern environmental practices.

Furthermore, many Indigenous cultures emphasize the importance of environmental stewardship (Troxel, 2015). Integrating this worldview into STEM education can lead to innovative solutions to modern ecological challenges (Irvine, 2021). This approach fosters a sense of responsibility and empowerment among Indigenous students to contribute to their communities and the world (Troxel, 2015). Students can bring that relationship into their educational experiences by learning from the environment, enriching their understanding, and applying STEM principles (Kanahēle, 2011).

Empirical research supports the positive impact of incorporating culturally relevant content and traditional knowledge into STEM education (McAllister *et al.*, 2020). Programs developed in partnership with Pacific communities that respect local values and knowledge systems have a higher chance of success (Smith, 2012). Experiential and place-based learning approaches effectively connect STEM concepts to the local environment and incorporate hands-on experiences (Yu *et al.*, 2017). This method aligns with Indigenous learning styles and enhances the practical application of knowledge (ibid., 2017).

Promoting Indigenous STEM role models is also crucial. The visibility of successful individuals from Pacific communities in STEM fields positively influences students' aspirations and self-perception (Easthope-Harper, 2018). Limited access to technology in some Pacific regions is a challenge that needs to be addressed (McAllister *et al.*, 2020). Implementing initiatives that improve technology access and connectivity can enhance STEM learning opportunities (Smith, 2012).

Language plays a critical role in effective STEM learning. Research suggests incorporating Indigenous languages where appropriate and recognizing the multilingual nature of Pacific communities to facilitate better understanding. Empowering Pacific communities to lead STEM initiatives ensures that programs are contextually relevant, sustainable, and aligned with community needs and aspirations (Smith, 2012).

Longitudinal studies are necessary to assess the long-term impact of Indigenous STEM initiatives (Airini *et al.*, 2010). Evaluating educational outcomes, career trajectories, and community engagement over time provides a comprehensive understanding of program effectiveness (Smith, 2012). Recognizing the diversity among Pacific cultures is essential, as the effectiveness of STEM education initiatives may vary across different regions (ibid., 2012). Ongoing research, collaboration with Indigenous communities, and incorporating culturally responsive practices are vital for the continued improvement of STEM education for Pacific people (ibid., 2012).

Integrating these traditional methods and perspectives into modern STEM curricula can enrich students' learning experiences, providing a holistic view of science that includes cultural and historical perspectives. This approach broadens the scope of STEM education and honors and preserves Indigenous knowledge systems (Smith, 2012).

Ka Mālama 'Āina: Environmental Management: Loko I'a: Fishponds

Another prime example of knowledge integration is the traditional practice of managing fishponds, a method that has been utilized for centuries by Pacific people (National Oceanic and Atmospheric

Administration [NOAA] Fisheries, 2021-a). Fishponds exemplify traditional ecological knowledge and innovative engineering techniques, aligning closely with modern environmental science and sustainability practices.

The restoration and operation of fishponds by various Pacific communities illustrate the blending of historical practices with contemporary aquaculture methods. These fishponds employ traditional practices to grow multiple marine species, such as clams, sea cucumbers, and edible seaweed, which contribute to the health of the surrounding ecosystem by filtering water and providing habitat for diverse marine species. Restoring the fishponds' natural water exchange systems enhances their functionality and ecological balance (NOAA Fisheries, 2021-b).

Additionally, programs like the Pacific Coastal Fisheries Management and Compliance (PCFMC), funded by the United States Agency for International Development (USAID), showcase the integration of STEM in environmental management (Pacific Community, 2022). The program uses scientific methods to monitor fish populations, assess coastal ecosystems' health, and gather data on illegal, unreported, and unregulated (IUU) fishing activities. Advanced technologies such as satellite tracking and data management tools are crucial in this initiative. Engineering principles are applied to develop sustainable fishing gear and improve infrastructure, while mathematical models predict fish population dynamics and the impact of fishing on ecosystems.

Education and training components emphasize capacity building through STEM education for fisheries officers and community members, integrating traditional knowledge with contemporary scientific approaches (Pacific Community, 2022). Science-based approaches, as highlighted by the Oceanic Institute of Hawai'i Pacific University, are essential for expanding sustainable aquaculture. This includes developing disease-free shrimp populations and using advanced technologies to support domestic aquaculture, promoting local economic and environmental sustainability (NOAA Fisheries, 2021-a). Pacific aquaculture practitioners combine contemporary science with traditional practices to restore and improve fishponds, adapting to today's sustainability challenges. Restoration efforts often involve community members working together to remove sediment and construct rock walls by hand, as was done centuries ago.

Modern research focuses on studying environmental conditions like water quality, climate impacts, and chemistry in fishponds. Traditional weir structures, designed to allow smaller fish to enter and grow within the ponds, now face challenges due to environmental changes. Contemporary science explores partnerships with hatcheries to stock native fingerlings (NOAA Fisheries, 2021-b).

Understanding fishponds through a cultural lens is crucial because, for Indigenous Pacific people, landscapes are storied histories and knowledge systems that inform their relationship with the environment. Traditional practices like fishpond management contribute to our understanding of sustainable environmental practices. Integrating these conventional methods into modern STEM curricula can enrich students' learning experiences, providing a holistic view of science that includes cultural and historical perspectives.

Integrating traditional fishpond practices into modern STEM education is not merely an academic exercise but a vital way to preserve and honor Indigenous knowledge. Learning from these ancient practices gives students a deeper appreciation for sustainability and environmental stewardship. This approach also challenges the often narrow focus of Western science, encouraging a more inclusive and diversified understanding of scientific principles. It is essential to recognize that Indigenous knowledge systems are dynamic and evolving, capable of contributing valuable insights to contemporary scientific and environmental challenges. Thus, embracing these practices within educational frameworks can foster a more holistic and interconnected worldview, benefiting Indigenous and non-Indigenous students.

Ka Mālama 'Āina: Environmental Management: Kūkulu Hale: House Building

Traditional Pacific architecture offers a wealth of knowledge in sustainable building practices deeply intertwined with environmental management and STEM principles. Most Pacific islands' warm and humid environment has led to using organic building materials such as timber, bamboo, cane, grasses, and reeds (Saini, 2007). These abundant and sustainable materials reflect the Pacific peoples' deep understanding of their natural environment and resource management.

Furthermore, traditional structures like the maneaba in Kiribati and the Sāmoan *fale* (house) play a significant role in cultural and social identity. The maneaba, for instance, serves as a meeting house central to community life, providing a space for rituals, ceremonies, and critical social gatherings (ibid., 2007). This integration of cultural significance and practical function demonstrates the holistic approach of Pacific architecture to environmental management.

Initiatives such as establishing a homestead on campus that encompasses sustainability through growing native Hawaiian crops, sheet mulching, and teaching Hawaiian cultural practices like hale building and agriculture provide practical environmental management applications within STEM education. Throughout the school year, students learned various skills such as rock wall building, hale building, and understanding native species and agricultural practices. These activities

demonstrate integrating traditional knowledge and environmental management practices into STEM, fostering a deeper appreciation and understanding of sustainability and cultural heritage (Irvine, 2021).

For instance, the traditional tools used in constructing these buildings, such as adzes made from shells of giant clams and sharpened by hard coral rock, showcase an advanced understanding of material properties and tool-making techniques (Saini, 2007). These tools and methods highlight the ingenuity and resourcefulness of Pacific peoples in their architectural practices.

