Exploring the Experiences of Māori Wāhine in a STEM Project-Based Secondary Classroom: A Relational and Intersectional Perspective

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Abstract

Using phenomenology, an intersectional lens, and the principles of Kaupapa Māori research, this study investigates how young Māori (Indigenous) wāhine (women) ākonga (students) experience interdisciplinary project-based STEM education. Historical educational policies in Aotearoa New Zealand required Māori to assimilate into a Pākehā (European) school system, contributing to persistent academic underperformance, particularly in science. Māori have been more likely to leave school early, and those who remain often opt out of science subjects, especially Māori wāhine. International literature suggests that transdisciplinary STEM education grounded in social justice and equity can improve engagement and outcomes for underrepresented learners. The study was guided by two questions: (1) how Māori wāhine experienced the STEM programme, and (2) what their challenges were to succeed in STEM.

In 2016, while teaching at a low-decile (socioeconomic disadvantaged), urban, co-educational English-medium high school, I trialled an integrated, interdisciplinary project-based STEM class that incorporated meaningful phenomena and culturally responsive pedagogy. The class's success led to STEM becoming a core component of a broader school initiative. In 2018, the seven Māori wāhine ākonga enrolled in the Year 11 (age 15–16) STEM class were invited to become "Story Sharers" and reflect on their experiences. As a teacher-researcher (insider), I used reflexive practices and clear role delineation to leverage contextual knowledge while minimising bias. Narrative data were collected over two years (2018–2019) through six semi-structured discussion groups and one individual interview. Quantitative data included tracking attendance records, retention, and academic achievement.

Findings indicate that the Story Sharers valued co-constructed topics and tasks, a supportive whānau (family/community) class format, and authentic project work undertaken over extended learning periods. They consistently identified strengthened relationships, particularly among peers as central to engagement, wellbeing, motivation to learn, and as the most salient indicator of success. Academic performance increased relative to prior Year-10 e-asTTle (Electronic Assessment Tool for Teaching and Learning in mathematics, reading, and writing) benchmarks, alongside improved STEM class attendance, retention in school, and intentions to continue in STEM.

Interpretive thematic analysis using an intersectional lens revealed that racism, stereotyping, and impacts on wellbeing were significant barriers to learning. These discriminatory experiences were pervasive across school, community, and online spaces and were compounded by gendered and intergenerational dynamics. The Story Sharers described complex, fluid, and intersecting identities shaped by lived experiences, including witnessing discrimination against Māori wāhine in their whānau and the legacy of colonial schooling practices such as the suppression of te reo Māori.

In this study, STEM project-based learning was shaped by two interwoven design elements: relational pedagogy and relational thinking. Relational pedagogy prioritised relationships and co-construction within a whānau-formatted classroom. Relational thinking described the interdisciplinary logic of the programme itself, connecting disciplinary knowledge to place, context, and community so that learning is organised around meaningful phenomena rather than siloed subjects. Together, these elements functioned as a counterspace that fostered inclusive engagement, affirmed identities, and supported belonging for Māori wāhine. Grounded in culturally responsive and whānau-based approaches, this model enabled learners to challenge deficit narratives and engage meaningfully in STEM. The outcomes offer assurance that integrated, project-based STEM education, underpinned by these relational frameworks, can improve outcomes for learners whose identities and experiences have been marginalised in traditional schooling. However, policymakers must remain attentive to historical policy barriers and intersectional factors that continue to perpetuate inequities within the education system.

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As with any undertaking as large as this I have many people to thank. First my supervisors Associate Professor Chris Eames and Professor Bronwen Cowie, both of whom have provided amazing support and motivation when life was trying to make me quit. To the Māori colleagues who helped me to navigate this space. The amazing people in the decolonizing space who whilst helping me understand and learn also carry the emotional load. The biggest thank you to all the Story Sharers who taught me far more than I taught them. I continue to be amazed by you and all you achieve. Thank you to the amazing friends who loved and supported me throughout this journey, especially Deborah who was my EdD buddy. Finally, my family, who have had to be content with less of me for far too long.

Dedication

For Whānau

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Chapter 1 Introduction

1.1 Introduction

Science, Technology, Engineering, and Mathematics (STEM), and, by extension, STEM education, is considered critical to secure Aotearoa, New Zealand's, future economic growth. However, data suggests students lose interest in science as they transition from primary to high schools (McKinley et al., 2015) which results in learners not choosing STEM subjects past their compulsory year 11 schooling. The domino effect is a reduction in the number of students who can progress into STEM careers. Of great concern is the number of Māori ākonga (students), especially Māori wāhine (women), who choose to stop studying STEM and who are over-represented within academic underachievement statistics within science subjects.

This introduction explains the basis of the research, which originated from my observing that Māori wāhine were not choosing science subjects past compulsory year 11. I begin by explaining why I am interested in this topic and then discuss the variations within STEM education and some of the reasons behind the recent emphasis on STEM. This is followed by an analysis of the differences in academic outcomes for Māori in STEM subjects, paying particular attention to Māori wāhine. Continuing this theme, the complex topic of culturally responsive teaching is explored alongside analysing whether pedagogical shifts to include mātauranga Māori (Māori knowledge) could improve academic outcomes for Māori ākonga (students). I discuss intersectionality, its links with feminism and critical race theory, and why it fits this study. Finally, I bring together the research inquiry and explain how it relates to the initial aim of the study, identify some of the critical unanswered questions, describe the research design and provide an overview of each chapter.

1.2 Research Motivations

Arriving in Aotearoa New Zealand, as a secondary science teacher in 2011, I was excited to be teaching the National Certificate of Educational Achievement (NCEA) with its opportunity to provide flexible courses and utilise engaging contexts. This flexibility is possible as NCEA has a selection of Achievement Standards that provide credits at levels 1 to 3 and is typically taught to years 11-13 (approx. 15-18 years old), enabling educators to

create flexible courses by offering a variety of standards in engaging contexts using different pedagogical approaches. However, in the school I was teaching, I soon learned that NCEA implementation was reminiscent of the traditional system I had experienced in England. I witnessed learners losing engagement and motivation, failing or opting out of science subjects.

I changed schools and became a Head of the Department of Science at an urban, decile-one (school in an area of socio-economic disadvantage), co-educational school with a large proportion of the students registered as Māori. At the time of the study, the Ministry of Education used census data to determine a school's decile rating. The decile rating ranged from one to ten, and the lower the decile rating, the more funding a school received, with approximately 10% of schools in each category. Upon arrival to my new role, I discovered that the school Board of Trustees (BOT) and the Senior Leadership Team (SLT) had decided science would become a compulsory subject for all year 11 (age 15-16) NCEA Level 1 students, which had previously been optional. The Board of Trustees set a target of 60% of students passing NCEA Level 1, which was calculated as students achieving a minimum of 16 NCEA credits in each subject. In addition, all the Achievement Standards chosen would have to contain literacy and numeracy opportunities. After selecting a range of Level 1 standards that fulfilled these requirements and working alongside the science teaching team, the department reached this new goal. For the first time, I felt empowered to change academic outcomes for students. However, although we were a school which utilised culturally responsive teaching strategies, too many students, particularly Māori ākonga (learners), were not staying at school to complete years 12 and 13. Worryingly, the remaining students were not choosing science subjects, especially Māori wāhine. Reflecting on the situation, I realised that the pedagogy felt outdated and uninspiring. We were not engaging or equipping our learners with the skills for further study or the workforce.

Knowing something had to change, I researched new possibilities for teaching science, leading me to identify STEM (Science, Technology, Engineering, Mathematics) education opportunities. The research highlighted that STEM education could incorporate a 21st-century teaching style, engage students, include critical skills and competencies, create student agency, and become a conduit for social justice and equity (Bell, 2019; Edwards & King, 2023). More importantly, by basing pedagogies such as project-based learning (PBL) within mātauranga Māori (Māori knowledge systems), we could move past culturally

responsive teaching and start to indigenise the curriculum (Hoskins & Jones, 2022). Indigenising the curriculum appealed to me as I could foresee this as an opportunity to improve the educational experience for Māori ākonga by providing a learning environment that was designed with Māori, for Māori (Hotere-Barnes et al., 2014). From this observation, expanding on my Postgraduate Certificate in Digital and Collaborative Learning, I set about creating a project-based interdisciplinary STEM class that would utilise design thinking and maintain cultural learning approaches, including co-construction and a whānau (family) format.

1.3 The importance of STEM Education

An emergency in science education was first highlighted in the USA in the 1950s with the Sputnik crisis when the former Soviet Union launched the world's first artificial satellite into orbit. The perceived threat that students in the former Soviet Union could surpass students' capabilities in STEM-type fields in the USA led to new governance and funding policies. Policies sought to ensure all students, including those from socioeconomic disadvantage and underrepresented groups, had access to up-to-date teaching and learning, especially in science and mathematics (Mohr-Schroeder et al., 2015). Despite this, over the next two decades, the crisis deepened with the confluence of declining scientific literacy rates and the introduction of new technology, which emphasised the need for a more educated workforce (Mohr-Schroeder et al., 2015). During the mid-to-late 1980s, the National Commission on Excellence in Education (NCEE) wrote a report highlighting that workforce demands needed to adapt to an increasing focus on technology, especially computers and robotics (Mohr-Schroeder et al., 2015). By the early 21st century, the USA introduced the American Competitiveness Initiative, which put science and technology education at the forefront, intending to ensure the long-term success of the USA (Mohr-Schroeder et al., 2015). Whilst these policies were implemented during the late 1990s, the acronym STEM, a shorthand for science, technology, engineering and mathematics, began to be used after the National Science Foundation (NSF) introduced a new STEM learning programme (Sanders, 2008). In 2009, the 'Educate to Innovate' campaign was launched, which aimed to raise the level of STEM education (Mohr-Schroeder et al., 2015). Educators and researchers welcomed these initiatives, aiming to define what STEM education is, how it can be implemented and the benefits to students' learning experiences (Granshaw, 2016; Vasquez, 2015).

Similarly, Aotearoa New Zealand, has a governmental push for a scientific and technological literature society (Salmon & and Priestley, 2015). Although STEM is not a distinct learning area within *The New Zealand Curriculum,* the component learning areas of science, mathematics and technology, which integrate engineering design methods, are included (Ministry of Education, 2017a). However, STEM education is promoted due to the opportunities offered through interdisciplinary learning (Ministry of Education, 2018).

Recognising that, unlike the discrete teaching of subjects, STEM education is more than just an acronym, offering a multi-disciplinary, cross-curricular, holistic, authentic teaching and learning method (Al Salami et al., 2017; Connors-Kellgren et al., 2016; Falk et al., 2016). In principle, STEM education provides the opportunity to improve students' understanding of how things work and implement greater use of technologies to aid problem-solving (Bybee, 2010; Dierking & Falk, 2016). Additionally, a STEM education programme can enable students to acquire 21st century skills and core competencies to become competitive in a modern economy (Vasquez, 2015). Seeking to aid educators in achieving this new form of instruction, Vasquez (2015) developed a stepwise method towards a fully integrated model of teaching STEM. The key elements relate concepts and skills of STEM integration at various levels, from a disciplinary status to a fully holistic transdisciplinary model (Vasquez, 2015). A fully integrated model links with the pedagogical approaches of project-based or problem-based learning. Complimenting the Vasquez (2015) model, it is also postulated that focusing projects on one of the seven tenets of STEM education for social justice and equity as discussed by Bell (2019) can aid in improving the participation and retention of underrepresented students in STEM.

In this thesis, I use ideas from interdisciplinary project-based STEM learning to describe a Year 11 study in which students investigated how to improve tomato yield in a hydroponic system during an extended learning period. In this framing, students connect contributions from science, technology/engineering, and mathematics while keeping each of these contributions visible. By contrast, transdisciplinary PBL-STEM refers to problem-solving in which disciplinary boundaries become functionally seamless across the project (Chowdhury et al., 2024; Vasquez, 2015). Accordingly, I adopt interdisciplinary as the operative term for this study and treat transdisciplinary as a longer-term horizon (Anderson et al., 2022; Deehan et al., 2024).

However, although educators recognise the opportunities STEM education offers, except for some exemplary cases, high schools implementing interdisciplinary STEM programmes have taken time (Symington & Tytler, 2011). Educators have reported that support is required to develop curriculum and pedagogical integration to fulfil an authentic interdisciplinary project-based STEM programme (Margot & Kettler, 2019). A study of STEM-focused schools in Buffalo and Denver in the United States of America (USA) documented how, after high enthusiasm and optimism, the courses offered failed to deliver the desired outcomes and were eventually ended (Weis et al., 2015). In this instance, the main reason the courses were unsuccessful was the competing necessity to ensure students gained the knowledge and skills needed for state-standardised assessment requirements for entry to their desired STEM pathways (Weis et al., 2015).

What is evident is that changing from the traditional teaching of individual subjects to teaching STEM as a holistic, interdependent subject that encapsulates learning based on real-world applications is challenging. Even more so when, to ensure students can access STEM career pathways, educators must intentionally connect the curriculum, assessments, and lesson design. In Aotearoa New Zealand, the NCEA system offers teachers the flexibility to engage students by tailoring courses to their needs and interests using various pedagogical approaches. However, universities have an entrance level expectation (University Entrance) that requires a certain number of specific NCEA credits, including some within specific subjects for specialised degree programmes. This raises the question of whether a project-based interdisciplinary STEM programme could encourage underrepresented students to continue in STEM while meeting the requirements for learners to progress onto their chosen pathways.

1.4 The importance of Māori Ākonga (Students)

Māori are the Indigenous people of Aotearoa, New Zealand. In 1840, Te Tiriti o Waitangi (the Treaty of Waitangi te reo Māori version) was signed to establish a political contract between the British Crown and Māori Rangatira (Chiefs) (Hetaraka, 2022). The original aim of Te Tiriti o Waitangi was to protect Māori rights and land whilst enabling the governance of the British Crown over the increasing number of British immigrants (New Zealand Government, 2024). However, disparities between Te Tiriti o Waitangi and the English version of the treaty resulted in Māori losing land and being dissociated from their culture (New Zealand

Government, 2024). Alongside these Te Tiriti o Waitangi breaches, Aotearoa New Zealand's education system was modelled on British imperialism (Hetaraka, 2022; Ka'ai-Mahuta, 2011).

Educational disparities between Māori and non-Māori have been discussed since the 1960s (Hetaraka, 2022). In 2017, a briefing report presented to the incoming Education Minister painted a worrying picture that stated educational disparities for Māori ākonga started in primary school (Ministry of Education, 2017c). In the report, regular attendance was defined as being in school 90% of the time: in primary school, Māori attendance was 43% compared to 60% for all learners; in high school, it was 61% compared to 71% (Krzyzosiak & Stewart, 2019; Ministry of Education, 2017c). The report highlighted that at Year 4 (8-9 years old) of primary school, Māori were half a curriculum level behind New Zealand European students in reading, writing and maths, and the disparity widened over time (Krzyzosiak & Stewart, 2019). Whilst 66.5% of Māori students attained Level 2 NCEA, only 19% gained University Entrance (Ministry of Education, 2017c). Specific data on NCEA achievement in science was collected for Māori ākonga in English-medium mainstream schools during the Starpath project. Outcomes documented that not only are Māori learners underperforming in science subjects but are more likely to be enrolled in internally assessed standards (Buntting et al., 2016), creating a blocker to progression in science courses that require completion of traditional external assessments. Whilst 2022 Programme for International Student Assessment (PISA) testing of 15-year-old Māori ākonga in English-medium schools demonstrated that their mean reading scores remained stable since the 2018 data collection, Maths and Science scores have decreased (New Zealand Government, 2022). Alongside this data, Theodore et al. (2015) reported disparities in higher education, with Māori accounting for less than 8% of tertiary students yet comprising 14.9% of the population. Also, most higher education Māori students were studying for an undergraduate qualification, only 3% were studying for a PhD, and half were first-generation tertiary students (Theodore et al., 2015). However, data presented in the 2017 report showed that the proportion of Māori in tertiary education was higher than for the general population (Ministry of Education, 2017c). Although this data included all tertiary organisations (universities, technology colleges and institutes, polytechnics), some provide trade qualifications and NCEA bridging courses. Considering this, the data suggests that Māori were studying lower levels of qualifications (level 4 or below) (Ministry of Education, 2017c). Data tracking Māori ākonga who were 15 in 2009 demonstrates that Māori wāhine (women) by the age of 28 are more often not in

employment, education, or training than men, regardless of their level of qualifications (Ministry of Education, 2024).

To counteract educational disparities in 1990 Kura Kaupapa (te reo Māori immersion schools) became state funded, five years after their initial inception through the kōhanga reo movement (Māori movement for the revitalisation of te reo Māori) (Tocker, 2015). Later in 1999, the policy *Ka Hikitia* was implemented, which led to the development of *Te Kotahitanga* programme to improve engagement and academic achievement for Māori ākonga (Bishop, 2011; Bishop et al., 2009). The *Te Kotahitanga* initiative developed from a research phase in 2001 to school implementation from 2004 to 2007 and was focused on aspects of culturally responsive pedagogy (Berryman, 2014; Bishop, 2011). The *Te Kotahitanga* initiative evolved into the *Kia Eke Panuku* programme with the aim of "Māori students enjoying and achieving education success as Māori" (Berryman & Eley, 2017, p. 99). I enjoyed participating in this programme when I first arrived in Aotearoa New Zealand, in 2011 and appreciated the professional development offered as a school facilitator of the *Kia Eke Panuku* programme. Professional development of the culturally responsive approaches included removing deficit theorising, improving student agency via the use of co-construction, creating classroom support structures with a whānau (family) format and building and maintaining relationships, which were deemed vital to improving both behaviour and learning outcomes for Māori learners (Berryman, 2014; Berryman & Wearmouth, 2018; Hall et al., 2015). More importantly, culturally responsive teaching based on relationality has been shown to improve engagement, behaviour and outcomes for all students in the classroom, not just Māori (Bishop, 2019; Hall et al., 2015). However, data reporting on academic achievement demonstrated that inequitable educational outcomes for Māori ākonga in English-medium schools remain (Krzyzosiak & Stewart, 2019).

As a teacher, I have always endeavoured to use inclusive pedagogical approaches to all students and express high expectations. However, whilst I appreciated the improved classroom environment and cultural learning approaches provided, I was concerned with the academic outcomes data for Māori ākonga. This made me curious how Māori ākonga were experiencing education in mainstream English-medium high school.

1.5 Considering an Intersectional Approach

Intersectionality was introduced by Professor Kimberlé Crenshaw (1989), who wrote about the unique experiences of African American women. Describing how gender, class and race intersect within the structures of oppression, discrimination and power, Crenshaw explained how the oppression and discrimination experienced by African American women is different from that of white women. She argued that the experiences faced by Black women cannot be explained independently by the terms Black and woman, but we must consider the interactions of these two identities, which can also reinforce each other (Crenshaw, 1989, 1991). That is, the unique experience for Black women consists of an intersection of racism and sexism, yet discourses have not been designed to address both at the same time (Crenshaw, 1989; Harris & Leonardo, 2018). More generally, intersectional theory addresses how a person's identity can be weaponised to oppress them on multiple fronts and can be connected to generational trauma (Grzanka & Miles, 2016).

In Aotearoa New Zealand, after colonisation, the subjugation of the Māori population resulted in colonial, misogynistic, imperial layers of oppression (Forster et al., 2016). A likely consequence is that Māori experience poorer health outcomes, socioeconomic inequality, and educational underachievement than Pākehā (White/European settlers) (Clark et al., 2018; Harris & Leonardo, 2018; Harris et al., 2018). Alongside outcome data, surveys demonstrate that Māori, especially Māori wāhine, experience racism and stereotyping in multiple forms daily (Smith et al., 2021). Reporting on the gender pay gap, Māori wāhine are socioeconomically worse off than women of other ethnicities (Haar, 2023), a potential consequence of historical colonising policies and receiving conscious and unconscious bias in hiring, promotion and pay negotiations (Ministry of Business Innovation & Employment, 2024; Rorintulus et al., 2024). For example, within the workplace, women can be disadvantaged due to perceptions of being inadequate for a position due to family commitments (Toyibah & Riyani, 2022). Highlighting these disparities, a 1998 study of seven Crown Research Institutes in New Zealand found that only 1.5% of employees identified as Māori women, with "none in management positions" and "only two were scientists" (McKinley, 2002, p. 109). A more recent article tracked the recruitment statistics of eight universities and six Crown Institutes, which demonstrated Māori and Pasifika continue to be underrepresented, with one university reporting not employing any Māori or Pasifika in their science department in a 10-year period, acknowledging the difficulty in providing an exact

number of Māori wāhine scientists within this data as there is no centralised database (McAllister et al., 2022). Feedback from Māori wāhine academics relay another layer of bias in that they are not only disadvantaged as women but also because they are ‘not white’ (Toyibah & Riyani, 2022, p. 44). Māori wāhine academics have highlighted the barriers they experience trying to get published, being identified as ‘Māori’ and ‘woman’ through their names (McKinley, 2005). For Māori wāhine, the complexity of being ‘Māori’, ' wahine’, and ‘scientist’ whilst living within a colonised system brings unique experiences and challenges.

To summarise Māori ākonga who attend English-medium mainstream schools continue to be overrepresented in academic underperformance due to an inequitable schooling system. Whilst culturally responsive programmes have had limited success in closing the equity gap, it has been postulated that STEM education with projects grounded in social justice can aid in improving the participation of underrepresented students. However, several layers of discrimination and barriers exist for Māori wāhine, particularly when overlayed with an extra level of bias for those who are ‘scientists.’ Utilising intersectionality allows researchers to understand the complex lived experiences of those who live at the intersection of multiple layers of discrimination and oppression

1.6 Focus of the Study

Wanting to reduce the disparities in the STEM pipeline and close the academic achievement gap for wahine Māori ākonga, my research aimed to investigate how and if a project-based interdisciplinary STEM class that uses cultural learning approaches including co-construction and a whānau (family) format could encourage Māori wāhine to succeed and choose STEM subjects past compulsory schooling. To facilitate this investigation, I developed two questions:

1. How do young Māori wāhine experience project-based STEM education?
2. What are the challenges to succeeding in STEM at an English-medium co-educational high school?

I created a project-based interdisciplinary STEM programme grounded in cultural responsiveness for year 11 (age 15-16) NCEA Level 1 learners. In 2018, the year of data collection, 21 students enrolled in the class completed their NCEA Level 1 achievement standards by completing project work. Student projects were based on the initial driving question: How can biochar increase the yield of tomato plants raised in hydroponic systems?

After an initial teaching period regarding project-based learning and completing NCEA credits in Health and Safety, students embarked on their project designs. Their projects enabled students to gain a mixture of science, technology, mathematics, agricultural/horticulture, and education for sustainability achievement standards and opportunities to achieve NCEA Level 1 Literacy and Numeracy. Discussions and data analysis focused on the narratives of the seven young Māori wāhine who participated in the programme and consented to inclusion in the study. Narrative analysis highlighted how they experienced the STEM class and the challenges they encountered as they travelled through year 11 and into year 12. Qualitative narrative data collection included six discussion group meetings and an interview with one participant. Quantitative data collection around this project learning included NCEA achievement, attendance and retention data.

The research findings provide valuable insights for educators and policymakers on how to better support Māori wāhine in project-based STEM education. They highlight how project-based learning can serve as a meaningful pathway for achieving NCEA standards, strengthening the STEM pipeline, and deepening understanding of the complex challenges faced by wāhine Māori ākonga in their pursuit of success

1.7 Structure of the Thesis

This thesis comprises five subsequent chapters. Chapter Two situates this study within the literature on STEM education, how Māori experience the education system and how intersectionality challenges our thinking. Chapter Three describes the research paradigm and design. It introduces the student participants, referred to as Story Sharers, the data collection and analytical methods used, and ethical considerations. Chapter Four presents the findings regarding how the Story Sharers experience the STEM class, and Chapter Five details the Story Sharers' commentary on the challenges of succeeding in STEM. Chapter Six revisits the research questions and links the findings with the literature. This chapter also includes a summary of the study’s key findings, implications, limitations and suggestions for further research.

Chapter 2 Literature Review

2.1 Introduction

This chapter examines the theoretical context and background of this study. To demonstrate the justification for this study and note any gaps regarding how young Māori wāhine (women) experience STEM (Science, Technology, Engineering, Mathematics) education and their challenges to succeeding in STEM, the literature review examines three distinct areas: STEM education, the education system in Aotearoa New Zealand, focusing on the impacts for Māori ākonga (students), and intersectionality.

STEM education is a broad term. To focus on the areas relevant to this study, section 2.2 discusses the impact of STEM education, the pedagogical approaches recommended for use within it, and the progress of implementing STEM education, especially within Aotearoa New Zealand, Special consideration is given to project-based learning and how STEM education can increase the STEM pipeline and provide a society literate in science and technology. The section also reviews how STEM education utilising project-based learning can create an educational experience grounded in social justice.

Section 2.3 reviews the history of the education system in Aotearoa New Zealand, and the resulting consequences for Māori ākonga. The section provides context to the discourse surrounding Māori education and attainment within the mainstream schooling system. It highlights concerns regarding the educational disparities experienced by Māori and how new ways of integrating knowledge systems, such as mātauranga Māori, could lend themselves to the indigenisation of the schooling system.

Finally, to demonstrate the complexity of understanding the lived experiences of Māori wāhine (women), section 2.4 examines the theory of intersectionality. As a framework, intersectionality provides an opportunity to understand the unique interwoven and interconnected lived experiences of those with multiple marginalised identities.

2.2 How STEM is Changing Education.

This section delves into the literature surrounding STEM education and covers what it is, why it is essential, how pedagogical approaches centring social justice and equity can

encourage under-represented students into the STEM pipeline, and how Aotearoa New Zealand, students participate and achieve in it.

2.2.2 What is STEM Education?

There has been an impetus for STEM since the 1950s (Section 1.3), resulting in STEM education being one of the most discussed issues in education (NSTA, 2016). STEM education may be the acronym for teaching Science, Technology, Engineering, and Mathematics education, but what exactly does STEM teaching look like? What does STEM education mean?

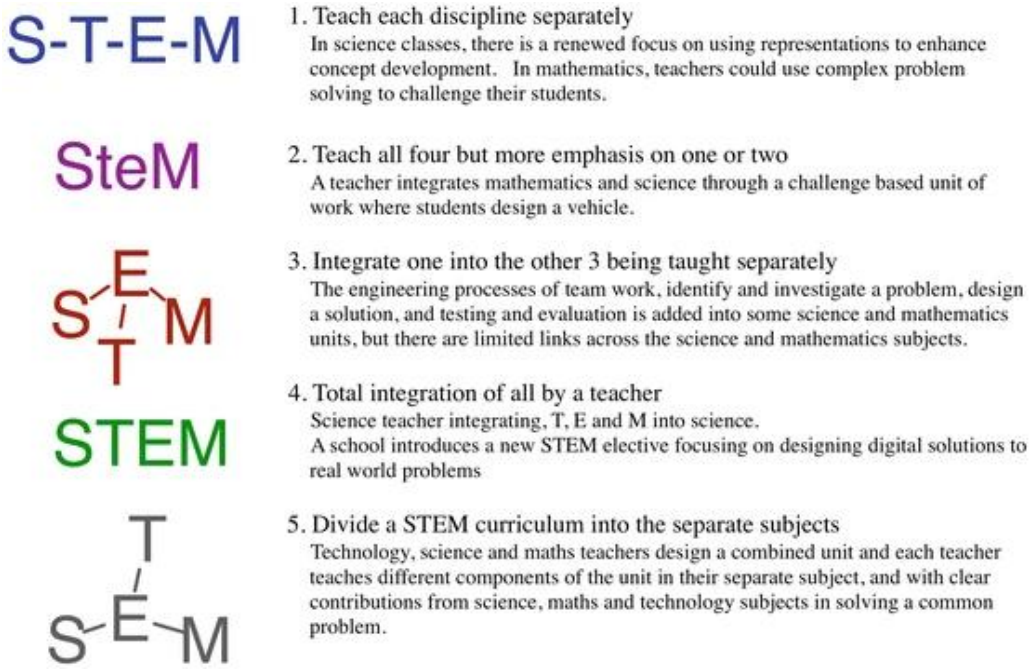
Aiming to unpack the discourse within STEM education, a literature review by Hasanah (2020) identified the common themes in STEM education research. The paper used secondary sources and literature reviews that included the phrases STEM implementation, STEM definition, STEM education, instruction, curriculum, and career. The review determined the critical definitions of the literature in STEM education could be divided into four categories: STEM as a discipline, as a form of instruction, as a field, and as a career.

STEM Education as a Discipline

Discipline was the most common literature description of STEM education, accounting for 16 of the 17 studies in the Hasanah (2020) review and was concerned with the integration of the components of STEM. However, this definition had the broadest criteria, with studies requiring implementation of at least two STEM subjects. The result is a wide variation in the four implementation models within this description, which included each subject being taught separately, teaching all four with an emphasis on one or two subjects, integrating at least three into one discipline and integrating all four subjects (Hasanah, 2020). However, Hobbs, Clark, and Plant (2018) analysed the Successful Student STEM programme (SS-STEM) in Australia using the same criteria as Hasanah (2020) and determined a fifth model, that of dividing the STEM curriculum into separate subjects and teachers in those subjects contribute to a core unit of work. Their visual representation is reproduced here in Figure 2.1 (Hobbs et al., 2018)

Figure 2.1

STEM Integration Models



Note. Teacher Collaboration and Integration Models Used by Schools in 2016 of the Successful Students'--STEM Programme. Reproduced with permission (Hobbs et al., 2018, p. 144)

The five variations of the STEM integration model by Hobbs et al. (2018) were determined from analysing data from the SS-STEM programme which is centred within schools catering to years 7 and 8 (ages 12 and 13). At the time of publication, the programme had been implemented for three years, providing insufficient data to determine whether a particular model was more advantageous, improved academic outcomes or enhanced students' preferences for STEM subjects or careers (Hobbs et al., 2018). Whilst the Hasanah review (2020) noted that by limiting STEM as a discipline, STEM education was constrained by the subject-specific curriculum and the knowledge of the lead teacher. In contrast, Hobbs et al. (2018) viewed this as an opportunity for a school to create its own STEM education vision. Neither the Hasanah (2020) review nor the Hobbs et al. (2018) study linked pedagogy within each of these five models, which could account for why educators within both these research papers were at odds as to whether STEM education was a new way of teaching Science, Technology, Engineering and Mathematics or a completely new paradigm.

There is wide variation in the integration and implementation of STEM within each of the STEM integration models, and the Hasanah (2020) review did not attempt to give insight into the impact on student outcomes using these different approaches or provide any basis for which model might be a preferred method or the types of pedagogical approaches best suited for their implementation.

STEM Education as a Form of Instruction

The second most frequent description was STEM education as instruction and eight of the 17 studies from the Hasanah (2020) review identified with this definition. These studies focused on how different pedagogical and practical approaches could be used to implement STEM education. The studies in this section were as varied as those within the discipline category, but what was evident was that pedagogy was changing. Teacher-centred or traditional teaching was transformed into student-centred, active learning (McDonald, 2016; Thibaut et al., 2018). The pedagogical approaches used in these studies included inquiry, argumentation, digital learning, robotics, cooperative learning, and hands-on assessment while also including developing 21st Century skills (McDonald, 2016). It was also evident that using varied STEM approaches to aid in problem-solving increased the teamwork aspect of curriculum design and helped include the design methodology from engineering (Hasanah, 2020). Focusing on instruction, STEM education was able to develop the natural connections between the STEM disciplines, build on students' prior knowledge, increase students' exposure to STEM and make STEM more accessible (Thibaut et al., 2018; Wang et al., 2011).

A five-stage framework for achieving an integrated STEM education model within high schools was postulated by Thibaut et al. (2018). The five areas include integrating STEM content, problem-centred, inquiry-based, design-based, and cooperative (rather than collaborative) learning. This theoretical framework model indicates an emphasis on student-centred teaching approaches. Grounded in social constructivism, teaching through integrated STEM instruction builds on students' prior knowledge and experiences (Hasanah, 2020; Thibaut et al., 2018).

Studies which defined STEM as instruction included data not evident under STEM as a discipline, such as increasing the effect on student's attitudes towards their learning and

future STEM careers (Hasanah, 2020; John et al., 2018; Thibaut et al., 2018). The literature concentrating on STEM instruction provides insight and opportunity to place the foundations of a paradigm shift in our understanding of STEM education. It enables educators to integrate STEM subjects as a new whole through the changing of pedagogy. It offers a new way of thinking and learning within a classroom and a curriculum.