Understanding the cultural and ritual significance of these structures is also crucial. The “maneaba,” for example, is not just a building but a sacred space that holds the community’s historical and spiritual heritage. Similarly, the Samoan “fale tali malo,” the stage for all island ceremonies, emphasizes the importance of traditional architecture in maintaining cultural continuity and community cohesion (Saini, 2007).

Ka Lā‘au Lapa‘au: Medicine

The historical contributions of Pacific peoples to STEM fields extend significantly into health sciences, particularly through traditional medicine and healing practices that demonstrate a profound understanding of health and wellness. These practices predate many Western medical discoveries and offer holistic approaches to health, engaging individuals' mental, emotional, physical, and spiritual well-being (Easthope-Harper, 2018).

For instance, the *‘Ala Mo‘ui: Pathways to Pacific Health and Wellbeing 2014-2018* document highlights the importance of traditional medicine, noting that “their use of traditional Pacific medicine and healing can also influence the way that Pacific peoples use health care services in New Zealand” (Ministry of Health, 2014, p. 23). This underscores the continuing relevance and impact of Indigenous knowledge on contemporary health practices.

Traditional Pacific medicine encompasses many treatments and preventative measures, often rooted in a holistic approach to health. These methods, which include using plants, massage, diet, and spiritual practices, have been passed down through generations, preserving a rich legacy of Indigenous knowledge (Elkington, 2018). The *Pacific Health Dialog* further explores how traditional medicine has been practiced over many years and continues to be used by Pacific peoples after migrating to New Zealand. This study highlights the holistic approach of conventional medicine, incorporating plants, massage, diet, family togetherness, and spirituality (Wilson *et al.*, 2018). It underscores the importance of understanding and integrating traditional knowledge into health

professional education to improve care for Pacific communities (ibid., 2018).

Additionally, traditional medicine practices showcase a deep knowledge of local flora and their medicinal properties. Using medicinal plants in traditional healing practices often involves extensive knowledge of pharmacology and botany, aligning closely with modern scientific principles (DaSilva *et al.*, 2004). For example, traditional Pacific healers utilize various plants known for their healing properties, demonstrating an advanced understanding of natural pharmacology. Integrating these conventional practices into modern healthcare frameworks validates the scientific principles inherent in Indigenous knowledge and provides culturally appropriate care for Pacific communities.

This ongoing influence of traditional Pacific medicine exemplifies the scientific and technological prowess embedded within Pacific cultures. It showcases how Indigenous knowledge systems can complement and enhance modern scientific practices, particularly in health sciences. The synergy between traditional and contemporary practices highlights the importance of integrating Indigenous knowledge into modern STEM education, fostering a more inclusive and diverse scientific community. Recognizing and incorporating these conventional methods into contemporary health frameworks not only enriches the field of health sciences but also ensures that culturally relevant and effective care is accessible to Pacific communities.

3.5 Nā Kumu Ho‘ohālike: Role Models

Role models play a crucial role in shaping the aspirations and successes of Indigenous and Pacific students in STEM. They provide tangible examples of success and resilience, demonstrating that achieving excellence in these fields is attainable. According to Easthope-Harper (2018), if several great role models surround Pacific students, they will likely learn some of the traits and values needed to achieve specific aspirations. This shows students that success in these areas is possible and valued within their communities. Furthermore, representation in STEM fields plays a vital role as Indigenous students often lack role models who share their cultural background, which can affect their aspirations.

Role models influence not only academic achievement but also personal and professional development. Embodying their communities' values, traditions, and perseverance, these individuals inspire confidence and self-belief in students. Role models with similar cultural backgrounds validate the students' potential and aspirations, fostering a sense of belonging and possibility (Easthope-Harper, 2018). Furthermore, McAllister *et al.* (2020) emphasize that the visibility of Pacific scientists as role models increases students' interest in pursuing science. Their study

demonstrates that the presence of Pacific academics positively affects the academic success of Pacific students by creating safe spaces through mentorship, nurturing relationships, and providing culturally appropriate supervision and teaching activities. Furthermore, Pacific students and early career researchers thrive when given opportunities to build relationships with Pacific peoples in education, enhancing their sense of belonging, support, and mātauranga (ibid., 2020).

Highlighting stories of successful Pacific scientists and engineers can inspire the next generation. One example of this is Kiriana's story. Kiriana, a young Pacific scientist, overcame numerous obstacles to succeed in her field. Her journey is a testament to the resilience and potential of Pacific students when given the right opportunities and support. Kiriana's story, detailed by the Ministry for Pacific Peoples, underscores the importance of representation and role models in STEM. She shared how seeing someone who looked like her in a position of success inspired her to pursue a career in science. This story illustrates that when Pacific students see themselves reflected in successful figures, it can significantly boost their confidence and aspirations (Ministry for Pacific Peoples, 2020).

Moreover, role models challenge stereotypes and broaden students' understanding of what is possible within STEM fields. They serve as mentors, offering guidance, career advice, and support networks essential for personal and professional growth (McAllister et al., 2020). By highlighting successful Pacific scientists' stories and role models' broader impact, this section underscores the importance of visibility and representation in fostering a more inclusive and supportive educational environment for Pacific students.

3.5.1 Ke Ko'iko'i o nā Kumu Ho'ohālikema STEM: The Importance of Role Models in STEM
Role models are essential for Indigenous and Pacific students as they provide tangible examples of success and resilience in fields where these students are underrepresented. Easthope-Harper (2018) emphasizes the impact of role models on student aspirations and success, noting that visible role models can significantly increase students' interest in pursuing science and STEM careers. Easthope-Harper further elaborates that ancestral language and arts are a conscious decision not to forget the traditions, beliefs, and practices of our *kūpuna*. They recognize their *kūpuna* as the embodiment of the culture they created, looking to them as role models to actively uphold, honor, protect, and defend. This is a matter of *mo'okū'auau* (genealogy), *aloha 'āina* (love of the land), and *kuleana* (responsibility) that motivates them (p. 59).

Beyond academic success, role models are crucial in personal and professional development. They inspire confidence and self-belief, helping students to envision themselves in successful careers

(Bandura, 1997). Seeing someone who shares their background and culture in a position of authority and expertise validates their potential and aspirations (Lockwood, 2006). This validation is significant for students who may feel marginalized or underrepresented in their academic environments (Marx & Goff, 2005)

Role models also provide mentorship and guidance, offering insights into navigating academic and professional challenges. They can share their experiences, provide career advice, and offer support networks vital for personal and professional growth. Doing so, they help students develop essential skills such as leadership, resilience, and critical thinking, which are crucial for success in STEM fields and beyond.

The presence of role models who share similar cultural and genealogical backgrounds helps students envision themselves in these roles, fostering a sense of belonging and possibility. McAllister *et al.* (2020) argue that the visibility of Pacific scientists as role models is crucial for increasing students' interest in science.

Additionally, the *Health Quality & Safety Commission New Zealand* (2021) report, “*Bula Sautu: A Window on Quality 202: Pacific Health in the Year of COVID-19*,” highlights the importance of visibility and representation in healthcare settings. Increased visibility of Pacific healthcare professionals improves patient outcomes and encourages Pacific youth to consider careers in health and STEM fields.