The Field of STEM Education

The definition of STEM as a field was a broad topic as it included those subjects and disciplines designated within the separate descriptions of Science, Technology, Engineering, and Mathematics. This area of the literature focuses on education at the University level, which often teaches STEM as a singular subject. Most of the literature within this area of the review by Hasanah (2020) was from the USA and was concerned with the two main influences on students choosing STEM as a field in their undergraduate or college courses. Those two influences included students' being proficient in one or more STEM subjects and those who become interested in STEM subjects early in their schooling (Gandhi-Lee et al., 2017). No data were presented to determine if there was a correlation between these two observations. However, studies suggest another important factor influencing students' interest and proficiency in STEM subjects in later schooling is the role of family. Targeting parents of students in the 10th grade (ages 15-16), typically a time when students choose to withdraw from courses such as Maths and Physics, Rozek et al (2017) used a theory-based intervention utilising a parent-centred utility-value approach and aimed to increase parents' awareness and value of their child studying STEM subjects. The study reported a 12% increase in students' USA college preparatory exam (ACT) results. The ACT test covers four academic skill areas: English, mathematics, reading, and scientific reasoning. A five-year follow-up of the participants revealed a rise in students pursuing STEM careers (Rozek et al., 2017). This study plays a double role in demonstrating the importance of high school STEM preparation leading to increasing STEM career pursuits, and the role parents and caregivers can play in encouraging their children into STEM subjects.

Remaining within the USA context, once at university, the Hasanah (2020) review identified three factors to improving the retention of undergraduates in STEM fields, which included: 1. positive interactions with faculty both in/out of the classroom, which included every interaction from formal teaching to research meetings and tutorials: 2. positive relationships

with peers and 3. the environment of the undergraduate courses (Hasanah, 2020; Watkins & Mazur, 2013). Regarding the environment, studies demonstrate that students who found their first-year STEM class more enjoyable were likelier to remain in their course (Watkins & Mazur, 2013). Course enjoyment was improved by pedagogical changes such as using student-centred approaches, student-peer instruction, contextualising programmes, and enhancing student agency (Hasanah, 2020; Hobbs et al., 2018; Watkins & Mazur, 2013).

A more recent position paper from Australia postulated that to increase the retention of under-represented undergraduates in STEM and enable student success, the tertiary sector must develop into teaching for Diversity, Equity, and Inclusion (DEI) (Ramiah et al., 2022). The authors used an intersectional approach (section 2.4) to describe how current pedagogical practices entrench inequality, stating that only by creating an inclusive learning experience, including re-analysing the needs and methods of assessment, will the tertiary STEM sector fulfil its criteria of improving retention of under-represented students (Ramiah et al., 2022). The authors argued that STEM education, which incorporates pedagogical practices interwoven with DEI, could enhance the engagement and retention of all STEM students.

STEM Education becoming a STEM Career

The final definition from the Hasanah (2020) review was STEM as a career, which was concerned with literature regarding STEM careers. This area of the review amalgamates the literature on critiquing the importance of increasing the number of STEM graduates for STEM jobs and careers requiring 21st century skills. However, this section of the review only included four studies. The papers within this definition centred around the increasing global need for STEM graduates and how the emergence of new technology has cemented the need for more people to fill the STEM gap. These findings support data demonstrating that since 2015, the most significant growth in employment in the USA has been in jobs requiring STEM skills (Breiner, 2016). This USA growth data matches similar experiences around the globe. For example, in Aotearoa New Zealand, the *Auckland Economic Development Plan* highlighted that growth industries would be high-tech, green-tech and biotech (Auckland Council, 2015). Since 2015, the digital technology sector has grown 77% faster than the general economy, a contributing factor to Digital Technologies entering *The New Zealand Technology Curriculum* in 2018 (Clark, 2022; McGrath, 2015; Ministry of Education, 2017a)

Literature under this definition also referred to the need to improve society's scientific literacy and 21st century skills for careers outside of STEM. These studies reflect the *New Vision for Education*, a document presented by the World Economic Forum (WEF) and Boston Consulting, which listed sixteen 21st century skills determined as a requirement for future student success (World Economic Forum, 2015). These 16 skills were grouped into three main areas: foundation literacies, competencies, and character qualities. This report highlights a need to include skills and competency acquisition alongside knowledge acquisition (World Economic Forum, 2015). The authors concluded that learning these skills is required to ensure a student is employable and a lifelong learner who can adapt to a changing world (World Economic Forum, 2015). Studies included under STEM as a career demonstrate the tenet that STEM education needs to create critical thinkers, increase scientific literacy and develop the next generation of innovators, not just scientists (Bybee, 2010; Kennedy & Odell, 2014; Kennedy & Sundberg, 2020).

The diversity of responses to STEM education within each definition highlights the range of discussions for scholars regarding STEM education and highlights the extensive catalogue of what STEM education is expected to accomplish. Alongside pedagogical changes that include planning for DEI, STEM education is also charged with producing an adaptable, critically thinking, scientifically and technologically literate society. With such wide-ranging requirements and no clear definition, it can be difficult to envisage what STEM education in the classroom should look like. The following section examines the pedagogical approaches used in STEM education and reports the positives and challenges of implementing a fully integrative STEM project-based learning approach.

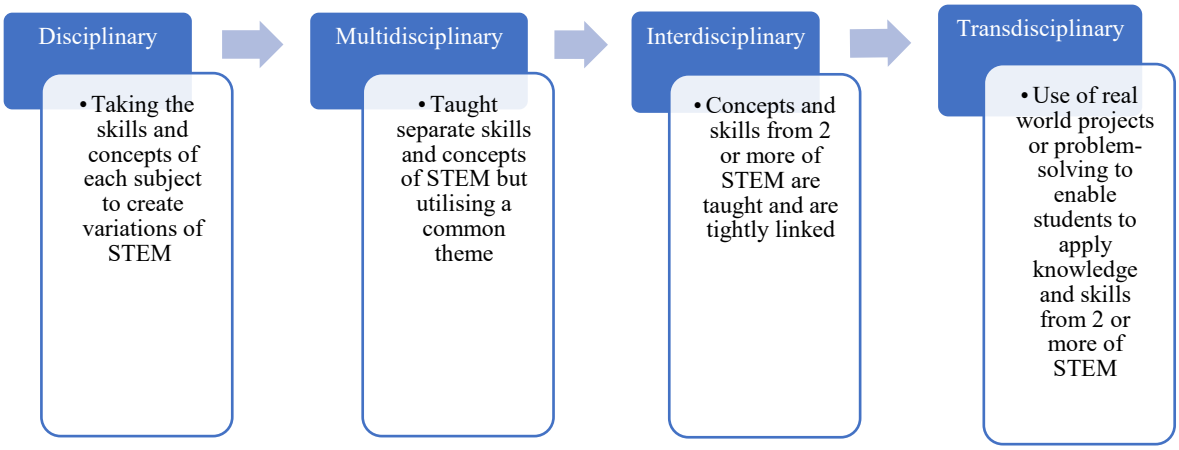
2.2.3 Pedagogical Moves in STEM Education

Pedagogical approaches to teaching STEM education can take multiple forms within a school setting. Examples used for teaching an integrated STEM programme include inquiry, problem-based and project-based learning. To implement a STEM education programme, it has been proposed the 5E model of engaging, exploring, explaining, elaborating, and evaluating gives the best opportunity to personalise STEM learning for students of all ages (Bybee, 2015). This model is grounded in constructivist learning theory, as students create knowledge by making connections and constructing their next level of understanding (Bybee, 2015; Kennedy & Odell, 2014; Kennedy & Sundberg, 2020). To complement 5E, Vasquez (2015) constructed a sliding scale of STEM integration, demonstrating that teaching an

integrated STEM programme by linking STEM skills and concepts can be viewed within four categories, from disciplinary to transdisciplinary, on an increasing scale of discipline complexity, as depicted in Figure 2.2 (Vasquez, 2015).

Figure 2.2

Sliding Scale of STEM Integration



Note. Adapted and reproduced with permission (Vasquez, 2015, p. 13)

Starting with disciplinary, STEM is taught with different content within each subject through multidisciplinary and interdisciplinary systems; connections are made through a common theme or a tight linkage between the STEM subjects and are taught appropriately. Finally at the end of the scale, transdisciplinary utilises pedagogical approaches in which STEM is taught through an intercalated and interconnected model. However, the common theme within these four approaches is that regardless of which STEM disciplines are included, students can break down any artificial barriers and understand their connection whilst applying the skills and knowledge from their learning experience (Bybee, 2015; Vasquez, 2015). This sliding scale enables educators to design authentic, integrated STEM programmes stepwise whilst using various pedagogical approaches. It also indicates how to include STEM concepts, which is vital for educators who must ensure curriculum and assessment criteria are met.

While Vasquez's continuum is a useful framework, recent peer-reviewed syntheses and empirical accounts show that, in secondary settings, integrated STEM is most often enacted in the interdisciplinary band of project-based learning (Anderson et al., 2022; Deehan et al.,

2024; Vasquez, 2015). The literature traces this pattern to two interlinked constraints. First, system structures including assessment requirements, specialist staffing and timetable architecture can set narrow operational conditions for classrooms (Anderson et al., 2022; Deehan et al., 2024). Second, within those constraints design capacity is limited by gaps in cross-disciplinary expertise and by the absence of shared planning and assessment frameworks that can integrate STEM disciplines while maintaining disciplinary depth (Anderson et al., 2022; Deehan et al., 2024). In practice, these conditions mean that integrative thinking tends to appear as brief, boundary-blurring episodes rather than as a sustained feature across an entire project (Chowdhury et al., 2024; Diego-Mantecón et al., 2021). In addition, instruments to identify transdisciplinary practice at the secondary level are still being developed and validated (Yang et al., 2025). Taken together, these background conditions explain why transdisciplinary project-based learning STEM is seldom realised in secondary settings.

While transdisciplinary STEM education remains an aspirational goal in secondary settings, the literature consistently identifies project-based learning as a pedagogical approach with the potential to bridge disciplinary boundaries and support integrated STEM instruction. Positioned within the interdisciplinary band of Vasquez's continuum, project-based learning offers a structured yet flexible framework through which students engage in sustained inquiry, apply disciplinary knowledge to authentic problems, and develop transferable skills. The following section reviews the literature regarding project-based learning, with a particular focus on the opportunities it presents for advancing integrated STEM education and the challenges that constrain its implementation in secondary school contexts.

2.2.4 STEM Education as Project-Based Learning

One pedagogical approach lending itself to the instruction of interdisciplinary STEM education is project-based learning (PBL). A reason for this is a common feature of all the STEM disciplines is problem-solving (Banks & Barlex, 2020). It is also proposed that project-based learning links with teaching 21st century competencies such as critical thinking, collaboration, communication and creativity, while linking learning with real-life contexts (Banks & Barlex, 2020; Bolstad, 2011b; Kennedy & Odell, 2023). Studies suggest a interdisciplinary STEM project-based learning experience can improve students' problem-solving skills, engagement, and metacognition and support student retention in STEM and

STEM subjects (Fiteriani et al., 2021; Hiğde & Aktamış, 2022; Salikha et al., 2020). A key outcome of implementing a project-based STEM education programme is that students of all ages can achieve and deepen their knowledge. The next subsections examine how project-based learning complements STEM education, is intercalated with relational thinking, can improve the classroom environment, foster relationships, the challenges to its implementation and the support available to educators.

Project-Based Learning in STEM Education and its Connection to Relational Thinking

Relational thinking, defined as the ability to discern meaningful patterns and connections among concepts, is a foundational cognitive skill in STEM education. It enables learners to move beyond traditional rote memorisation and engage in higher-order reasoning, such as identifying analogies, anomalies and causal relationships (Alexander et al., 2016). In high school STEM education, relational thinking is particularly critical as students' encounter increasingly abstract and interdisciplinary content. Project-based learning offers a pedagogical structure that naturally supports the development of relational thinking by embedding students in complex, authentic tasks that require the integration of diverse knowledge domains (Smith et al., 2022).

The relational dimension of project-based learning is further reinforced by its capacity to integrate interdisciplinary knowledge. In STEM contexts, students are encouraged to draw upon science, technology, engineering and mathematics in tandem, often within socially relevant frameworks (Lee & Lee, 2025). This integration demands relational thinking as students' must understand how concepts interconnect and how their collaborative efforts contribute to holistic solutions. Relationality in project-based learning can extend beyond the classroom as projects often involve encouraging students to understand the societal implications of their work. Meta-analytic evidence further supports the connection between project-based learning and relational thinking. Zhang and Ma (2023) found that project-based learning significantly improves academic achievement and higher-order thinking skills. These results were enhanced when project-based pedagogy was implemented with small groups and over extended periods (Zhang & Ma, 2023).

Project-Based Learning and Extended Learning Periods

To facilitate the implementation of complex authentic projects and create a transformative learning experience that project-based learning offers, some schools have started trialling extended learning periods. Taking an overview of the literature Hipkins (2008) noted that although teachers and students have expressed a preference for extended learning periods the reasons are still unclear. Whilst in the USA, Zepeda and Mayers (2006) analysed 58 studies regarding block scheduling (extended learning periods) and reached similar conclusions, but they do offer some generalised insights. For example, they noted that for teachers, the most common cited reasons for preferring block scheduling included opportunities for increased student-teacher interactions, better student discipline, increased student attendance rates, and time to implement new teaching strategies. Whilst within the studies, students most commonly mentioned benefits were increased student-teacher interactions, more time for in-depth learning, a less hectic school day and getting better grades. To further study the effect an extended learning period can have for students' and teachers' experiences, Hipkins, Shanks and Denny (2008) studied a high school in Aotearoa New Zealand, that had moved from a traditional 50-minute timetable to 100-minute learning periods with a three-day extended project at the end of each term. Data for the study included teacher surveys, student surveys, interviews with the foundation senior management, teacher feedback at staff meetings (post survey results) and four student focus groups (Hipkins et al., 2008). Findings showed that 82% of teachers agreed or strongly agreed their preference for the 100-minute lessons, however only 43% of students mirrored the same outcome. Still, a noticeable difference was observed in the three-day extended project with teachers commenting it was easier to make connections between topics and students' lives, that students could make connections to other subjects and the result was a marked improvement in student engagement and lower absenteeism during this time (Hipkins et al., 2008). Hipkins and colleagues commented that teachers believed there was a higher degree of transformative learning during the three day extended projects. However, these events were not subject to any standardised assessment requirements and notably, the teachers involved considered the three-day event as centred on "learning" and "fun" (Hipkins et al., 2008, p. 48). What was not discussed is what pedagogical approaches were used during the extended learning periods beyond using a variety of learning strategies and whether there was a preference for the 100-minute lessons depending on the learning approaches and subjects taught.

Project-Based STEM Education Improving the Classroom Environment.

Alongside using real-life contexts, utilising project-based learning for STEM education lends itself to replicating the real-life environments engineers and scientists experience. As an authentic project-based learning environment, this encourages students to collaborate, challenge viewpoints, argue, and share concepts (Chang & Chen, 2023). The result is a beneficial learning environment where students can work collaboratively with their peers, teachers, and others to ensure the best performance and outcomes (Chang & Chen, 2023). The social and emotional process involved in debating and collaborating whilst constructing knowledge in project-based learning has been found to facilitate shaping students' interpersonal and intrapersonal skills (Tsybulsky & Sinai, 2022). Also, improving students' skills in project management and problem-solving whilst building relationships can improve aspects of student wellbeing such as self-efficacy (Allison et al., 2015).

In various educational institutions, including vocational training institutes, high schools and primary schools, students have reported that project-based STEM programmes improve student-teacher and student-student relationships and that they are proud of their projects (Alves et al., 2019; Hugerat, 2016; Sunarno, 2019). For example, in a study by Hugerat (2016), 458 ninth-grade science students were divided in half between traditional teaching and project-based learning groups. Like other studies, students in the project-based learning cohort reported that their classroom environment was more satisfying and enjoyable, with improved student-teacher relationships. The qualitative area of this mixed-methods study reported this outcome for two reasons: students' perception of receiving greater teacher support and the class having less tension and difficulty (Hugerat, 2016). The study stated that this second outcome was due to the students being more engaged and actively involved in their learning and the participants feeling like the work was easy. However, whilst Hugerat (2016) mentions that the teacher did not have to 'push' students to complete work he does not state whether this was a student perception or a change in teaching style, which subsequently improved the student-teacher dynamic.