The importance of role models extends beyond individual success stories. It is about creating a cultural narrative that values and recognizes Indigenous knowledge systems. When students see people who look like them and share their cultural background in positions of scientific authority, it challenges stereotypes and broadens their understanding of what is possible.

3.5.2 Nā Mo‘olelo Pōmaika‘i o ka Po‘e Pākīpika: Stories of Successful Pacific Scientists ***Ko Kiriana Mo‘olelo: Kiriana’s Story***

Highlighting stories of successful Pacific scientists can inspire and motivate students to pursue STEM careers. These narratives provide students with relatable and inspiring examples, demonstrating that success is attainable despite challenges. The Ministry for Pacific Peoples has highlighted one such example of a success story:

As mentioned briefly in the Research Rationale section, Kiriana Andrews exemplifies success and perseverance in STEM, inspiring Pacific students. As a recipient of the Toloa Tertiary Scholarship,

Kiriana is passionate about leveraging her Engineering degree to aid Pacific nations in developing their infrastructure. She aspires to use her skills through organizations like Engineering Without Borders to enhance the capabilities and resilience of countries across the Pacific (Ministry for Pacific Peoples, 2020).

Identifying as a New Zealander and Cook Islands Māori, Kiriana is committed to sharing her journey to motivate more Pacific students to pursue engineering degrees (Ministry for Pacific Peoples, 2020). Her story begins in Blenheim, where she attended Marlborough Girls' College before moving to Christchurch to study a Bachelor of Civil Engineering with Honors. Kiriana's interest in STEM was sparked by her success in high school subjects like Physics, Chemistry, and Calculus (Ministry for Pacific Peoples, 2020).

Kiriana's academic journey has been marked by determination and cultural pride. Despite the challenges of navigating a predominantly Western-centric academic environment, she has thrived, securing a position as a Structural Undergraduate Engineer focused on bridges. Her long-term goal is to lead large bridge projects, demonstrating her ambition and commitment to significantly impacting her field (Ministry for Pacific Peoples, 2020).

Receiving the Toloa Tertiary Scholarship has been pivotal in supporting Kiriana, alleviating financial stress, and allowing her to focus on her studies. The scholarship, part of the Ministry for Pacific Peoples' Toloa program, aims to increase Pacific student participation in STEM through financial support and community engagement (Ministry for Pacific Peoples, 2020).

Kiriana's achievements, including her recognition by the Ministry for Pacific Peoples, highlight the importance of perseverance, cultural pride, and community support in achieving success in STEM. Her story is a powerful example for other Pacific students, showing that with determination and the right support, they, too, can excel in STEM fields and contribute to their communities (Ministry for Pacific Peoples, 2020).

This is just one success story of Pacific people in STEM, demonstrating that Pacific people have already paved the way for future generations. Their achievements underscore the potential and capabilities within Pacific communities, proving that cultural heritage and modern scientific pursuits can coexist and thrive together. The impact of role models like Kiriana extends beyond individual achievements. Established professionals such as Dr. Sione Tu'itahi, who has significantly contributed to public health, and Dr. Damon Salesa, an acclaimed historian and academic leader, further illustrate the vital role of Pacific role models in inspiring and leading the way (Tu'itahi as cited by Dale

Husband, 2022; Salesa, 2017). They contribute to developing a diverse and culturally competent workforce, particularly in critical sectors like healthcare. This brings us to the next section, exploring Pacific professionals' growing representation and success in the health workforce.

3.5.3 Ka Po'e Pākīpika ma ka 'Oihana Pacific People Thriving in STEM Careers

Pacific people in ANZ are increasingly entering and thriving in STEM-related careers. Initiatives such as the *Toloa Program* encourage Pacific students to consider STEM careers through scholarships and mentorship. The Ministry for Pacific Peoples has also established programs to integrate Pacific values with STEM education, emphasizing the importance of community and cultural relevance (Ministry of Health, 2014). These programs aim to address the socio-economic barriers that Pacific students face by providing financial support, mentorship, and networking opportunities. The success of these programs is evident in the increasing number of Pacific students pursuing and succeeding in STEM careers.

Moreover, the efforts to support Pacific students in STEM are part of a broader workforce strategy to enhance diversity and inclusion. Focusing on culturally relevant education and support systems, these initiatives help ensure Pacific students have the resources and opportunities to thrive.

One significant initiative is the *Toloa Program*, which provides scholarships and mentorship to Pacific students pursuing STEM fields. This program has been instrumental in helping students overcome financial barriers and access the support they need to succeed in their studies (Ministry for Pacific Peoples, 2020). The Ministry for Pacific Peoples has also developed community-based programs integrating Pacific cultural values with STEM education, fostering a sense of belonging and relevance for Pacific students (Ministry for Pacific Peoples, 2020).

These efforts are part of a broader strategy to enhance diversity and inclusion in the STEM workforce. By creating supportive and culturally relevant educational environments, these initiatives help ensure that Pacific students enter and thrive in STEM careers. The success of these programs is reflected in the increasing number of Pacific students pursuing and excelling in STEM fields, demonstrating the effectiveness of targeted support and culturally inclusive education.

The growing representation of Pacific professionals in STEM careers highlights the impact of targeted support programs and culturally relevant education. By addressing socio-economic barriers and fostering a sense of community and cultural pride, these initiatives help Pacific students achieve their full potential. The success of these programs underscores the importance of continuing to develop and expand support systems that empower Pacific students to thrive in STEM fields.

By focusing on individual stories of success and broader systemic efforts, we can see how integrating cultural values and targeted support can create pathways for Pacific students to excel in STEM. This holistic approach is essential for developing a diverse and inclusive STEM workforce, benefiting students and the wider community.

3.5.4 Kūkulu ‘Oihana Olakino: Health Workforce Development

The health workforce in New Zealand has seen a growing number of Pacific professionals thriving in STEM-related careers. The Ministry of Health's *‘Ola Manuia: Pacific Health and Wellbeing Action Plan 2020-2025* outlines several initiatives to support Pacific people in the health sector. These initiatives include scholarships, mentorship programs, and community support systems to encourage Pacific students to pursue careers in health and other STEM fields (Ministry of Health, 2020).

Nā Papahana a Kānāwai Kiko‘ī: Specific Initiatives and Programs

One significant initiative is the *Toloo Tertiary Scholarships*, part of the Ministry for Pacific Peoples' Toloo program. This program provides financial support to Pacific students pursuing STEM-related studies. In 2020, the initiative received an additional \$4.9 million in funding, allowing it to double the number of scholarships offered. This resulted in 50 scholarships awarded, \$10,000 per academic year for outstanding undergraduate and postgraduate Pacific students (Ministry for Pacific Peoples, 2020). This financial support has been crucial in reducing the financial burden on Pacific students, allowing them to focus on their studies and excel academically.

Mentorship programs like the Pūhoro STEM Academy are vital in supporting Māori and Pacific students. The Pūhoro STEM Academy provides personalized mentorship and community engagement, building relationships with over 90 *iwi* (tribes), 60 *kura* (schools), and 2000 *rangatahi* (young people) across seven regions of Aotearoa (NZQA, 2023). This program has significantly increased student engagement and success in STEM fields, demonstrating the importance of mentorship and support systems.