Improving student-teacher and student-student relationships in project-based learning environments has also been shown to be particularly beneficial for Māori learners because these relational dynamics align with culturally grounded pedagogies that prioritise connection, reciprocity, and identity affirmation. In classrooms where Ako (reciprocal

learning) and Whakawhanaungatanga (relationship-building) are actively fostered, Māori students report feeling more engaged, respected, and motivated to learn (Tolbert et al., 2024). Project-based learning, with its emphasis on collaboration and real-world relevance, naturally supports these relational principles, creating spaces where Māori learners can see their cultural values reflected in the learning process. Importantly, these environments also promote relational thinking, where students are encouraged to make connections across concepts, disciplines, and social contexts. Relational thinking is central to Māori epistemologies, which value holistic understanding and interconnectedness (Wearmouth, 2017). When project-based learning is implemented through a relational lens that honours Māori worldviews, it not only enhances classroom climate and interpersonal relationships but also deepens cognitive engagement, enabling Māori learners to thrive both academically and personally.

Project-based learning in STEM education offers a dynamic approach that supports both cognitive development and the cultivation of meaningful relationships. Through the integration of complex, authentic tasks, students engage in interdisciplinary problem-solving that encourages them to make connections across STEM domains while also navigating the social and emotional aspects of collaboration. This emphasis on relational thinking enhances students' ability to link concepts and work collectively, contributing to a classroom environment that promotes deeper engagement and stronger student-teacher and peer relationships. Although students often express a preference for collaborative and authentic learning experiences, the evidence surrounding extended learning periods is mixed, particularly when projects are closely tied to assessment requirements (Hipkins, 2008; Hipkins et al., 2008; Margot & Kettler, 2019). Nevertheless, research suggests that when students feel intellectually and socially supported, they experience increased self-efficacy, reduced tension, and a stronger sense of belonging (Allison et al., 2015; Hugerat, 2016; Tolbert et al., 2024). These outcomes position project-based learning not only as a strategy for academic enrichment but also as a framework for fostering holistic learning environments where cognitive growth and interpersonal wellbeing are closely connected.

Challenges with Implementing Project-Based STEM Education

Challenges to implementing a project-based STEM education initiative have been recorded in a systematic review by Margot and Kettler (2019). Based in the USA with preK-12 teachers,

thematic analysis of 25 articles identified six areas of concern with implementing project-based STEM education. Barriers included pedagogical and curriculum challenges, structural challenges, concerns about students such as safeguarding the needs of diverse students, and uncertainty about whether specific STEM concepts were taught, especially for assessment and pedagogical requirements (Margot & Kettler, 2019). Teachers also voiced concerns that students in project-based STEM education would be either unable or unwilling to be successful in the STEM initiatives (Diana et al., 2021; Margot & Kettler, 2019). The concerns highlight the challenges educators must navigate to implement a project-based STEM education initiative when students must demonstrate traditional knowledge and meet assessment requirements. The result is that STEM education can have inequitable discipline representation, for example, skewed towards science and omitting technology (English, 2016; Millar, 2020). It has been recommended that when implementing a project-based STEM education initiative, educators must ensure students' understanding of the integrated content is developed (English, 2016).

However, a growing body of research demonstrates that students who learn in a project-based STEM learning environment can achieve in standardised testing at the same, and sometimes higher, levels than students taught using traditional instruction (Mergendoller et al., 2006; Strobel & Van Barneveld, 2009). This finding has been corroborated by Craig and Marshall (2019), who studied students at two different schools within the same central school district in Texas (USA). Students in the study were in grades 9, 10, and 11 (ages 14 to 17) and enrolled at either a school using traditional teaching methods or another using authentic project-based learning. Measuring students' performance in the Texas Assessment of Knowledge and Skills (TAKS) standardised tests in science and mathematics demonstrated that the project-based STEM group achieved significantly higher science scores, including outperforming the national figures (Craig & Marshall, 2019). However, Maths results indicated no statistically significant differences between the two groups. The authors hypothesised this was because the science questions on the TAKS exams were based on applying knowledge in real-life applications (Craig & Marshall, 2019). It is important to note that although the Maths results did not improve, there was no detrimental effect. These findings could give educators confidence that students taught in authentic project-based STEM classes can learn the required STEM concepts and continue to achieve in traditional standardised assessments and tests.

Support for Project-Based STEM Educators

To successfully support educators in implementing an integrated STEM initiative, Wilhelm, Wilhelm and Cole (2019) unpacked three studies using Project-Based Instruction (PBI) in high school settings within Earth Science, Maths, and Industrial Electronics classes. The focus was to question what constitutes a "good" project and create a guide for educators (Wilhelm et al., 2019). The authors comment that each study implemented the projects in a variety of ways with an emphasis on different types of outcomes but there were overlapping characteristics from each study which led the authors to recommend eight key features for project learning:

1. The teacher selects the driving question. The question can be informed by learning goals, curriculum or standards.
2. Students select sub-driving questions. Ensuring student engagement and agency within the project.
3. Students have opportunities to develop their background knowledge and confront or disrupt misconceptions.
4. Engagement is sought beyond the classroom; students, teachers, researchers, and "expert" community members collaborate.
5. Students use benchmark activities and technological tools to scaffold conceptual understanding and assist with research, data collection, data analysis, feedback, and communication.
6. Students are given ample feedback and time for revisions (via project milestones).
7. Students create an end artefact related to their initial sub-driving question.
8. Students share their learning experiences with a community of learners, which includes their parents/guardians. (p. 19)

The eight recommendations act as a guide to enable educators to provide an authentic project-learning environment whilst scaffolding the process for teachers and ensuring support for students.

Project-Based Learning for Social Justice and Equity

Additionally teaching tools and resources have been developed focusing on the evolution of project-based STEM education to encapsulate equity and social justice (Bell, 2019). Building on project-based STEM education's ability to increase interest and engagement in STEM fields, this next step aims to broaden the participation of under-represented students (James &

Singer, 2016). In the USA, scholarships and mentorships have led to more diverse students entering STEM. Still, these students often leave the STEM pipeline, citing that the STEM environment and experience did not meet their needs and values (Johnson, 2012; Johnson et al., 2021). However, STEM education pedagogy, such as project-based learning, is developing to meet the needs of diverse learners (James & Singer, 2016). In the USA, a collaboration between researchers, teachers, and the National Science Foundation (NSF) has produced an online tool to provide educators with practice briefs, resources and project ideas to enhance social justice and equity project-based STEM education (Bell, 2019). To enhance social justice and equity STEM education Bell (2019) advocates that projects focus on the inclusion of one of seven key factors:

1. Engage in culturally based pedagogies: create equity through cultural responsiveness.
2. Support diverse sense-making: improve and build on resources to enable students to bring their diverse experiences.
3. Disrupt ableism: go beyond universal design.
4. Centre racial justice: counter-racist pedagogies and responses to systemic racism
5. Arrange for cross-age, family, and community science learning: Families become instrumental in co-designing education. STEM education is accountable to community goals and values. Cross-age and cross-generational learning become normalised and aid in dismantling settler-colonial schooling.
6. Design course sequences using a range of meaningful phenomena: Ensure learners investigate and act upon natural phenomena, including justice centred.
7. Promote place-based learning and ecological caring: socio-ecological practices and justice. (p. 687)

These seven tenets of project-based STEM education for social justice and equity can be seen as interconnected. By focusing on one of these factors, the others become apparent through their interconnected nature. For example, culturally-based pedagogy is interwoven with racial and ability justice (Bell, 2019). Using the seven tenets as the basis or philosophy of projects can create an opportunity to equip students with a deeper understanding of inequities and injustices and develop the skills and knowledge to become agentic transformers.

STEM Education using Counterspaces for Social Justice and Equity

Whilst Bell (2019) offers guidance on how to increase the number of under-represented students in STEM by utilising pedagogical approaches centred on social justice and equity,

another aspect being proposed is the use of counterspaces. Acknowledging that the dominant narratives within STEM education can marginalize under-represented groups of students, counterspaces offer a safe space in which students can 'counter' the discourse and develop a positive STEM self-concept (Shirazi, 2019). For example, seeking to cultivate a counterspace to encourage young Black girls in the USA to engage in STEM, Edwards and King (2023) utilised an out of school STEM programme facilitated by two Black women middle school teachers. A total of 12 students aged 12-14 enrolled into the programme with 11 identifying as African American and one as Afro Latina. Alongside the researchers, the teachers developed the *Sisterhood I Am STEM* curriculum which was centred on Black women in STEM, using key STEM concepts and contexts that matched with students' experiences. When designing the curriculum, teachers and researchers used a co-creating approach with the students to ensure inclusion of student voice and experience. Embedding the programme within both Critical Race Feminism (CRF) and Culturally Relevant Pedagogy (CRP) findings included participants noting the self-confidence to "do anything if I just stick my mind and heart to it" (p. 12) and wanting to pursue STEM careers (Edwards & King, 2023). The study concludes by noting how counterspaces when added to critical race feminist interventions can aid in encouraging under-represented marginalized students to engage and persist in STEM (Edwards & King, 2023).

At a time when STEM education is tasked with increasing the number of under-represented marginalised students into STEM careers, literature which recommends support and guidance offers educators the opportunity to fulfil this challenge. Utilising pedagogical approaches such as project-based learning can increase student engagement and retention. These outcomes can be enhanced when educators focus projects on one of the seven tenets suggested by Bell (2019) and provide counterspaces enabling the improvement of social justice and equity dynamics of STEM education.

STEM education has become a greater priority for governments due to the opportunities that it has to offer in increasing and diversifying student participation in STEM subjects, careers and increasing scientific literacy to better enable a 21st century workforce. The following section explores the progress of the implementation of STEM within the education sector.

2.2.5 STEM Education Implementation Progress

Due to the priority given to STEM education (section 1.3) and the advances STEM education has made, what is its progress with being implemented in the education sector? Tracking the status and perspectives of STEM education, a review by Ellis et al. (2020) highlights the implementation progress within several countries, including Australia, Belgium, Brazil, China, Israel, Russia, Taiwan and the USA. Each of these countries reported on what type of STEM education programme was taking place within junior and senior high schools, the positive aspects of the programmes and what the constraints were. For example, Australia reported they were moving from the discipline of STEM education to a real-life context and integrated approach denoted as iSTEM (Banks & Barlex, 2020; Ellis et al., 2021). Policymakers have noticed reports of positive engagement and outcomes from the iSTEM programmes, resulting in 262 New South Wales (NSW) schools integrating iSTEM. Designed to address local needs and fit into their curriculum, this approach is supported by the NSW Education Standards Authority (Ellis et al., 2021). However, Israel has taken a broader approach with the implementation of iSTEAM, which denotes the integration of iSTEM with the Arts (Banks & Barlex, 2020). The next development phase for Israel is training more teachers to teach project-based iSTEAM. Israel is managing this in three ways: professional development of current teachers, educating management and teachers on how to co-ordinate project-based iSTEAM programmes, and providing a Masters of Education (M.Ed) that is taught using the same methods (Ellis et al., 2021).

Whilst in China, policy makers have recognised the ability of project-based STEM education to aid in producing innovative thinkers (Banks & Barlex, 2020; Ellis et al., 2021). The policy *China STEM Education 2029 Innovation Action Plan* aims to transform teachers' pedagogy and includes five action points (Ellis et al., 2021):

1. STEM education should be included in the national innovative talent training strategy.
2. STEM education is a national lifelong learning activity.
3. STEM education is a coherent curriculum group across disciplines and segments.
4. STEM education is a carrier for cultivating the comprehensive quality of all students.
5. STEM education is an educational innovation practice involving the whole society. (p. 251)

Initially, 70 pilot schools were enrolled, and 200 seed schools are utilising the learning from the pilot programmes (Banks & Barlex, 2020). This approach marks a turning away from the traditional teaching of STEM subjects in China.

A final remark by the review authors highlights two salient points from these regional perspectives on STEM education. A lack of cohesion in defining STEM education has driven a response that is not 'pigeonholed' (Banks & Barlex, 2020). Alternatively, without definition, STEM education can become 'imbalanced', and priority is given to one aspect, especially when resourcing is available. One example included prioritising science to the diminishment of other STEM subjects (Banks & Barlex, 2020). Again, what has not been made clear within these policies is how educators are to address the dichotomy of implementing project-based STEM education initiatives, whilst traditional assessment requirements remain unchanged.

Although there has been a global drive to increase the number of students entering STEM education, the outcomes of these policies still need to be clarified. A USA-based non-profit charitable organisation called the Centre for Excellence in Education (CEE) tracks outcomes of the International Olympiad competitions in Biology, Chemistry, Physics, Maths and Informatics. Recent data demonstrate that over the last two decades, the performance of European students has fallen down the rankings index, and Asian countries have risen (McLean, 2023). For example, the People's Republic of China has dominated each event for the last 30 years, whilst Japan and Taiwan have been ranked third and fourth, respectively. The exceptions to these results were the increased rankings for the United Kingdom, which placed 10th, and the USA, which placed second (McLean, 2023). The authors of the analysis postulate that the improvements in USA students' scores and their new second-place ranking are due to the increasing prioritization on STEM. The result is that students who want to distinguish themselves take part in academic competitions such as the International Olympiad (McLean, 2023). The CEE could not account for the country with the most significant improvement, as the UK moved to 10^{th} place from the previous year's 22^{nd} ranking. However, it is essential when considering these results that the students who participate in the International Olympiad competitions are usually interested in STEM and have achieved highly in their subject.

In contrast, the USA National Science Foundation (NSF) data highlights a different perspective. The NSF 2024 publication documenting the progress of Elementary and Secondary STEM students notes that the average scores for maths in the 2022 National Assessments, after plateauing for several years, had dropped to pre-2005 levels (NSF, 2024). It is hypothesised that this steep decline is due to the disruption caused by the Covid-19 pandemic. The report also recognises that the decline was most significant for Black and Hispanic students, students eligible for free school lunch and those already in the 10th percentile of Maths attainment. The report finished by acknowledging that although high school students were earning more Maths credits and completing more advanced Maths courses than in previous years, the National Mathematics Assessment scores had remained the same (NSF, 2024).

STEM Education Progress in Aotearoa New Zealand

In Aotearoa New Zealand, most mainstream schools design their programmes based on the official policy document, *The New Zealand Curriculum* (*NZC*). The *NZC* has an overarching statement that its design is to ensure young people develop the competencies they need for study and work whilst becoming lifelong learners who can realise their potential (Ministry of Education, 2007, p. 8). The Government of Aotearoa New Zealand recognises the importance of STEM education in producing both STEM professionals and a scientifically and technologically literate society (Ministry of Education, 2018). This sentiment is supported by the *NZC*, in a position statement within the science section that states students can become "critical, informed and responsible public citizens" (Ministry of Education, 2007, p. 17).

One measure the Ministry of Education (MOE) took to increase STEM participation was fostering a close partnership with the Ministry of Business, Innovation and Employment (MBIE) and their programme, *Nation of Curious Minds*. This programme supports the national strategic plan for Science in Society and aims to increase young people's awareness of the importance of science and technology (Curran M, 2016). However, reporting on Aotearoa New Zealand, STEM initiatives, McKinley et al. (2015) discuss how students' enjoyment of Science and Maths diminishes when transitioning from primary to secondary schooling (McKinley et al., 2015). Meanwhile, Trends in International Mathematics and Science Study (TIMSS) data provides evidence that Aotearoa New Zealand, has a large proportion of students with low levels of scientific literacy compared to other top-performing

jurisdictions (Buntting et al., 2016). Of concern is that Māori and Pasifika students are over-represented in academic underachievement in science subjects (section 2.3.2) (Buntting et al., 2016).

A more positive representation of STEM success in Aotearoa New Zealand, is presented in the April 2021 edition of the *Education Gazette*. The article focuses on the various projects and resources available to encourage and support teachers and students in STEM careers (Education Gazette, 2021). Although not a peer-reviewed journal, the *Education Gazette* is a publication produced by the Ministry of Education, and it gives insight into school programmes across the country. The report documents the rise in the use of robotics in teaching and learning and how Techwomen NZ has set up a mentoring programme called ShadowTech for women teachers and girls in years 9-11 (ages 13 to 16) to support the technology aspect of STEM (Education Gazette, 2021). To support Māori ākonga, two programmes were mentioned: Science Alive Mātauranga and Pūhoro STEM Academy. Science Alive provides STEM learning content for students aged 9-13, whilst Pūhoro is a mentoring programme designed to support Māori leadership and capability in science and is available to view online (Pūhoro, 2025). Although the article gives insight into the resources, support and pedagogical change available for STEM education, it reinforces how uptake is based upon the needs of individual teachers and schools and not because of a defined strategy. Without a definition or strategy, there is significant variation in the documented STEM education projects, which cover both the discipline and instruction models.

To aid in moving STEM education forward, a framework of changes within science learning pathways published by the New Zealand Council for Education Research (NZCER) recommended four competencies be added alongside any *NZC* updates. The competencies include honouring Te Tiriti (the Treaty of Waitangi, Māori version) and including mātauranga Māori (Māori knowledge and ways of knowing), thus enabling students to draw upon other knowledge systems and acknowledge the broader diversity within Aotearoa New Zealand, (Hipkins et al., 2022). Alongside this was the recommendation for including diverse pedagogical approaches linked with using science for decision-making and action (Hipkins et al., 2022). Included as a priority was working with science literacy, which is specially placed to discuss connections, science communications and how these can be linked to misinformation and disinformation (Hipkins et al., 2022). These competencies can be integrated into any school science or STEM programme, especially as they encapsulate the

philosophies of DEI and have the flexibility of being integrated into any step of the Vasquez (2015) STEM education integration model.

In summary, the recognition of the importance of STEM education for bridging the gap in the STEM pipeline and improving the scientific literacy of the general population has resulted in STEM education gaining traction globally. However, an unclear picture emerges with data at a national level suggesting that the push for STEM education has yet to bridge the gap between students' interest in STEM and the educational outcomes of STEM subjects. Yet data from project-based STEM education schools in the USA detail greater engagement with STEM subjects and improved academic outcomes, and a similar picture emerges in Aotearoa, New Zealand. Whilst STEM education as interdisciplinary project-based learning is discussed within the *New Zealand Curriculum*, any formal policy has yet to be set, and any initiative is a decision for each school. Evidence indicates a marked decline in students' engagement with science during the transition from primary to secondary education, with Māori and Pasifika learners disproportionately represented among those underachieving in STEM disciplines. Whilst articles in the *Education Gazette* have documented school STEM initiatives and the resulting student engagement, this has yet to be translated into a national improvement in STEM interests and outcomes. However, the NZCER has provided a framework of recommendations that can be integrated into schools' and educators' science/STEM planning. These recommendations align with planning for DEI and could address inequalities experienced by Māori whilst assisting in developing an integrated STEM curriculum.

2.2.6 STEM Education Summary

STEM education has emerged as a global priority, driven by data indicating a growing demand for STEM carers and 21st-century competencies. The result is governments are implementing policies to cement STEM education into teaching and learning. In Aotearoa New Zealand, science, technology and Mathematics are represented within *The New Zealand C*urriculum, but the integration into an interdisciplinary STEM initiative is yet to become policy and remains the remit of a school or individual teacher. Although there has yet to be a consensus on STEM education, over the last decade, there has been a pedagogical shift towards STEM education as a new paradigm rather than its singular parts. However, in the

high school setting, STEM education can be constrained by the school structure, and the knowledge and assessment requirements.

When paired with project-based learning, STEM education can transcend the limitations of teaching individual subjects into an interdisciplinary holistic style of learning which mimics the working realities of those who choose STEM careers. Along with integrating these subjects into a new paradigm, a interdisciplinary project-based STEM programme enables students to acquire complex communication skills, intra- and inter-social skills, problem-solving skills, self-management, project management skills and systems thinking to help compete in the modern economy (Chang & Chen, 2023; Vasquez, 2015). As project-based learning requires students to collaborate on authentic tasks, it inherently promotes relational thinking and encourages learners to make meaningful connections across concepts, disciplines, and social contexts while building strong interpersonal relationships (Banks & Barlex, 2020; Bybee, 2010).

Many positive outcomes of project-based STEM education can be attributed to improving classroom environments, including student-teacher and student-student relationships. Students also perceive receiving greater teacher support and a sense of pride in their project work. Research further shows that project-based learning fosters a sense of belonging and wellbeing by embedding social and emotional processes such as collaboration, argumentation, and shared problem-solving (Banks & Barlex, 2020; Bolstad, 2011a; Kennedy & Odell, 2014). These outcomes position project-based learning not only as a strategy for academic enrichment but also as a framework for holistic learning environments where cognitive growth and interpersonal wellbeing are closely connected.

For Māori learners, these relational dimensions are particularly significant because they align with culturally grounded pedagogies that prioritise whanaungatanga (relationships) and ako (reciprocal learning). When implemented through a relational lens that honours Māori worldviews, project-based STEM education can affirm identity, strengthen engagement, and promote equity (Highfield & Webber, 2021).

Providing counterspaces and centring social justice and equity within project-based STEM education can aid with increasing the number of under-represented and marginalised students entering STEM, whilst reducing the number leaving the STEM pipeline (Bell, 2019; Edwards

& King, 2023). Embedding culturally sustaining practices and community partnerships further enhances these outcomes, creating opportunities for students to co-construct knowledge in ways that reflect both Western and Indigenous epistemologies (James & Singer, 2016).

In summary, STEM education integrated with project-based learning and relational approaches offers a transformative pathway to develop 21st century competencies, foster belonging, and address systemic inequities. The following section examines how historical and structural factors have shaped Māori learners' educational experiences and why these relational strategies are critical for equity.

2.3 How Māori Ākonga (students) Experience Education

Māori being over-represented in academic underperformance has been a discussion point among politicians and educators since the Hunn report was completed in 1960 (Hetaraka, 2022). To gain a deeper perspective on this issue, this section explores how Māori ākonga experience education in Aotearoa, New Zealand. It examines how the founding principles of the education system, born of British imperialism, have resulted in Māori experiencing an education debt that continues to affect them, especially Māori wāhine in science and STEM. The final section explores how one remedy to these issues could be the inclusion of mātauranga Māori and its potential to move education away from its colonial roots and lead it onto a path of indigenisation.

2.3.1 Education Policies Towards Māori

To fully appreciate how Māori ākonga experience education in Aotearoa New Zealand, it is imperative to understand how the current education system was created. Examining the educational policies that founded the current mainstream education system can give insight into the political, structural, and intersectional (section 2.4) barriers that Māori experience. To remedy these issues, recent policies and programmes striving for cultural reform have been implemented striving to improve educational outcomes for Māori.

Colonising Policies

Educational policy in Aotearoa New Zealand, was historically constructed from the position of British imperialism to indoctrinate Māori into the 'white civilised world' (Hetaraka, 2022).

This process started with the colonisation of Aotearoa New Zealand in 1816 when Thomas Kendall opened the first (Anglican) missionary school in the Bay of Islands in Northland (Hetaraka, 2022). A common theme of missionary schools was to educate indigenous people into a 'civilised' life. They were instrumental in eradicating Indigenous knowledge by preventing the intergenerational teaching of te reo Māori (Māori language) and culture and enforcing the worldview of the missionary churches and teachings (Hetaraka, 2022; Ka'ai-Mahuta, 2011). In 1840, Te Tiriti o Waitangi, the founding document of Aotearoa New Zealand, was signed between tāngata whenua (Māori indigenous people) and the British Crown. Disagreements due to the variations between Te Tiriti (te reo Māori version) and The Treaty (English translated version) contributed to the process of land confiscation, which culminated in the Land Wars in the 1860s (Hetaraka, 2022; Ka'ai-Mahuta, 2011). By 1847, Sir George Grey introduced the Education Ordinance Act, which aimed to guarantee all schools ensured children could read and speak English. However, this Act also provided for boarding schools to remove Māori children from their whānau (family) (Hetaraka, 2022). The 1867 Report to the Minister of Native Affairs found Mission schools were not fulfilling their role of removing Māori children, prompting the Native Schools Act, which gave government oversight of all the schools in Aotearoa New Zealand (Ka'ai-Mahuta, 2011). The 1877 Education Act was implemented to centralise education and establish state primary schools. However, this policy was separate from the Native Schools Act and created a two-tier education system for Pākehā settler children and Māori (Hetaraka, 2022). This produced the illusion that the Education Act was established to create equality, but the equality was between rich and poor Pākehā (non-Māori/settlers) and not between Māori and Pākehā (Hetaraka, 2022; Ka'ai-Mahuta, 2011). The Native Schools Act remained in place for 90 years, and the last native schools were not transferred into the control of education boards until 1969. The resulting negative impacts of the colonial educational system, including language and cultural loss, were documented in the 1960 Hunn report, which highlighted the growing disparity in the academic achievement and attainment between Māori and Pākehā, with the report finding 3.78% of Pākehā children going on to sixth form (current Year 12 for 16-year-olds at high school) compared to only 0.5% of Māori children (Hetaraka, 2022; Ka'ai-Mahuta, 2011; Kidman et al., 2011).

Summing up historical educational policies, Lee and Lee (1995) concluded that Māori have been conquered through division and assimilation, and this provided the foundations for an education system in Aotearoa New Zealand, that results in outcomes that disadvantage Māori.

Bicultural Policies

Launched in 1999, *Ka Hikitia* was the first policy produced to specifically support the educational achievement of Māori (Berryman & Eley, 2017). *Ka Hikitia* means to 'step up', 'lift up' or 'lengthen one's stride' and was developed in collaboration with Te Puni Kōkiri (Ministry of Māori Affairs) and drew upon Māori research and community views and experiences (Berryman & Eley, 2017). The policy focused on achieving three main goals: to support the growth of high-quality Kura Kaupapa (Māori-medium) education, raise the quality of English-medium education for Māori, and support greater Māori involvement and authority in education (Berryman & Eley, 2017). Further cultural strategy documents were released due to reviews and audits of the *Ka Hikitia* policy (Ministry of Education, 2017b), including *Managing Success 2008-2012* (Ministry of Education, 2009) and *Accelerating Success 2013-2017* (Ministry of Education, 2013), and each focused on key areas to support Māori in education. Within *Managing Success 2008-2012* the report highlights 'stepping up' the education system to ensure Māori succeed as Māori (p. 11). The policy recommends a collaborative approach between the education system, whānau (family), Iwi (tribe) and hapu (sub-tribe), the aim of which was to foster support for Māori self-development and self-determination. In the classroom, educators were encouraged to consider language, culture and identity. Educators were tasked to value who their students are, share knowledge and ensure Māori learners are participating in te ao Māori (the Māori world) (p. 20). *Accelerating Success 2013-2017* maintained the vision of Māori succeeding as Māori and ensuring students can participate in te ao Māori. The overarching aim was for all Māori learners to demonstrate the expected literacy, numeracy and language skills levels and achieve at least National Certificate of Educational Achievement (NCEA) Level 2 or an equivalent qualification (p. 8). However, this policy also suggested ākonga (learners) should feel supported in goal setting and "experience teaching and learning that is relevant, engaging, rewarding and positive to gain the skills, knowledge and qualifications they need to achieve" (p. 2). It noted that educators must develop teaching and learning approaches that are "engaging, effective and enjoyable for all Māori students" (p. 2) whilst strengthening "capability and accountability for Māori education and language outcomes across all stakeholders" (p. 8). The document continued by outlining how high-quality teaching must be supported by effective leadership and governance.

In addition, *Tātaiako, cultural competencies for teachers of Māori learners* (Ministry of Education, 2011), was released to provide teachers of Māori learners with descriptors of cultural responsiveness from which to navigate and apply *Ka Hikitia* to their teaching practice (Ministry of Education, 2011). These competencies went on to be linked to behavioural indicators within the Graduating Teacher Standards, part of the Education Council's practising teacher criteria required to be a registered teacher (Berryman & Eley, 2017; Lourie, 2016; Teaching Council, 2017).

The progress and outcomes in educational achievement for Māori ākonga (learners) (section 1.4) since implementing *Ka Hikitia* call into question the effectiveness of past and current educational strategies designed to increase Māori educational outcomes. Analysing contemporary culturally responsive education policies and whether they have improved Māori achievement, Krzyzosiak and Stewart (2019) document each in turn. Their review included data from *Ka Hikitia*, *Tātaiako*, and the combined policies of *Tau Mai Te Reo* and *te Ahu o Te Reo Māori,* which are focused on the inclusion and revitalisation of te reo Māori (Māori language) (Krzyzosiak & Stewart, 2019). The review concluded that although these policies are ambitious, they have made little impact on the statistical inequities for Māori under-achievement, since they were highlighted in the Hunn report in the 1960s. It also called into question why policies focus on cultural responsiveness, which should be part of good teaching practice, rather than policies that include professional learning about the accurate histories of Māori-Pākehā relationships and transformative teaching that aids in overcoming the impact of poverty (Krzyzosiak & Stewart, 2019).

It has been argued that bicultural education policies that stemmed from the Fourth Labour Government in Aotearoa New Zealand, were only developed to quell the growing protests by Māori, which were threatening social cohesion, adding weight to the argument that bicultural policies have been used to address cultural differences rather than placing culture as critical to Māori development and outcomes (Lourie, 2016). Using the examples of the Education Act 1989 and *Ka Hikitia,* Lourie (2016) highlighted how primary legislation remains intact, whilst culturally responsive policies are 'tacked on' (p. 640).

What has been missed within these policies is systems-wide transformative change. The education system is still grounded within a Pākehā (New Zealand European settler) worldview. For example, knowledge and assessment requirements remain unchanged. Whilst it is the responsibility of each school to implement culturally responsive policies, no

requirement is directed towards educators developing new ways of thinking grounded in te ao Māori (the Māori world), which would lead to transformative teaching. This raises the question of whether the policies themselves are deficient or the implementation through a sustained Pākehā education system, leaving the responsibility for cultural reform resting solely with schools and teachers.

Cultural Reform

During the consultation period and drafting of *Ka Hikitia,* the Ministry of Education supported research funding for the development of Māori education, and one such project was *Te Kotahitanga* (Berryman & Eley, 2017). By 2001, the first phase of the *Te Kotahitanga* programme, one of the most extensive educational programmes conceived to increase academic outcomes for Māori students, was started by Russell Bishop (Bishop, 2011). The programme evolved from studies documenting the narratives of Māori ākonga school experiences and their opinions on why they thought they were less successful at school. The overwhelming issue Māori ākonga discussed was the poor relationships with their teachers. However, a more extensive list of problems revealed why the education system was ineffective for Māori learners, including ineffective teaching methods, teacher racism, peer racism, less positive feedback, fewer teacher-student interactions, more negative comments targeted towards Māori, and failure to uphold mana Māori education (Mana Māori includes knowledge, respect, humility, prestige and has a spiritual dimension) (Berryman et al., 2023; Berryman & Eley, 2017; Bishop & Berryman, 2010; Webber, 2024) . The focus for teachers within the *Te Kotahitanga* programme was pedagogical change and professional development to enhance student-teacher relationships and teacher efficacy (Bishop & Berryman, 2010). The overarching aim was to change the narrative away from deficit theorising, which posited that Māori were over-represented in educational underachievement due to negative perceptions about Māori and their ability and turn it towards the idea that culture is fundamental to academic success (Berryman & Eley, 2017; Bishop & Berryman, 2010).

Schools implemented the Effective Teacher Profile (ETP) to achieve these goals. It was designed to help unpack and review teaching practices and change the dialogue into an ‘agentic’ position. It enabled the learning environment to acknowledge and engage culture as a co-contributor to the learning space (Bishop & Berryman, 2010). Predictions included that the implementation of the ETP and ensuring the inclusion of co-construction to improve student agency would result in developing positive relationships between student and teacher

(Berryman & Eley, 2017; Bishop & Berryman, 2010; Bishop et al., 2014). Relationships and relational teaching have been identified as core principles for improving educational experiences for Māori learners (Berryman et al., 2023; Berryman & Wearmouth, 2018).