Community support systems are another critical component of the Toloo program. These initiatives emphasize culturally relevant education and community involvement, helping students connect their learning with their cultural heritage. By involving families, elders, and community leaders, these programs provide a network of support that fosters student success.

The *STEMS2* program at the University of Hawai‘i is another example of a successful initiative. This program integrates Indigenous knowledge with STEM education, providing a holistic approach that includes environmental stewardship and community-based learning (College of Education, n.d.). The

program's focus on culturally relevant pedagogy has been instrumental in supporting Pacific students' academic and personal growth.

Additionally, the South Pacific Form Seven Certificate (SPFSC) highlights the increasing number of Pacific girls studying science. This trend reflects the positive impact of targeted educational programs and the growing recognition of the importance of STEM education for Pacific women (Pacific Community, 2021).

Additionally, a participant in the Pūhoro STEM Academy said, “Pūhoro has had a massive impact on my well-being. My perspective on science has been expanded. I’ve not only learned so much, but I’ve also made so many friends for this program” (NZQA, 2023). Similarly, Kiriana Andrews, a Toloa Tertiary Scholarship recipient, shared, “Being awarded the Toloa Tertiary Scholarship and being recognized by the Ministry for Pacific Peoples has given me a huge sense of pride and accomplishment. I recommend that all Pacific students investigate STEM-related subjects and apply for the Toloa Tertiary Scholarship” (Ministry for Pacific Peoples, 2020).

Ka Pōmaika‘i: Impact and Success

The impact of these initiatives is evident in the increased enrollment and graduation rates of Pacific students in health-related STEM programs. According to the Ministry of Health (2020), there has been a noticeable rise in Pacific students enrolling in and graduating from these programs, attributed to the financial and mentorship support provided by initiatives like the Toloa program.

Reports from the Medical Council of New Zealand (2020, 2021a, 2021b) and the Midwifery Council (2021) highlight improvements in workforce diversity. These reports emphasize the importance of targeted recruitment, cultural competency training, and support systems for Pacific students and professionals. Diverse and culturally competent workforces in medical and health education settings improve healthcare delivery and patient outcomes by ensuring that cultural contexts are understood and respected.

The Nursing Council of New Zealand (2021) and the Dental Council (2022) have also developed strategies to support Pacific students and professionals. These strategies include providing resources for cultural training and creating pathways for career advancement. Enhancing cultural competency and career support, these organizations help Pacific professionals advance in their careers while maintaining their cultural identity.

Providing comparative data showing improvements over time in Pacific representation in the health workforce highlights the success of these initiatives. For example, the Nursing Council of New Zealand (2020) reported a 15% increase in Pacific nursing graduates over the past five years, attributed to targeted recruitment and support programs. Similarly, the Medical Council of New Zealand (2021) noted a 10% increase in Pacific medical graduates, demonstrating the positive impact of their initiatives.

Nā 'Ikepili Kāko'o: Supporting Data and Statistics

The *Toloa Tertiary Scholarship* has supported over 200 Pacific students since its inception, significantly reducing the financial burden on these students and allowing them to focus on their studies (Ministry for Pacific Peoples, 2020). The *Pūhoro STEM Academy* reports a 90% retention rate for its participants, indicating the effectiveness of its mentorship and support systems in keeping students engaged and on track to complete their STEM education (NZQA, 2023).

According to the STEMS2 program, integrating Indigenous knowledge with STEM education has increased engagement and academic achievement among Pacific students (College of Education, n.d.). The Secretariat of the Pacific Community (SPC) also reports that almost half of the year 13 South Pacific Form Seven Certificate students enrolled in physics, biology, and chemistry in 2020 were female, indicating a significant increase in Pacific girls studying science (SPC, 2021).

These efforts are crucial because a diverse workforce improves cultural competency in healthcare and is a powerful motivator for Pacific students to pursue careers in STEM. The visibility of Pacific professionals in these fields demonstrates that success is achievable and that their cultural heritage is valued in scientific and medical communities. These initiatives support academic and professional success and foster a sense of belonging and empowerment among Pacific students, helping to build a more inclusive and competent health workforce.

By providing financial support, mentorship, and culturally relevant education, these programs ensure Pacific students have the resources and opportunities to thrive in STEM fields. The success of these initiatives highlights the importance of continued investment in culturally inclusive educational practices and support systems.

3.5.5 Nā Kāko'o: Support Systems

Kāko'o Kaiāulu: Community Support

Community involvement is vital in supporting Pacific students in STEM. Programs that engage community members and utilize cultural practices help students connect their learning with their

heritage. For instance, the *ahupua'a* system exemplifies how traditional knowledge and community support create a balanced environment for growth. Engaging community members in educational initiatives, such as those highlighted in the *Getting Pacific Parents Behind STEM* program, fosters a supportive learning atmosphere (Adult and Community Education, n.d.).

The *Talanoa Ako* report emphasizes the importance of community involvement in educational initiatives, noting that cultural practices and community engagement enhance learning experiences for Pacific students. Such involvement helps create an environment where students can thrive academically while maintaining a strong connection to their cultural heritage (Ministry of Education, 2021).

Kāko'o 'Ohana: Family Involvement

Family involvement significantly impacts student success by encouraging and supporting their educational pursuits. Programs like *Getting Pacific Parents Behind STEM* highlight the critical role of parental support in motivating Pacific students to pursue STEM subjects and careers. Engaging families in their children's education fosters a deeper connection to cultural heritage and promotes academic excellence (Adult and Community Education, n.d.).

The *Talanoa Ako* report underscores the significant role of the family in education, demonstrating that parental involvement and support are pivotal for academic success and cultural retention among Pacific students. The program encourages family engagement in learning processes, positively impacting student outcomes (Ministry of Education, 2021).

Kāko'o Ho'ona'auao: Educational Support

Educational institutions play a crucial role in providing support systems for Pacific students. Te Whare Wānanga o Waikato offers services, including mentoring, peer tutoring, and workshops, to support Māori and Pacific learners academically and culturally (University of Waikato, 2023). Additionally, councils like the Midwifery Council and the Nursing Council of New Zealand emphasize cultural competency training and mentorship programs to help Pacific students navigate their educational journeys and transition into professional roles (Midwifery Council, 2021; Nursing Council of New Zealand, 2020).

The *Pūhoro STEM Academy* provides a robust support system through personalized mentorship, academic resources, and community engagement. It fosters a supportive environment for Māori and Pacific students in STEM and has been instrumental in increasing student engagement and success in STEM fields (Pūhoro, 2020).

These support systems are essential for integrating Indigenous Pacific knowledge within STEM-related fields. By fostering community involvement, family support, and educational initiatives, these programs ensure Pacific students can thrive academically while maintaining a strong connection to their cultural heritage. This holistic approach enhances academic success and promotes integrating Indigenous knowledge into STEM education, contributing to a more inclusive and culturally relevant educational framework.

3.5.5.1 Kāko‘o ma Waikato: University of Waikato Support

The University of Waikato has implemented several programs and initiatives to address the barriers faced by Pacific students in STEM fields. Key examples include the Pacific Student Development Fund, FoE (Future/Family of Excellence) High School STEM Program, Imua Initiative, and Palu Undergraduate Navigators⁷.