Implementing Cultural Reform with Relational Teaching

Research suggests that students who feel safe interacting in a classroom environment report positive student–teacher relationships, and these feelings of safety are strengthened by positive peer relationships (Wanders et al., 2020). For Māori ākonga, improved relationships with teachers and peers are key motivators for engagement and achievement (Berryman et al., 2023). High-achieving Māori learners consistently identify three critical factors for success: strong teacher relationships, high-quality teaching, and collaborative peer learning (Adams, 2018). These findings align with relational pedagogy, which positions whanaungatanga (relationships), manaakitanga (care), and ako (reciprocal learning) as central to effective teaching. Evidence from Te Kotahitanga demonstrates that schools embedding these principles, alongside high expectations and dialogic, co-constructed learning, achieve improved outcomes for Māori students (Bishop, 2019; Bishop et al., 2009).

Another consideration with building relationships with Māori learners is improving the connection between schools, educators and whānau. To facilitate relations between non-Māori educators and Māori whānau, three principles are recommended: teacher reflexivity grounded in te ao Māori, improved student-teacher interactions, and respectful teacher-parent interactions (Saunders, 2024). An emphasis on relationships with Māori whānau is included due to Māori learners reporting their most significant motivating source to succeed was their whānau (Adams, 2018; Webber et al., 2016). A kaupapa Māori qualitative study by Rolleston, McDonald and Miskelly (2022) revealed the critical dynamics of support, security and the unique cultural learning environment whānau provide Māori learners. It is important to note, however, that within the survey many Māori respondents were concerned about the disconnect and erosion of relationships between themselves and their tamariki (children) due to the influence of digital technology (Rolleston et al., 2022). By strengthening school-home partnerships and relationships, educators create another layer of connectedness for students motivated to succeed for themselves and their whānau (Webber, 2024). Again, these outcomes are not limited to Māori ākonga. Research indicates that students with a sense of belonging and connectedness are more likely to exhibit positive school behaviours, improved

academic performance and have an improved sense of wellbeing (Bower et al., 2015; Elliott et al., 2004; Osterman, 2000; Webber, 2024).

Systematic evidence from *Te Kotahitanga* and its evolution into *Kia Eke Panuku* shows that relational pedagogy has the greatest impact when it is adopted across a school, monitored for progress, and adapted to context. *Kia Eke Panuku* further incorporated mātauranga Māori to enable Māori to succeed as Māori, although the programme's sustainability was constrained when funding ceased (Bishop, 2019; Kia Eke Panuku, 2023). While principles such as holding high expectations remain influential, research shows that deficit theorising can persist in some contexts. Later analyses suggest that teachers' assumptions are often more strongly associated with socioeconomic status than ethnicity alone (Rubie-Davies & Peterson, 2016; Turner et al., 2015). This leaves educators with a conundrum, as Māori are more likely to be over-represented in underprivileged socio-economic areas, and no advice is given on separating the two. A further extrapolation of this dilemma is that focusing on the improvement of Māori educational achievement by concentrating all efforts solely on cultural identity has made this a school-only problem and distracts from the government having to direct policies that tackle the beyond-school causes of inequality, such as Māori being over-represented in socioeconomic inequality.

Relational pedagogy also intersects with pedagogies that promote relational thinking. Relational thinking involves reasoning about relationships among ideas, patterns, and structures rather than focusing solely on procedural steps. When integrated into project-based learning, these strategies create opportunities for students to build and deepen relationships through sustained collaboration and shared problem-solving, while simultaneously engaging in relational thinking for example, making sense of patterns, structures, and connections across STEM concepts in authentic, real-world contexts (Lee & Lee, 2025; Smith et al., 2022). Culturally responsive project work can further strengthen these effects by embedding local knowledge, language, and values in STEM, creating learning environments that affirm identity while maintaining high cognitive demand. For Māori learners, this combination of relational pedagogy, relational thinking, and culturally sustaining project-based learning provides opportunities to co-construct knowledge in ways that reflect both Western and Indigenous epistemologies, and is associated with increased engagement and achievement (Hunter & Hunter, 2024; Sexton, 2024).

Adding to the discourse, a reason given that culturally responsive policies do not realise their objectives is due to assumptions all Māori students want their cultural identity to be their primary identity, which may not be accurate (Lourie, 2016). This may be especially true for Māori, who, because of colonisation, do not know their whakapapa (genealogy) or have a connection to their Iwi (tribes), which are needed to claim Māori identity and access resourcing formally. This can result in Māori struggling to acknowledge their Māori identity socially (Lourie, 2016). When culturally responsive policies are founded upon the idea of Aotearoa New Zealand, as a bicultural nation, as ethnically distinct people living in partnership, this ignores the more representative idea of identity for young people as one that is multiple and fluid (Cho & Wang, 2020; Lourie, 2016).

In summary, research consistently demonstrates that Māori learners thrive in educational environments where relational pedagogy is central, fostering strong connections between students, teachers, peers, and whānau. Positive student–teacher and peer relationships contribute to a sense of safety and belonging, which are foundational for engagement and achievement (Wanders et al., 2020; Berryman et al., 2023). High-achieving Māori ākonga identify quality teaching, collaborative peer learning, and strong teacher relationships as critical success factors (Adams, 2018), aligning with principles of Whanaungatanga, Manaakitanga, and Ako (Bishop, 2019). Initiatives such as *Te Kotahitanga* and *Kia Eke Panuku* illustrate the effectiveness of embedding these principles school-wide, especially when combined with high expectations and co-constructed learning. Strengthening school–whānau partnerships further supports Māori learners, acknowledging the central role of whānau in motivation and identity formation. However, culturally responsive policies must account for the diversity of Māori identities and avoid assuming cultural identity is uniformly prioritised (Cho & Wang, 2020; Lourie, 2016).

While these approaches are particularly effective for Māori learners, extensive evidence from initiatives such as *Te Kotahitanga* and *Kia Eke Panuku* demonstrates that relational and culturally responsive pedagogies not only enhance outcomes for Māori students but also lead to broader improvements in school culture, teacher efficacy, and student engagement across diverse learner groups (Berryman & Eley, 2017; Berryman et al., 2018). Relational pedagogy aligns closely with project-based learning and STEM education, where sustained collaboration, shared problem-solving, and culturally grounded teaching have been shown to

deepen relationships and foster engagement among all learners (Lee & Lee, 2025; Smith et al., 2022). Furthermore, recent research confirms that culturally responsive teaching strategies, such as integrating students' cultural backgrounds into curriculum and fostering inclusive relationships, significantly improve motivation, participation, and academic achievement for all students, not just Māori (Berryman et al., 2018). These findings affirm that educational strategies which support Māori learners also promote inclusive and equitable learning environments for all students.

2.3.2 Māori Ākonga Experiences in Science Education

It is widely recognised that Māori ākonga taught in Kura Kaupapa (Māori-language immersions schools) achieve better academic results than Māori in mainstream schools (Buntting et al., 2016; Stewart, 2012). However, there is a disparity in these results when analysing science subjects. Of the students in a Kura Kaupapa, up to five per cent of those who gain a national qualification through the National Certificate of Educational Achievement (NCEA) at levels 1, 2 or 3 do not have any science subject credits (Buntting et al., 2016). One explanation for this is given by Stewart (2007) as part of her PhD thesis and articles that have followed it regarding the complexity of language within a te reo Māori immersion school and the primarily English medium science vocabulary, leading students not to choose these subjects (Stewart, 2011a, 2011b; Stewart, 2012).

Different reasons have been postulated in English-medium mainstream schools where claims have been made that Māori are not achieving because they are excluded from gaining higher-level NCEA qualifications in science (Buntting et al., 2016). This claim of exclusion was based on the results and narratives arising from the University of Auckland's Starpath Project (Buntting et al., 2016). It should be noted that although the Starpath Project tracked nine large urban high schools, with a significant proportion of Māori and Pasifika students (50%), the exclusion claim comes from the narratives of three schools. The schools' reasoning for 'exclusion' of Māori from science subjects is based upon its commitment to gain the best NCEA Level 1 grades for their underachieving students (Buntting et al., 2016). The schools streamed their classes, and students classified as at risk of failing were placed into predominantly internally assessed, non-science, achievement standards to give them the optimal chance of passing NCEA Level 1. This resulted in students' inability to continue their

science subjects into Levels 2 and 3 as they had not fulfilled the entry criteria (Buntting et al., 2016).

However, in Aotearoa New Zealand, schools can set their direction, agenda, curriculum, and courses according to the requirements laid out by their Boards of Trustees. As each school will have their priorities, it is impossible to hypothesise that every mainstream high school reflects this position. Also unreported is the outcome for internally assessed students who continued their science education through NCEA Level 2 and 3 as to whether they gained the requisites for University Entrance (UE) as this would require them to participate in external exams (section 1.3). However, this creates another dichotomy for schools under increasing pressure to ensure students achieve their NCEA qualifications who implement measures recommended in a student's best interest but may harm their ability to further their education. This highlights the delicate balance schools and educators need to take when implementing programmes that aim to deliver improved student academic outcomes, as they must maintain a student's opportunities to progress.

What is not addressed by the literature is why Māori and Pasifika are over-represented in the group sitting internally assessed achievement standards at NCEA Level 1, when reports suggest they entered school at similar levels to their non-Māori peers. With data demonstrating that students lose interest in science between primary and high schooling, does this suggest Māori and Pasifika could be over-represented in this group? How can science and STEM subjects in mainstream high schools create such a reduction in interest and engagement in science subjects for Māori ākonga (learners)? One hypothesis for why Māori are not choosing science is a lack of representation. Demonstrating this point, an article by McAllister et al. (2022) documents how Māori and Pasifika scientists are under-represented in Universities and Crown Research Institutes (CRI) (McAllister et al., 2022). Adding complexity, the data highlighted how some human resource departments within these institutions did not know if they employed any Māori or Pasifika scientists. It is unclear whether the lack of Māori and Pasifika scientists employed at these institutions is due to a lack of candidates or institutions not actively recruiting Māori applicants.

However, another proposition for the underrepresentation of Māori in science is the over-representation of Māori in socioeconomically disadvantaged households (Stewart, 2023). In response to the paper in which McAllister (2022) listed the "50 reasons why there are no

Māori in your science department", Stewart explained how the 51st reason is a catalogue of issues caused by socioeconomic disadvantage (McAllister, 2022; Stewart, 2023). The problems documented include not having a quiet study space at home to learn the necessary knowledge in science subjects; parents and caregivers not going to parent-teacher interviews because they need time outside of working hours or require childcare and reimbursement for travel expenses; and many Māori students not staying at school past their compulsory age at Year 11 (aged 16 years) (Stewart, 2023).

What seems clear is that Māori who attend a Kura Kaupapa achieve qualifications at higher rates than Māori who attend an English-medium mainstream high school, except for science subjects (Buntting et al., 2016; Stewart, 2012). Data suggest Māori could be over-represented as the learners most likely to lose interest in science between primary and high schooling. Hypotheses to the barriers to Māori achieving academically in science subjects include lack of representation, and socio-economic factors. However, I postulate that these explanations are synergistic and woven together. Māori students are being prevented from attaining in science due to socioeconomic factors *and* a lack of representation, creating a reinforcing barrier to success, highlighting how the overlapping and interconnected nature of how Māori experience science education can be complex.

2.3.3 Māori Wāhine (women) Experiencing Science Education

Whilst discussing statistics of the Māori population of Aotearoa New Zealand, it is important to ascertain how such data is collected. Identification of Māori in official statistics, by the state is determined through three related but distinct categories: 1. Identifying Māori descent through whakapapa (lineage) with Māori parents or grandparents: 2. Identification through ethnicity, whereby a person must tick an ethnic group(s) box such as Chinese or Māori: 3. The final identity marker is through Iwi (tribal) affiliation (Statistics New Zealand, 2013). Statistics New Zealand records that in 2013, 14.9% of the population identified as Māori and 19.6% of the Māori population participated in full-time or part-time study. Māori wāhine were more likely to study than men, 59% compared to 41%, and more likely to stay at school until 17, 86.5% compared to 81.4%. There was also an increase in Māori entering a bachelor's degree; again, there were more women than men, 12.3% compared to 7.4% (Statistics New Zealand, 2013). Yet in 2012, the Australian College of Physical Scientists and Engineers in Medicine (ACPSM) data on tertiary studies found for women entering a

Bachelor of Science degree in Aotearoa New Zealand, only 7% were Māori and 4% Pasifika (Crowe & Kairn, 2016).

In 2003, Elizabeth McKinley explored the experiences of 16 Māori wāhine scientists. The groundbreaking work documented what it means to be at the intersection of Māori, wahine/woman, and scientist (McKinley, 2003). Through these narratives, it became evident that the perception of a scientist for Māori is somebody with a white body and an 'unremarkable name' (McKinley, 2003). It appears that Māori wāhine scientists must navigate being a woman in a male-dominated industry whilst being visibly Māori and having identifiable names (McKinley, 2005; Reedy et al., 2006). Māori wāhine scientists have also reported problems when trying to publish their academic findings due to being recognised as having racial differences through their names and language. This issue may date back to preconceived ideas of the Māori language and its relationship to "being bright" (McKinley, 2005; Reedy et al., 2006; Simmonds, 2011). This is exemplified by one scientist who spoke of how schools and higher educational institutions were suppressors of Māori language, especially for 'bright' students (McKinley, 2003). This could be seen to be validated by the underlying bias that choosing Māori language as a school subject would not be a desired pathway for a 'bright' student, as this would take them away from other studies (McKinley, 2005).

Unfortunately, such bias was evident in some socioeconomic disadvantaged Aotearoa New Zealand, schools. Discussing how subject choices limit student choices, Jensen, McKinley, & Madjar (2010) demonstrated that the distribution of subject choices limits students to what was perceived as 'higher academic' subjects, such as physics, away from the 'less academic' subjects, such as te reo Māori (Jensen, McKinley, et al., 2010). The authors highlighted how discrimination can occur when, for instance, a student must choose subject options from five columns, one subject for each. In these columns, physics and te reo would be aligned so a student could not take both subjects, and subject clashes persisted throughout subject options (Jensen, McKinley, et al., 2010). Even if these clashes of subjects are coincidental, they continue to give merit to the beliefs of students, teachers and the broader community that those students who want to choose subjects such as physics would not be Māori, or if they are, would not want to identify with their culture and language (Jensen, Madjar, et al., 2010; Jensen, McKinley, et al., 2010). This type of discrimination, similar to the streaming of students in science subjects noted in the Starpath project, is another layer of discrimination

that schools (unwittingly) undertake against their Māori students (Buntting et al., 2016; Melinda, 2018).

Trying to belong in the science fraternity as Māori wāhine starts in school and is the focus of a study by Stewart (2023), who noted how science resources, mainly textbooks, used in mainstream high schools had been found to alienate the Māori girls (Stewart, 2023). The report documented how studies demonstrate that when using science textbooks, many images depict science as triumphalist and scientists as 'White', 'European' and 'Male' (Stewart, 2023). Added to the lack of representation of Māori science teachers and university professors, not providing representation in the classroom in the form of resources and imagery can create another layer of 'othering' Māori students', notably Māori wāhine (McAllister, 2019; Stewart, 2023).

Māori wāhine encounter multiple layers of discrimination when choosing science subjects at school and 'belonging' in science careers. Not accommodating the needs of Māori students when choosing science subjects and not providing resources that include the representation of Māori scientists perpetuates the allegory that science is for 'white European males.' This is especially true for Māori wāhine, who exist at the intersection of multiple bias layers.

2.3.4 Mātauranga Māori (Māori Knowledge) and Science Education

One educational development aiming to change the narrative is the mooted inclusion of mātauranga Māori into the school curriculum, including in science. Mātauranga Māori (Māori knowledge) takes a broad approach and includes knowledge originating from Māori ancestors, whilst holding a Māori worldview and cultural practices (Hikuroa, 2017). However, this move has not been without its challenges and continues to highlight the barriers for Māori within the education system, especially within science/STEM. At the time of this study, the science curriculum and the NCEA Level 1, 2 and 3 science-based subjects did not include mātauranga Māori. Therefore, no achievement data exists for students studying mātauranga Māori or its impact on the STEM pipeline. However, from 2024, high schools were given the option to teach mātauranga Māori as part of their year 11 science syllabus and for it to be given equal status (Ministry of Education, 2023a). At the time of writing, the NCEA Level 1 standards for how and what to teach for mātauranga Māori were just being prepared for publication and implementation.

However, the announcement that mātauranga Māori was to be included in year 11 science classes and given equal status has caused controversy amongst the scientific community. A letter published in *The Listener* magazine in July 2021 revealed seven Aotearoa New Zealand, university academics disapproved of mātauranga Māori being included in the science curriculum and given equal status (Clements et al., 2021). They stated that science was "universal to humanity", with its origins in ancient Egypt and Greece, and they included how the "Muslim world made significant contributions to mathematics and astronomy". They disagreed that science had been used to "support the domination of Eurocentric views" and the "suppression of Māori knowledge". They continued that scientific knowledge had to meet the scientific criteria for "empirical, universal truths" (Clements et al., 2021, p. 4). Whilst the authors recognized Indigenous knowledge's contribution to culture, public policy, and science, they concluded that mātauranga Māori did not reach the same academic rigour as science (Stewart, 2024; Waitoki, 2022). In response to this letter, the university where these seven academics held positions had an investigation and acknowledged the hurt and harm the letter had caused students and alums. But the controversy did not stop. Elon Musk, the tech billionaire, and Richard Dawkins, emeritus fellow at New College Oxford, weighed into the debate. They argued that including mātauranga Māori with science was 'ludicrous' and that mātauranga Māori only had valuable tips on 'edible fungi' and 'star navigation' (Leask, 2023). Some responses to the discourse included Māori academics who agreed mātauranga Māori should not be given equal status to science as it is best placed as a philosophy of science rather than science itself (Stewart, 2022). Other responses refuted the idea of a universal science and that science was not just 'Western' and was a colonial trope (Waitoki, 2022). Responses also questioned how the letter positioned itself as if believing ideas had developed through a 'natural development of healthy exchange' rather than due to imperialist expansionism or colonialism, concluding how there were racist undertones by relegating Māori knowledge to just culture and ignoring Te Tiriti (The Treaty of Waitangi, te reo Māori version) (Waitoki, 2022).

This discourse highlights how people in positions of authority and power within the science community can create extra layers of discrimination and oppression of Māori. Lessening Māori knowledge and positioning it as inferior to Western science maintains a Eurocentric and colonial perspective that has disadvantaged Māori, including within the schooling system. However, School Boards of Trustees and educators must uphold the principles of Te

Tiriti and have the flexibility to construct their programmes based on the *New Zealand Curriculum* and the community's priorities. Providing a syllabus that encapsulates mātauranga Māori, supported with both resources and NCEA achievement standard credits, creates an opportunity for schools to indigenise their curriculum, ensuring equity and social justice in their science and STEM teaching, as depicted in the seven tenets by Bell (2017) (Section 2.2.4).

Adding mātauranga Māori to the education system creates an opportunity to move away from Indigenous inclusion through cultural responsiveness and journey towards indigenisation. Indigenous inclusion can lead to the superficial inclusion of Indigenous knowledge and values, often resulting from poorly written or implemented culturally responsive policies. In contrast, indigenisation normalises indigenous ways of being and knowing (Hoskins & Jones, 2022). When schools are encouraged to be culturally inclusive, the implication is one of 'including' with the aim of 'helping', which can lead to deficit thinking as it starts with a standpoint of 'othering' (Hoskins & Jones, 2022). Indigenisation moves away from tokenistic inclusion and has the power to transform institutions into ones that normalise indigenous ways of knowing and being (Hoskins & Jones, 2022). Embracing mātauranga Māori could do more for Māori than all previous culturally responsive policies. Highlighting the importance of the reinstatement of mātauranga Māori, Broughton and McBreen (2015) conclude, "The rationale for mātauranga revitalisation arises from Tino rangatiratanga (self-efficacy) and the need to flourish if Māori are to survive as Māori" and "mātauranga is the key to Māori living and developing as Māori" (Broughton & McBreen, 2015, p. 84).

Integrating mātauranga Māori into the science curriculum not only challenges conventional understandings of science and pedagogy but also holds the potential to strengthen relationships with Māori learners and communities, an essential objective underpinning initiatives such as *Te Kotahitanga* and *Kia Eke Panuku*. Creating an opportunity to start indigenising the education system while reducing the disenfranchisement of Māori learners from science subjects. It is an approach that could see two independent knowledge systems working alongside each other to expand thinking and knowledge generation (Broughton & McBreen, 2015).

2.3.5 Māori Ākonga and Education Summary

The colonial history of the education system in Aotearoa New Zealand, has been instrumental in the loss of Māori language and culture. The resulting impact sees Māori suffering an education gap where they are over-represented as being more likely to leave school early with fewer qualifications and taking jobs that maintain socioeconomic inequality (Statistics New Zealand, 2013; Stewart, 2023). A long history of teachers and educators blaming Māori for not achieving, rather than investigating the policies and impacts of colonisation, perpetuates the reductionist attitudes by some teachers, which include stereotyping and racism along with low expectations (Bishop, 2019; Pack et al., 2016). Even after the introduction of culturally responsive initiatives such as the *Te Kotahitanga* and *Kia Eke Panuku* programmes, Māori continue to experience racism and stereotyping within the education system, and the tenacious harmful myths about Māori persist. For example, when the Native Schools were first introduced, Māori were encouraged to learn by working in the fields. Today, that historical artefact is perpetuated as a vision of Māori as primarily kinaesthetic learners who supply the country with its labour workforce (Hetaraka, 2022).

Culturally responsive programmes will continue to fail to meet their objectives whilst they continue to be 'tacked on' and ignore the 'white' cultural norms of the classroom. School subject selection systems and programmes to increase NCEA Level 1 results can hinder Māori from choosing STEM subjects past compulsory year 11 schooling, and these systemic biases compound the narrative that you cannot be 'bright' and 'Māori'. Representational barriers to Māori entering STEM include resources within science education depicting the subject as 'white, male, European', which particularly alienates Māori wāhine who experience intersectional barriers.

Schools are gaining support from the Ministry of Education to counter colonial spaces by including mātauranga Māori in their programmes. Entwined with the recommendations by the NZCER, it could result in a conduit for educators to disrupt the traditional teaching of STEM subjects. This could create a space for social justice and equity through indigenisation and providing a multi-layered approach for those living an intersectional experience.

Evidence from *Te Kotahitanga* and *Kia Eke Panuku* demonstrates that embedding relational pedagogy, centred on whanaungatanga, manaakitanga, and ako, alongside high expectations and dialogic, co-constructed learning improves Māori engagement and achievement (Bishop,

2019; Berryman et al., 2023). Strengthening school–whānau partnerships further supports motivation and belonging, acknowledging the central role of whānau relationships (Adams, 2018; Rolleston et al., 2022; Webber et al., 2016). These relational approaches align with updated directions in STEM education, where relational pedagogy intersects with relational thinking and project-based learning to create culturally sustaining, mana-affirming environments (Lee & Lee, 2025; Smith et al., 2022). This evidence underscores a broader perspective that approaches which affirm Māori identity and foster relational learning not only uplift Māori ākonga but also enhance engagement, equity, and achievement across the wider student population.

Taken together Māori ākonga often face multiple, compounding challenges in STEM education, including cultural misalignment, deficit-based assumptions, underrepresentation, and systemic barriers that can affect both engagement and achievement. Taken together, integrating mātauranga Māori with relational pedagogy and relational thinking provides a coherent pathway to indigenise STEM learning, counter deficit expectations, and support equitable participation and success for Māori ākonga. The next section introduces intersectionality as a framework for understanding how overlapping identities and systemic barriers shape these experiences.

2.4 How Intersectionality Challenges Our Thinking

This section explores intersectionality theory and how multiple systems of inequality and discrimination, such as gender, race, ethnicity, sexual orientation, disability, and class, can intersect. Intersectionality is a multifactorial topic, and for this thesis, I focus on how to define intersectionality, intersectional identity, how intersectional discrimination can affect an individual's sense of wellbeing and how intersectionality is developing education research.

2.4.1 Defining Intersectionality

Aspects of identity such as race, gender, sexuality and class can lead to experiences of discrimination or privilege. To understand the unique lived experience of those who inhabit at the intersection, Crenshaw (1989) detailed how Black women who had been victims of domestic and sexual violence are discriminated against within the justice system. Using a comparison between Black women, white women, and Black men, Crenshaw (1989) detailed how Black women have neither the privilege of whiteness nor of being male because they are

at the intersection of race and gender (Haynes et al., 2020). According to Crenshaw, the interlocking systems that account for intersectionality can be divided into three pillars: structural, political, and representational (Crenshaw, 1989, 1991; Haynes et al., 2020).

Structural

Structural intersectionality examines how institutions and structures create and perpetuate social inequalities, such as economic social systems which can discriminate or confer privilege. This term includes the system levels of bias, which can perpetuate disparities within educational institutions, healthcare or workplaces (Carastathis, 2016; Collins & Bilge, 2016). For example, a workplace may have a hiring policy that disadvantages women of colour more than other workers. Structural intersectionality explains that people's experiences within a particular identity category are qualitatively different depending on their own intersectional identities (Dennissen et al., 2020). The dynamics of identity mixed with the shifting of structural systems highlights how an individual's experiences of inequality can be chronic or transitory but are always unique (MacKinnon, 2013). Within education, Stewart (2023) posited that socioeconomic disadvantage was a key reason for the lack of Māori scientists. However, the paper goes on to describe other factors within the education system that also disadvantage Māori learners, such as the content of the science curriculum and how traditional science teaching focuses on rote learning, which requires students to spend time on homework and having a quiet study space (Stewart, 2023). Through an intersectional lens, the structural features of the education system, such as conventional science instruction, dominant knowledge frameworks, and standardized assessments, can be understood as legacies of historical educational policies, now deeply entwined with broader patterns of socioeconomic inequality.

Political

Whilst structural intersectionality concerns the intersection of unequal social groups, political intersectionality challenges the notion that political systems and structures are neutral; instead, it highlights how they are often shaped by and perpetuate intersecting oppressions (Carastathis, 2016; Collins, 2015; Crenshaw, 1991). For example, data suggest it is historical colonising policies that have hindered Indigenous women from reaching gender equality (Rorintulus et al., 2024). At the political level, marginalised individuals might find their concerns are side-lined because they don't fit neatly into one political category (Carastathis,

2016). Within political movements that aim to address the rights and issues of marginalised groups, overlapping agendas can either support or undermine one another (Hancock 2007). For example, in Aotearoa New Zealand labour law reforms were introduced partly to tackle equality for women in the workforce. From an intersectional perspective, this reflects a focus on equality rather than equity. While policies promoting equal pay for equal work aim to address gender disparities, they often fail to account for structural inequities resulting in a persistent gender pay gap, with men earning, on average, 10% more than women (Ministry of Business Innovation & Employment, 2024).

But many factors account for the pay gap, including lack of arrangements for women who must provide care for children, women taking career breaks due to family responsibilities, and the value placed on the jobs and skills in women-dominated careers such as caregiving. The result is that 68% of those on the minimum wage are women (Ministry for Women, 2017). However, research by the Ministry of Women reported that the most likely cause of the pay gap is conscious and unconscious bias, particularly when decision-making is at managerial discretion, whereby conscious and unconscious bias can influence hiring, pay or bonuses and promotion (Ministry for Women, 2017). Concerning intersectionality, data from the *Whakatika: A survey of Māori experiences of racism* report demonstrates that Māori wāhine (women) are more likely to experience discrimination in the form of racism and stereotyping than white women (Smith et al., 2021). The result is Māori wāhine are socioeconomically worse off than women of other ethnicities and report greater discrimination and poorer job satisfaction and wellbeing (job stress and anxiety) (Haar, 2023; Reilly, 2019). Within the political landscape, Māori wāhine must decide how to fit within feminist movements when their experience as Māori women is unique. Of note, in 2020, an amendment was made to the 1972 Equal Pay Act to instruct businesses to provide pay equity rather than equality; at the time of writing, there was insufficient data to report the outcomes of this change (Ministry of Business Innovation & Employment, 2024).

Representational

Representational intersectionality focuses on how cultural representations and stereotypes can reinforce or challenge intersectional discrimination (Hooks, 2015). Crenshaw (1995) draws upon published works to denote how African-American women are portrayed as ‘wild and animal-like’ and extrapolates this narrative further as being influential in the violence

perpetrated against women of colour (Crenshaw, 1991; Hooks, 2015). In Aotearoa New Zealand, *Whakatika* (Smith et al., 2021) found that the second most frequently reported source of racism experienced by Māori was the media specifically, the negative portrayal of Māori and the lack of Māori representation across media platforms (Galy-Badenas et al., 2023; Pack et al., 2016), and Māori wāhine are the demographic increasingly experiencing racial prejudice (Smith et al., 2021). Galy-Badenas et al. (2023, p. 92) assert that Māori face negative media coverage and are often portrayed as "marginal, problematic or 'other' in their land of origin". Responses to *Whakatika* reveal that 79% of 2073 respondents report that Māori had been portrayed negatively by non-Māori media all of the time or often, and 91% recalled observing clips from overseas media regarding racism and violence towards Indigenous communities (Smith et al., 2021). Māori communities are frequently depicted with stereotypical images as places of violence and criminality with links to gang culture (Barnes & McCreanor, 2023). Whilst Māori activists in general are portrayed as 'stirrers' or 'attention seekers', Māori wāhine activists are the symbolic figure of Māori 'trouble' and 'bullies' (Galy-Badenas et al., 2023). However, art, literature and other mediums can enable counter-narratives by providing space for marginalised groups to challenge and assert their stories and perspectives (Crenshaw, 1991; Hooks, 2015). For example, in 2024 the Metropolitan Museum of Art in New York, hosted the 40th anniversary of Ngā Taonga, a curated collection of audiovisual Māori taonga (treasures). Between the original display in 1984 and the anniversary addition 40 years later, the exhibit has attracted over 1.5 million visitors globally, challenged stereotypes, changed the narrative for curation of taonga Māori and fostered great pride amongst Māori communities. An online version is still available (Ngā Taonga, 2024).

Intersectionality describes how different aspects of a person's identity can lead to discrimination and marginalization and how multiple identities intersect to create a unique experience. Discrimination and marginalization are caused by the interlocking system of the three pillars of intersectionality (Collins & Bilge, 2016). Understanding how these structures reproduce and uphold structural systems of power and privilege enables policymakers and researchers the opportunity to provide inclusive research and practice. To comprehend the interplay of the three pillars, we must appreciate the complexity of the lived experience of those with an intersectional identity.

2.4.2 Intersectionality and Identity.

Intersectionality examines the interconnections of how power systems can create identities and how identities can make (or block) power (Collins, 2015; Collins, 2019). To understand this process, intersectionality requires all aspects of identity to be examined, analysing how the various layers interact, how they affect a person's perception of themselves, and how society views them (Besic, 2020; Collins & Bilge, 2016). This may explain how some identity groups are excluded while others are included through inherent privilege (Collins, 2015; Collins, 2019). Intersectionality analyses power hierarchies between and within groups; it examines societal relations, including how identities are influenced by interpersonal, structural, cultural, and disciplinary domains of power (Collins & Bilge, 2016). Intersectional identities demonstrate how each and every identity marker is connected and creates a whole that is unique and different from individual components (Besic, 2020). Given the fluidity and shifting dynamics of social identity formation, intersectionality has the potential to continuously generate new explanations for intersecting phenomena (Harris & Leonardo, 2018). Understanding how intersectional identity influences a person's lived experiences can aid in dismantling systems of oppression, reducing barriers, and creating equitable opportunities (Besic, 2020; Collins, 2019; Vincent-Ruz & Schunn, 2018). Within multicultural education intersectionality gives educators and researchers the tools to highlight the lived experiences of students at the intersection of multiple marginalized identities, leading to understanding educational outcomes and persistence (Azmitia & Thomas, 2015). However, identity development is complex and for adolescents the process can be stressful as they learn to navigate their roles and positions within an adult society (Shmulsky et al., 2021).

Adolescence and Identity Development

As adolescents traverse into adulthood they must navigate developing a coherent identity (Branje et al., 2021). This complex process requires adolescents and young adults to develop personal ideologies and identities as they interact with and within the context of their close relationships, social structures and become conscious of how they are placed within their environments, including societal power and justice inequalities (Branje et al., 2021; Velez & Spencer, 2018). Advocating for the placement of intersectionality within phenomenological adolescent identity formation research, Velez and Spencer (2018) discuss how identity

formation is a socially constructed, fluid and contextual process which requires an ontological shift. They argue that identity formation is based upon developmental-based phenomenological processing whereby an individual has to navigate their lived experiences, which for many youth includes encountering interlocking systems of power, oppression and support (Velez & Spencer, 2018). For example, as a youth navigates through the risk and protective factors of an environment, they phenomenologically process the experience as either one of support or a stressor (Moffitt et al., 2020; Velez & Spencer, 2018).