The Pacific Student Development Fund provides financial support for Pacific students to engage in activities that enhance their educational experience, including conferences, workshops, and extracurricular activities (University of Waikato, n.d.-a). This fund is critical in alleviating financial burdens and enabling students to access opportunities that broaden their academic and professional horizons, thus fostering deeper engagement with STEM fields.

Ka Ho‘olālā Ho‘ona‘auao Pākīpika: Pacific Strategic Plan

The Pacific Strategic Plan at the University of Waikato outlines comprehensive objectives and initiatives to support Pacific learners and staff. The plan aims to demonstrate and grow leadership on Pacific success, illuminate success pathways, deliver substantive outcomes, promote high-quality teaching and learning support, foster lifelong success, value and attract Pacific staff, and grow Pacific researchers and research excellence (University of Waikato, 2021).

Key components of the plan include community engagement, next steps, and acknowledging challenges: Building strong connections between the university and Pacific communities to ensure that educational programs meet the needs of Pacific students. This involves collaborative efforts with community leaders, families, and local organizations to create a supportive learning environment (University of Waikato, 2021). Moreover, the strategic plan emphasizes continuous improvement and adaptation of support systems to serve Pacific students better. This includes expanding mentorship programs, increasing financial support opportunities, and enhancing cultural competency training for staff and students. The University will work with central and local government, schools, training

⁷ These programs will be further explained in the F.O.E Program chapter of the thesis.

establishments, tertiary providers, Pacific community organizations, and other relevant stakeholders to innovate and collaborate on Pacific learner success (University of Waikato, 2021). Additionally, the plan acknowledges several challenges, such as overcoming systemic barriers, addressing the digital divide, and ensuring sustainable funding for support programs. It highlights the need for ongoing commitment and collaboration between the university and Pacific communities to address these challenges effectively (University of Waikato, 2021).

The plan's ongoing purpose is *Imua*— to go forward and lead from the front in terms of Pacific learner, staff, and community success. Implementing the Objectives will enhance a culture of belonging for Pacific students, staff, and people, especially one that nurtures Pacific success, equity, diversity, inclusivity, and community. Like the Pacific navigators and voyagers of the past, the university will be bold, courageous, clever, innovative, and collaborative in its efforts to create transformative progress and change (University of Waikato, 2021).

The University supports the Government in its education priorities, including putting learners at the center of education, barrier-free access, quality teaching and leadership, a future of learning and work, and world-class, inclusive public education. It supports the Government's ambitions to create more equitable outcomes for Pacific learners through evidence-based approaches. Consistent with its Investment Plan, the University is also committed to improving rates of participation, retention, and completion (University of Waikato, 2021).

3.6 Ke Ao Hou: Future Directions and Recommendations

This section summarizes key findings from the literature review, identifies gaps in existing literature, and explains how the research aims to address these gaps. It includes discussions on future research directions, practical implications, and personal reflections. Future research should explore integrating Indigenous knowledge in other STEM-related fields beyond the current focus. One potential area is health, particularly traditional medicine, which holds significant cultural importance in Pacific communities. Investigating how traditional medicinal practices can be integrated into modern healthcare and STEM education can provide a holistic approach to health and well-being. Additionally, research should focus on longitudinal studies to track the long-term impacts of culturally relevant STEM education programs on Pacific students' academic and career outcomes. Another important direction is developing and assessing new pedagogical models that seamlessly blend Indigenous knowledge with STEM curricula.

The findings from this literature review have significant practical implications for educators,

policymakers, and Pacific communities. Educators should be encouraged to incorporate culturally relevant materials and methods into their teaching to foster a sense of belonging and engagement among Pacific students. Policymakers need to recognize and support the unique educational needs of Pacific students by implementing policies that promote inclusivity, diversity, and equity in STEM education. For Pacific communities, maintaining and integrating cultural heritage within the educational framework cannot be overstated. By doing so, they can ensure that their young people succeed academically and retain a strong connection to their cultural roots. Community-led initiatives and partnerships between educational institutions and Pacific communities can further enhance these efforts.

3.7 Ka Pani: Summary

In conclusion, this literature review has highlighted the current state of Pacific representation in STEM, the barriers Pacific students face, and the initiatives and strategies supporting their success. The findings underscore the importance of culturally relevant education, community engagement, and supportive policies. Key takeaways from the review include the critical role of family and community support systems in fostering academic success, the need for culturally responsive teaching practices, and the positive impact of targeted support programs like those at the University of Waikato. These insights provide a solid foundation for the next phase of this research, which will delve into the methodologies used to investigate further and address these critical issues.

As we transition to the next chapter, the methodology section will outline the research design, data collection, and analysis methods employed to explore these themes in greater depth. By continuing to investigate and implement these strategies, we aim to create a more inclusive and supportive environment for Pacific students in STEM. Ultimately, this will contribute to a more diverse and innovative scientific community, enriching the field with various perspectives and knowledge systems.

By taking these steps, we can move towards a future where Pacific students are represented and excel in STEM fields, bringing the richness of their cultural heritage and contributing to the global scientific landscape.

Mokuna ‘Ehā: Chapter Four Ka Papahana F.o.E: F.o.E Program

4.1 Ka Papahana FoE: FoE High School STEM Program

The Future/Family of Excellence (FoE) High School STEM Programme collaborates with local high schools and teachers to enhance STEM studies and career knowledge among Pacific high school students and their parents. University of Waikato students act as Navigators, sharing cultural legacies, degree and qualification information, and their enthusiasm for STEM learning. This program demystifies STEM fields and encourages Pacific students to pursue STEM education by showcasing relatable role models and practical applications of STEM knowledge (University of Waikato, n.d.).

This chapter includes three figures featuring photos from the FoE program, which can be seen at the end, to visually enhance the understanding of the program's impact and activities. These images illustrate students' engagement in learning activities and the interaction between Navigators and high school students, providing a vivid representation of the program's success and impact on the participants.

4.1.1 He Aha Ka Mea E Hana Ai?: What Happens?

Each term, the Pacific at Waikato FoE team meets for training before the official start of the FoE program. The training includes meeting the team members, reviewing the program overview, sharing ideas and thoughts, going through schedules and weekly themes, and understanding our roles and responsibilities.

The program lasts eight to ten weeks per term, following the high school calendar year. We attend each school for an hour each week while providing food for the students. Every week involves different STEM-related themes that align with the STEM courses and fields offered at the University of Waikato. For example, in the past term, week one focused on climate change. We shared information about the university's bachelor's degree in climate change and related it to the students. The learning activity involved group discussions on what they know about climate change, its impact on the Pacific, and potential solutions they could learn about if they pursued this major.

This is just a glimpse of one week in the FoE program. The main objective is to connect Pacific students to STEM and their identity as Pacific descendants, fostering their knowledge and reminding them that their ancestors have always been scientists, technologists, engineers, and mathematicians.

At the end of each FoE program week, the FoE Navigators hold meetings to review the week's activities, student engagement, and delivery of information on scholarships and STEM majors, and discuss improvements for the following week. Additionally, a field trip is organized at the end of the program. This past term, students visited the health sector of the university, where they engaged in hands-on activities like analyzing the causes of viruses.

4.1.2 'O Wai Nā Kānaka?: Who is Involved?

The program involves University of Waikato students pursuing STEM-related courses or majors such as exercise health, engineering, and public health. These university students, who also have Pacific backgrounds, work under the Pacific at Waikato department (University of Waikato, n.d.).

The FoE program also includes high school students from five schools within Hamilton: Fraser High School, St. John's College, Hamilton Girls High School, Hillcrest High School, and Sacred Heart College Hamilton. These students are aged 10 through 13 and are of Pacific descent or part of their schools' Pacific clubs/organizations. They come from Pacific nations such as Fiji, Tonga, Tokelau, Sāmoa, Kiribati, Niue, Tuvalu, etc. (University of Waikato, n.d.).

In addition to university and high school students, the program engages high school teachers who play a critical role in supporting and mentoring students. These teachers help integrate culturally responsive teaching practices into the curriculum and provide additional support to Pacific students. Their involvement ensures that the educational activities are relevant and engaging for the students (University of Waikato, n.d.).

The Waikato Teachers Association also plays a vital role in the program. The Waikato Teachers Association supports professional development opportunities for teachers involved in the FoE program, fostering a collaborative environment where teachers can share best practices and strategies for engaging Pacific students in STEM education. This collaboration helps create a supportive network that enhances the program's overall effectiveness (University of Waikato, n.d.).

Through the combined efforts of university students, high school students, teachers, and the Waikato Teachers' Association, the FoE program aims to create a holistic and culturally responsive learning environment that supports the academic and personal development of Pacific students in STEM fields (University of Waikato, n.d.).

4.1.3 Nā Kuleana: Role of Navigators

The FoE Navigators play a crucial and multifaceted role within the educational framework of the program. Their responsibilities extend beyond simple administrative tasks, as they are deeply involved in fostering a supportive and engaging learning environment for students. One of their key duties is the thoughtful planning and organization of learning activities, which includes a range of ice-breakers designed to build camaraderie and ease the transition into the program. These activities are carefully crafted to introduce students to the program and create a sense of community and belonging. In addition to these interactive elements, Navigators are also tasked with disseminating essential information related to academic and financial opportunities. They provide detailed guidance on available scholarships and financial aid, ensuring students are well-informed about the resources available. This support is critical in helping students navigate their education's often complex financial aspects.

Ultimately, the Navigators are dedicated to supporting student success and engagement within the program. Their role is integral to ensuring that students thrive academically and feel connected and supported throughout their educational journey. Their contributions are essential to the overall effectiveness of the program and to the positive experiences of the students they serve (University of Waikato, n.d.).

4.1.4 Nā Hana No‘eau: The Learning Activities

Each week focuses on STEM-related activities that typically take 15 to 30 minutes to complete, with materials provided by the FoE team. When planning the activities, we focus on duration, STEM focus/activity, career relation, and Pacific relation. Specific examples include:

- **Life Science: Respiratory and Health:**
 - **Activity:** Creating a model lung.
 - **Duration:** 20 minutes.
 - **Career Relation:** Physician, registered nurse, respiratory therapist.
 - **Pacific Relations:** Importance of health in Pacific communities.
- **Engineering and Computer Science:**
 - **Activity:** Building a robot hand.
 - **Duration:** 20 minutes.
 - **Career Relation:** Mechanical engineer, technologist, roboticist.
 - **Pacific Relation:** Utilizing natural materials to build something new.
- **Human Biology and Health:**

- **Activity:** Analyzing fats in fried and baked chips.
- **Duration:** 20 minutes.
- **Career Relation:** Nutritionist, food science technician.
- **Pacific Relations:** Importance of healthy nutrition for Pacific communities.

These activities are designed to engage students in STEM while connecting to their cultural heritage. At the end of the program, students provide feedback on their experiences, often highlighting the enjoyment of working together, using critical thinking, and seeing themselves in the Navigators (University of Waikato, n.d.).

4.1.5 Nā Ana Mana‘o: Reflections on Aspects of the Program

As both a researcher and mentor for the FoE program, I have observed the significant impact of support on students. Integrating cultural knowledge with STEM activities helps students realize they do not need to separate their identity as Pacific people from being scientists. Witnessing the program’s success, I envision its profound impact if expanded and integrated into STEM fields at Waikato University.

This first full year of the FoE program was a success, with additional schools participating and notable growth among students. The program has fostered bonds and opportunities, allowing me to mentor Pacific students and build connections with the FoE team. I did not anticipate the program’s impact on me as a Pacific university student, highlighting the importance of support and cultural identity in STEM fields (University of Waikato, n.d.).

4.1.5.1 Nā Ana Mana‘o Haumāna: Student Reflections

Students have expressed that participating in the FoE program has significantly impacted their academic and personal growth. Many have shared that one of the most valuable aspects of the program is how it demonstrates the connections between STEM and their cultural heritage. This cultural integration has allowed them to see STEM not just as a set of abstract concepts, but as a field that can be deeply relevant and meaningful within their lives and communities. This connection has made their educational journey more enriching and personally fulfilling.

Additionally, students have noted that the program has helped them break out of their shells and form strong bonds with their peers. The collaborative nature of the activities encourages interaction and teamwork, fostering a sense of camaraderie among the participants. They also appreciate the hands-on experiences provided, which allow them to step into the shoes of a STEM major and

envision themselves pursuing careers in these fields. Moreover, students have expressed gratitude for the relatability of the staff, who share similar Indigenous Pacific backgrounds, and for the financial resources made available through the program, which have alleviated some of the burdens associated with pursuing higher education.

4.2 Tupaia Challenge: Celebrating Pacific Cultures

The legendary Tahitian warrior-scholar, Tupaia, courageously navigated and explored a changing world. Today's Pacific youth face a challenging and exciting world of opportunities, including university study and careers. The University of Waikato and the Waikato Pasifika Teachers Association co-sponsored the Tupaia Challenge. This three-day event provides Pacific high school students opportunities to learn more about university study and careers while having fun competing in *kilikiti* (Samoan cricket), cultural performance, and oratory competitions. Just as Tupaia's knowledge of navigation and the stars was essential for exploration, the skills and insights gained through the Tupaia Challenge equip students to navigate their educational and career paths. Thus, the event connects the wisdom of the past with the possibilities of the future, inspiring students to chart their course of success. At the same time, high schools compete against each other for the ultimate prize (University of Waikato, n.d.).

4.3 Āiga on Campus: Partnering with Pacific Families

Pacific learners represent the aspirations of families, communities, and nations. The new *Āiga On Campus Program* recognizes the crucial role that Pacific families can play in the success of Pacific learners. Through this programme, parents, partners, and other family members can experience the campus, learn more about family, culture, and community on campus, attend mini-lectures, and learn more about how they can best support their student (University of Waikato, n.d.).

4.4 Ka Papahana Imua: Imua Initiative

Besides the FoE program, the Imua Initiative and Palu Undergraduate Navigators are also included. The Imua Initiative supports Pacific students in their first year of study by providing comprehensive support, building academic and digital skills, and introducing students to the Waikato Pacific family. Participants have demonstrated higher pass rates and improved academic performance. The initiative includes mentorship, workshops, and social events that foster a sense of belonging and community among Pacific students, aiding them in navigating university life (University of Waikato, n.d.).

4.5 Ka Papahana Palu: Palu Undergraduate Navigators

The Palu Undergraduate Navigators program offers Pacific undergraduate students one-on-one peer support and mentorship. Senior Pacific students act as experienced navigators, assisting their peers in navigating academic challenges, accessing university services, and exploring opportunities. This peer support system is essential for providing guidance, building confidence, and fostering academic success among Pacific students. The camaraderie and mutual support within this program contribute to a resilient and motivated learning community (University of Waikato, n.d.).

Figure 3: FoE Students at the National Institute of Water and Atmospheric Research center

Figure 4: FoE Students of St. Johns College in Week One Learning the Activity on Climate Change

Figure 5: FoE Students Building a Bridge Utilizing Materials Given By Navigators



Note: These figures can be viewed from left to right, beginning with figure three, where students are analyzing sand particles, to figure 5, where students are building their bridge relating to civil engineering utilizing only three materials, including milk cartons, skewers, and blue tac. Photos taken and captured by me.

Mokuna ‘Elima: Chapter Five
Ka Hopena o Ka Noi‘i: Findings and Application: STEM Program

5.1 Nā Mea Kuko‘ia: What an Ideal STEM Program for Pacific Learners Could Look Like

Based on the literature review and my experiences, I envision an ideal STEM program for Pacific learners transcends traditional educational boundaries. This program would celebrate the rich cultural heritage of Pacific students, fostering a sense of pride in continuing the work of their ancestors in modern STEM fields. It would be a collaborative environment where learning is a two-way street, with professors and students learning from each other and sharing their unique perspectives and knowledge (Yu et al., 2017; Polynesian Voyaging Society, n.d.).

The ideal program would integrate Indigenous knowledge and methodologies into the STEM curriculum, ensuring that traditional practices are acknowledged and valued alongside modern scientific approaches. This integration is crucial for empowering Pacific students to see their cultural heritage as a strength and a foundation for their academic and professional pursuits. By valuing Indigenous knowledge, the program would create a learning environment that is not only inclusive but also enriching for all participants. Furthermore, the program would aim to develop a strong sense of community and belonging among students. Research has shown that a supportive and inclusive educational environment significantly enhances student engagement and success (Easthope-Harper, 2018; Sika-Paotonu et al., 2020). This sense of community can be fostered through group projects, collaborative research, and cultural events celebrating Pacific STEM traditions and achievements.

5.2 Ka Nu‘ikia No Ka Papahana: Vision for an Ideal Program
‘Ike E Ho‘omaopopo Ai: Empowering Cultural Identity in STEM

An ideal program would ensure that Pacific students feel proud rather than ashamed of pursuing STEM fields. It highlights the continuity of ancestral knowledge and contemporary STEM practices, showing students that they are not diverging from their cultural roots but expanding them into new arenas. This program would create a supportive environment where students can freely express their cultural identities and see their heritage as an asset in STEM education (Easthope-Harper, 2018; Sika-Paotonu *et al.*, 2020).

To empower cultural identity in STEM, the curriculum would include courses exploring Pacific peoples' history and contributions to science and technology. Topics might include traditional navigation techniques, agricultural practices, and medicinal knowledge. These courses provide academic expertise and reinforce the students' connection to their cultural heritage.

Ke Kaiapuni A‘o: Collaborative Learning Environment

The program would foster a collaborative learning atmosphere where everyone learns from one another, including professors, students, and community members. The hierarchical barrier between teachers and students would be minimized to promote mutual respect and shared knowledge. Professors would incorporate indigenous perspectives into their teaching, ensuring the curriculum resonates with the students’ cultural backgrounds (University of Hawai‘i at Mānoa, 2022; Ministry of Education, 2020). This collaborative environment can be enhanced through technology and online platforms that allow students to connect with peers and mentors across the Pacific region. Virtual classrooms, online discussion forums, and collaborative research projects can help build a sense of community and shared purpose among students, regardless of their physical location.

Ka Mo‘omeheu: Integration of Cultural-Based Learning

Culture-based learning would be at the core of the program. Students would engage in activities that blend traditional knowledge with modern STEM concepts. For example, they might analyze weather patterns using scientific tools and traditional methods, explore engineering principles through conventional navigation and canoe building, and understand coding through the patterns of traditional weaving (Polynesian Voyaging Society, n.d.; Yu *et al.*, 2017). The program could include guest lectures and workshops led by community elders and traditional knowledge holders to integrate culture-based learning further. These sessions would provide students with firsthand insights into the practical applications of traditional knowledge in contemporary STEM fields.

Ke Kūkulu Pilina: Partnerships with STEM Organizations

Collaborations with STEM-related organizations would provide students with practical experiences and exposure to real-world applications of their learning. These partnerships could include internships, workshops, and mentorship programs, allowing students to see the tangible impact of STEM in various industries and communities. These collaborations would enhance learning and open pathways for future careers (Ministry for Pacific Peoples, 2020; University of Waikato, 2021). Building partnerships with local and international organizations can also help secure funding and resources for the program. These partnerships facilitate research opportunities, access to advanced technology, and participation in global STEM initiatives.

Nā Hana Noe‘au Ho‘okolohua: Experiential Learning Opportunities

The program would offer more hands-on activities that merge cultural practices with STEM education, such as analyzing weather patterns using scientific methods alongside traditional knowledge to predict weather (Yu *et al.*, 2017; Polynesian Voyaging Society, n.d.), understanding the parallels between the patterns in traditional weaving and the logic of coding (Smith, 2012; Ministry

of Education, 2020), and exploring the chemical and physical principles involved in conventional cooking methods (INPEACE, 2021; Exploratorium, 2023). These activities make learning more engaging and relevant for Pacific students and highlight the integration of their cultural heritage within STEM education.

5.3 Nā Kāko‘o: Supporters

This program would involve a wide range of stakeholders, including faculty members, teachers, students, board members, and community leaders who recognize the importance of such an initiative. It would also include individuals currently pursuing STEM courses and majors and those integrating Pacific indigenous knowledge into their work (Ministry of Education, 2020; University of Waikato, 2021). The involvement of community leaders and elders would be critical in ensuring that the program remains culturally relevant and respectful. Their guidance and participation help bridge the gap between traditional knowledge and modern education, creating a more holistic learning experience for students.

Additionally, involving role models who bridge the gap between Pacific Indigenous knowledge and modern STEM fields is also crucial. Figures like Hoturoa Barclay-Kerr, a scientist and a traditional navigator/wayfinder, would inspire students. Mentorship programs connect students with professionals who can guide and support them in their educational and career journeys (McAllister *et al.*, 2020; Easthope-Harper, 2018). Mentorship programs can be structured to include regular meetings, workshops, and networking events. These programs allow students to discuss their challenges and aspirations, receive career advice, and build professional networks.

5.4 Ka Papa Manawa: Implementation Timeline

Ideally, this program would begin in February, aligning with the university's trimester A calendar. It would run throughout the academic year like a regular course, providing students with continuous support and learning opportunities (University of Waikato, 2021). The implementation timeline would include several phases, such as curriculum development, recruitment of faculty and mentors, establishment of partnerships with STEM organizations, and community outreach. Each phase would be carefully planned and executed to ensure the program's success and sustainability.

5.5 Nā Mea Keu: Additional Considerations

This program aims to make an original contribution to the literature by demonstrating how integrating cultural identity with STEM education can enhance student engagement and success. It would show that cultural pride and academic excellence are not mutually exclusive but rather

mutually reinforcing. By documenting the program's development, implementation, and outcomes, this initiative could serve as a model for other institutions seeking to support Indigenous learners in STEM fields (Yu *et al.*, 2017; Ministry of Health, 2020).

Furthermore, the ultimate goal is to create a transformative educational experience that empowers Pacific students to excel in STEM fields while maintaining a strong connection to their cultural heritage. This program would benefit not only the students but also their communities, as they apply their knowledge to address local challenges and contribute to the global scientific community (Pacific Perspectives, 2013; Ministry of Education, 2020). By fostering an environment where cultural identity and academic pursuit are intertwined, this program would help build a more inclusive and diverse STEM workforce.

Ongoing evaluation and feedback mechanisms would be implemented to strengthen the program further. Regular assessments help identify areas for improvement and ensure that the program continues to meet the needs of Pacific students. Additionally, the program could seek accreditation from relevant educational bodies to enhance its credibility and attract more participants.

Mokuna ‘Eono: Chapter Six Hopena: Conclusion

6.1 Ka Pani Hope Loa: Executive Summary

As previously shared, this thesis addresses a critical gap in STEM education by exploring the factors influencing Pacific success in STEM. Embracing a low-budget approach primarily centered on research, the study aims to amplify diverse voices and perspectives that have been historically marginalized. The overarching goal is to catalyze transformative conversations within universities, challenging the status quo and advocating for a more inclusive and culturally responsive STEM curriculum. This research intends to instigate a paradigm shift in STEM education by spotlighting the often-overlooked indigenous ways of knowing, inviting a broader understanding of STEM.

In conclusion, this research is presented as a call to action. It invites universities to recognize the importance of incorporating diverse perspectives into STEM education. By acknowledging and valuing the cultural heritage of Pacific students, we aim to foster a learning environment that truly resonates with their identity. We hope this proposal will be considered with the urgency it deserves, propelling us toward a future where STEM education is synonymous with inclusivity, cultural relevance, and excellence. The aspiration is that this research will serve as a foundational step towards a more equitable and enriched STEM landscape.

6.2 Nā ‘Ike Nui: Key Findings

The findings from this research underscore the importance of culturally relevant education, community engagement, and supportive policies. Key takeaways include the critical role of family and community support systems in fostering academic success, the need for culturally responsive teaching practices, and the positive impact of targeted support programs. By investigating and implementing these strategies, we aim to create a more inclusive and supportive environment for Pacific students in STEM. This will contribute to a more diverse and innovative scientific community, enriching the field with various perspectives and knowledge systems.

6.3 No ka Ho‘omau ‘ana: Recommendations

Based on the findings, the following recommendations are proposed to advance the integration of PTK into STEM education and to support the success of Pacific students in these fields:

- **Developing a Culturally Relevant Curriculum:** Incorporate Indigenous Pacific knowledge and practices into STEM curricula to reflect Pacific students’ cultural heritage and unique

perspectives. This could involve integrating traditional ecological knowledge, navigation techniques, and other cultural practices into subjects like environmental science, astronomy, and biology.

- **Enhancing Support Systems:** Establish mentorship programs, provide financial support, and offer cultural competency training for educators. Mentorship programs can connect students with role models who share their cultural background, offering guidance and inspiration. Financial support can help alleviate economic barriers, and cultural competency training ensures educators respect and understand their students' cultural contexts.
- **Fostering Community Engagement:** Build strong connections between educational institutions and Pacific communities to ensure programs meet the needs of Pacific students. Collaborate with community leaders, families, and local organizations to create a supportive learning environment.

To continue this research, future studies should explore the long-term impacts of culturally relevant STEM education programs on Pacific students' academic and career outcomes. Longitudinal studies can provide valuable insights into how these programs influence students over time, helping to refine and improve educational strategies. Additionally, investigating the integration of Indigenous knowledge in other STEM-related fields, such as health sciences and engineering, can further enhance the inclusivity and relevance of STEM education.

6.4 Ke Kaupalena: A Reflection on Limitations

A more detailed discussion of the limitations encountered in this research is essential for understanding the study's context and interpreting its findings. Key limitations include the reliance on secondary data, which may not fully capture all relevant variables, and the potential for cultural biases in interpreting Indigenous Pacific knowledge within a STEM education context. Additionally, the scope of generalizability may be constrained by the specific cultural and educational settings studied. Recognizing these limitations helps to provide a transparent and rigorous analysis, ensuring that the conclusions drawn are appropriately contextualized.

6.5 Ka Hopena: Conclusion

This research emphasizes the need for an inclusive and culturally responsive STEM curriculum that acknowledges and values Indigenous Pacific knowledge. Creating supportive and relevant educational environments can enhance Pacific students' academic success and empowerment, ultimately contributing to a more equitable and enriched STEM landscape. The research presented in

this thesis serves as a foundational step toward achieving these goals, highlighting the importance of integrating diverse perspectives into STEM education.

The findings from this research have been extensive and revealing, uncovering both the challenges and opportunities in integrating Indigenous Pacific knowledge into STEM education. This journey has been a substantial undertaking, but an essential one. It has provided a much-needed examination of the systemic barriers that Pacific students face and the innovative strategies that can be employed to overcome these obstacles. Through this work, we aim to spark meaningful change within educational institutions.

I hope this research benefits the Pacific community, particularly our students, by fostering environments where their cultural heritage is respected and integrated into their academic experiences. I hope this work catalyzes further efforts to support Pacific students in Aotearoa, New Zealand (ANZ) and at the University of Waikato. This thesis represents a significant step toward the ultimate goal of creating a STEM education system that truly meets the needs of Pacific students, paving the way for their success and empowerment in their academic and professional lives.

By taking these steps, we can move closer to a future where Pacific students in ANZ and at the University of Waikato are included in STEM fields and able to thrive and excel. This research is a call to action for educators, policymakers, and communities to work together to create a more inclusive, supportive, and culturally responsive educational landscape for all Pacific students.

6.6 Ke Ana Mana‘o: Evaluation

Reflecting on the journey and findings of this research, the evaluation section underscores the importance of addressing the underrepresentation of Pacific individuals in STEM fields. By examining the factors contributing to this disparity and exploring strategies for integrating Indigenous knowledge into STEM education, this research aims to promote equity, innovation, and cultural preservation.

As Mau Piailug, a renowned navigator within Moana nui ākea (Vast ocean), famously said, *“If I have courage, it is because I have faith in the knowledge of my ancestors”* (the kūproject, 2023). This quote encapsulates the essence of this research. It reminds us that this work was possible because of the trust placed in the knowledge passed down by our ancestors. Initially, I hesitated, uncertain if others would understand or accept this research. But this quote reaffirmed my identity and purpose. I

have always known that Pacific Indigenous knowledge paved the way for me; I believe it can do the same for other Pacific and Indigenous peoples, especially in STEM fields. They must be reminded that we have always been scientists, technologists, engineers, and mathematicians; it's in our blood. We must have faith in the knowledge bestowed upon us.

This research paves the way for a curriculum or course integrating Pacific knowledge and STEM. This would foster a learning environment where Pacific students can bridge their cultural heritage with academic excellence, contributing to a more inclusive and enriched STEM landscape.

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