Alongside environmental considerations, a coherent sense of self identity formation happens within the contexts of close relationships such as with family, peers and friends (Branje et al., 2021). Data suggest that adolescents tend to experience more difficulties developing a coherent identity when they do not experience closeness or supportiveness within their family relationships (Branje et al., 2021). However, a positive impact on relational and educational identity occurs when adolescents find support with their friends (de Moor et al., 2019; de Moor et al., 2021). Characteristics of having a well-adjusted identity narrative have also been observed in adolescents who have a high-quality relationship with one best-friend (de Moor et al., 2021). A three-wave longitudinal study of 304 adolescents by Albarello, Crocetti and Rubini (2017) found that adolescents' identification with their classmates and with their groups of friends are interconnected. Also, over time the ways in which adolescents develop their identity in educational and interpersonal domains becomes intertwined (Albarello et al., 2018). The data suggest that as adolescents become more comfortable in their larger peer groups, they have the foundations from which to explore their personal identity.

Building on the importance of close relationships, relational identity offers a useful lens for understanding how these connections shape identity development. Relational identity refers to aspects of the self that are defined through significant dyadic relationships, such as those with parents, teachers, or close friends, where identity is co-constructed through roles and reciprocal interactions (Crocetti et al., 2023). Recent research underscores that identity formation is not only an individual process but is embedded in these relational contexts, with family and peer support acting as key drivers of exploration (Cherewick et al., 2024; Zhou et al., 2023). High-quality friendships and supportive family ties provide a secure foundation for identity development, whereas relational conflict or instability can disrupt a coherent sense of self. Digital environments can extend these relational processes; for instance, social media often acts as a 'social mirror,' allowing adolescents to explore self-presentation, receive

feedback, and negotiate belonging in ways that actively shape their evolving identities (Angelini et al., 2024; Pérez-Torres, 2024).

Intersectional identity development extends relational perspectives by recognising how overlapping social categories shape adolescents' experiences of connection, belonging, and identity formation (Azmitia, Garcia Peraza, & Casanova, 2023). As a framework, intersectionality highlights that identity is not only co-constructed through close relationships but also shaped by broader social structures that influence access to affirmation and inclusion (Moffitt et al., 2023). For youth with marginalised identities, relational contexts like family, peers, and schools can either support or constrain identity development depending on how responsive they are to diverse lived realities. In Aotearoa New Zealand, these intersectional dynamics are particularly relevant for rangatahi Māori (adolescent or young Māori), whose identity development often involves navigating multiple affiliations within cultural and systemic contexts (Roy & Greaves, 2021; Zhang & Gao, 2024).

Emerging from these intersectional and relational dynamics, identity development for rangatahi Māori is deeply embedded in cultural frameworks that prioritise collective belonging and reciprocal relationships. Identity is cultivated through whakapapa (genealogy), whānau (family), and whanaungatanga (reciprocal relationships), which together provide a foundation for belonging and guide the navigation of multiple social identities (Greaves et al., 2021; Hamley et al., 2023). Recent research demonstrates that strong whanaungatanga, measured through connections with whānau, peers, and supportive adults, predicts well-being and resilience among Māori youth (Greaves et al., 2021). Extending this understanding of whanaungatanga, Hamley et al. (2023) interviewed 51 rangatahi (young people) aged 12–22 years across Aotearoa. Participants included 34 rangatahi wāhine (young women), 16 rangatahi tāne (young men), and 1 young person who did not disclose their gender. The resulting *Te Tapatoru, a rangatahi-informed model* comprised of three interconnected elements: (1) ko wai, the reciprocal connection to people and more-than-human entities; (2) he wā pai, the genuine time and place for connection; and (3) he kaupapa pai, the shared activities aligned with rangatahi aspirations. These findings highlight that identity for Māori youth is enacted through lived, relational practices rather than individualistic processes, underscoring the importance of developmental contexts, such as schools, that can affirm cultural identity and strengthen these relational ties.

Positively navigating the complex process of multiple social-group identification is pivotal to identity harmony, which has been related to greater psychological wellbeing (Nielson et al., 2024; Settles & Buchanan, 2014). Also, for adolescents and young adults, a positive identity development experience is critical to self-confidence and wellbeing (Shmulsky et al., 2021; Verhoeven et al., 2019). Whilst adolescents who develop a positive student identity are more likely to have positive school outcomes, including improved school and peer engagement (Shmulsky et al., 2021; Verhoeven et al., 2019).

Schools Supporting Adolescent Identity Development

The schooling system can contribute to adolescent identity formation, particularly student identity, by ensuring a sense of belonging. Within the psychology literature, belonging has been defined as an individual's subjective feeling that they are integral to part of their surrounding communities, including family, friends, school, work environments, local communities, cultural groups, and physical places (Hagerty et al., 1992; Johnson et al., 2020). Like identity formation, a student's sense of belonging is context dependent. For example, a classroom sense of belonging can affect a students' performance in that class as distinct to their sense of belonging to a school (Strayhorn, 2018). A study in the USA recorded narratives through focus groups with 46 high-school youths in foster care during 9-12th grade, asking how they navigated a sense of school belonging (Johnson et al., 2020). Two main outcomes were noted: first, participants described the struggle to find a sense of belonging when residential change created educational instability requiring them to sever ties with established relationships and communities. The second notable outcome detailed how the participants had to navigate a sense of belonging as interlinked with their foster youth identity (Johnson et al., 2020). Participants had to negotiate how, when and with whom they would disclose their foster identity and how disclosure could be used as a strategy to fit in at school and a buffer against negative consequences and stigma, consciously concealing their foster identity as a protective mechanism. The authors note that when describing relationships with teachers and peers, the word "trust" was used countless times within the focus groups. For example, one participant stated, "I can't trust my teachers because I don't know them and don't know if they have my best interest in mind" (p. 6). However, the participants who described enjoying a supportive relationship with teachers and peers noted the positive outcomes and improved sense of wellbeing they achieved by revealing their identity to those they trusted, explaining they could "finally be myself" and "a weight was lifted" (p. 6).

A positive sense of school belonging can aid students in developing their sense of self, self-esteem and self-concept (Allen et al., 2016; Dost & Mazzoli Smith, 2023). It also contributes to academic self-efficacy, intrinsic motivation, engagement, learning outcomes, and success (Dost & Mazzoli Smith, 2023). However, a literature review by Verhoeven et al. (2019) which analysed 111 studies investigating the personal, social and school-related identity dimensions demonstrated that schools could contribute unintentional detrimental impacts through their practices including low teacher expectations, teaching strategies, and streaming or selection. On the other hand, they can aid in fostering a student's identity development and sense of belonging by providing a supportive classroom climate and meaningful explorative learning experiences (Verhoeven et al., 2019). Relational pedagogies, such as project-based learning in STEM, exemplify this by creating collaborative, trust-based environments where students can exercise agency and connect learning to real-world contexts, reinforcing both belonging and identity development (Lee & Lee, 2025; Taiaroa & Smith, 2017; Verhoeven et al., 2019).

In Aotearoa New Zealand, Davies and O'Neill (2022) studied adolescent students' experience of identity development and the degree to which they felt supported. A total of ten adolescents aged 14-18 took part in the interviews, nine of whom attended state high schools, and one who attended Aho o Te Kura Pounamu (state distance education provider). Participants included two Māori, one Pasifika, three New Zealand Europeans (Pākehā) and three who identified as 'other'. Four themes emerged from the study: belonging and affiliation, appreciation of diversity, teacher support and self-expression. Several recommendations for educators are provided in the conclusion of this study, including enabling students to have agency over their learning and creating an environment that promotes a feeling of being "seen" for their positive identity (Davies & O'Neill, 2022). The authors suggest educators use inquiry-based learning strategies that can be guided by a student's interests and aspirations. Another suggestion is to ensure students can develop their need to belong through the opportunities offered by celebrating culture and cultural affiliation.

Exploring the role of identity and culture, Taiaroa and Smith (2017) followed six Māori students through their four-year Bachelor of Physical Education course. The authors unpacked what their Māori identity meant to the students as well as their experience of the

programme. The participants displayed a strong sense of their Māori identity, with five conveying that they were not only students but Māori students. The conclusion of this study documented how all the participants appreciated their lecturers' attempts to integrate Māori culture into the programme through bicultural pedagogical techniques, using te reo Māori and Tikanga (cultural practices). However, participants expressed a desire for more Māori lecturers who could provide authentic Māori learning experiences, role models and mentors. The authors make a note of caution about educators solely relying on a student's Māori identity in creating a sense of belonging. For example, one of the participants who self-identified as Māori did not have the same experience as the rest of the group. Unable to speak te reo Māori and perceiving that they were not accepted as Māori by society, or by their Māori peers, they chose not to join the whānau group or other Māori support networks (Taiaroa & Smith, 2017). For Māori students in particular, identity development is relational and collective, meaning that pedagogies which embed collaboration and cultural responsiveness, can provide powerful opportunities for belonging and positive identity formation (Webber, 2024; Webber & Macfarlane, 2020).

Adolescents must navigate their identity development into the world of adulthood. This complex process can be both supported and hindered by schools and educators. Recognising that identity is a fluid and dynamic process schools can support identity development by encouraging a sense of belonging. An adolescent who feels supported by educators and peers, is given agency over their learning and builds trusting relationships with their teachers, is more likely to have a positive identity development experience and improve their sense of belonging, which can result in improved school outcomes.

Adolescents Developing a Science/STEM Identity

Similar to the positive effect a school can have on a student's identity development, students who develop a strong science identity are more likely to be engaged, persist in science, and pursue STEM careers (Le et al., 2019; Vincent-Ruz & Schunn, 2018). Again, adolescents developing a science identity is a complex process built upon lived experiences and interactions at home, in school and within the wider community (Ofek-Geva, 2025).

In the USA, looking to understand the 'transformative stages in young adolescents' perspectives and attitudes to science through science identity development,' Ofek-Geva (2025

p1) tracked nine students over two years as they transitioned from elementary into middle school, which has been shown to be a time when students' interest and attitudes to science can diminish (McKinley et al., 2015; Ofek-Geva, 2025). This study utilised the three interrelated dimensions of science identity development by Carlone and Johnson (2007), which includes recognition by self and others as a science person; performance regarding the ability to do science; competence within the ability to understand science. Ofek-Geva (2025) also examined experiences across diverse contexts which included home, school, friendships and after-school activities related to science. To facilitate a structured presentation of the findings the author used two groupings, those who expressed an interest in pursuing a science career and those who did not. For students who do not express an interest in a science career, family support and flexible pedagogy can sustain an interest in school science. Whilst for the students who expressed a desire to pursue science careers, Ofek-Geva noted that to maintain this interest, students needed environments that fostered exploration and provided academic recognition, which was critical during the period of puberty. However, several aspects were observed in both groups in enabling continued enthusiasm for science learning, which included providing positive learning environments. Ofek-Geva noted the positive effects science educators had on fostering increased engagement by "cultivating a positive emotional atmosphere" and "strong interpersonal connections with students'" (Ofek-Geva, 2025, p. 11).

Reflecting similar outcomes, Avraamidou (2020) described how in a group of young female high school students who became interested in a physics career, the most significant influence was recognition by their teacher (Avraamidou, 2019; Brown, 2004). However, emotions are another factor involved in identity development. The classroom environment is inherently emotional, as students and teachers can experience different feelings, resulting in emotional labour (Avraamidou, 2019, 2020). With an intersectional lens, the political dimensions of emotions related to power and social justice link personal histories (the past), social positioning (present), and a future self (in this case, as scientist) (Bowleg, 2008; Le et al., 2019).

Studying the complexities for those at the intersection of gender, ethnicity and social class, Godec (2018) discussed how students must navigate and do identity work to belong in science. Participants in Godec's (2018) year-long qualitative study attended two schools with a higher-than-average number of students with English as their Second Language and students who received free school meals (a marker of socioeconomic inequality). The 15

participants, aged 11-13, were ethnically diverse and deemed ‘working class’, denoting they were impacted by socioeconomic disadvantage. Godec used post-structural feminist theory and theories of gender performativity, gender “intelligibility”, and an integrated intersectional approach to the data. From the narrative analysis, four strategic themes emerged:

1. Gender invisibility: One participant had joined a STEM club and was the only girl who attended. When asked how she felt being the only girl, she responded that she had not ‘thought about it’ and was only interested in the ‘learning part’. This participant had also distanced herself from other girls who were into ‘fashion’.
2. Representation: The participants identified and discussed how it was stereotyping to label science as something for boys, as there had been famous women scientists. However, it was interesting to note that the only female scientist they could name was Marie Curie.
3. Reframing science as caring or nurturing: Participants' descriptions included how science looked after the environment and animals and saved lives. Within this theme, there was a distinction between the biological sciences as being ‘caring’ and physics as not. While science teachers could be any gender, the participants stated boys would prefer engineering as they would not mind ‘getting dirty’. For me, an alternative label for this theme would be feminising science.
4. Cultural discourses of desirability: This theme was related to the three participants with a South Asian background. They described how their parents had high expectations for them to attain high academic achievement and training for high-paying careers such as doctors or lawyers. Their parents understood the prerequisites for such courses would include high academic achievement in subjects such as science.

The common theme within all four strategies was the perception of a requirement to do identity work to belong in science. From an intersectional perspective, the feminising of science, especially within the biological sciences, creates another silo, as the antithesis to this is that it continues to push other sciences, for example, physics and engineering, into a masculine stereotype. Such effects of pushing masculine stereotypes can result in women struggling to ‘fit’ into this dominant narrative which can cause identity conflict (Morgenroth et al., 2020; Nielson et al., 2024; Settles & Buchanan, 2014). Like other studies, Godec (2018) concluded by recommending science teaching aid in the reconstruction of the

dominant science culture by providing students with a diverse representation of scientists. Also evident in this study is how those who live at the intersection require multiple opportunities and a multi-layered approach to create a sense of belonging within science education.

Fostering a Sense of Belonging in STEM with Counterspaces

Counterspaces are considered a 'safe space' in which marginalized people can support each other from deficit-orientated narratives and microaggressions (Gray et al., 2025; Ong et al., 2018; Strayhorn, 2018). Within STEM education counterspaces can aid in challenging dominant cultural and traditional stereotype narratives of scientists as 'White' and 'male' (Ong et al., 2018; G. T. Stewart, 2023). It has been postulated that STEM education can improve the participation and retention of marginalized individuals by providing counterspaces.

For example, within a higher education context in the USA, Ong, Smith and Ko (2018) sought to understand how women of colour search out or create counterspaces to persist in STEM. Using Critical Race Theory and an intersectional framework, the authors tracked 39 women of colour in STEM higher education and documented the five ways in which counterspaces operate. The study outlines how counterspaces can be "physical settings, conceptual or ideological", can vary in terms of "race/ethnicity, gender and power levels of participants" (p206). The prevailing five domains of counterspaces that aided in persistence in STEM included peer-to-peer relationships, mentoring relationships, national STEM diversity conferences, STEM and non-STEM campus groups, and STEM departments. Of note in this study is the final category of STEM departments as counterspaces. Participants who noted their STEM departments as counterspaces listed several factors that contributed to this outcome including enabling students to include their culture within their field of study, noticing departments recruiting more students from diverse backgrounds, creating collaborative and supportive rather than competitive spaces, and the provision of all-female faculty dinners.

Seeking to understand how to improve gender equity for young people within STEM education, a study in Rio de Janeiro by Reznik et al. (2023) detailed how an improved sense of belonging was created through the development of a 'counterspace'. The 25 participants

recruited were aged 13-22 years (the majority were 14-16) attending at 15 different low-income public (state) schools. Four extra-curricular projects were run throughout the year with the support of the local university. The participants attended lectures, visited universities, conducted experiments, and completed intervention projects. Five dimensions were categorised as aiding the participants in developing a science identity and a sense of belonging in STEM: individual dimensions (intrinsic motivations); family dimensions (encouragement and recognition); educational dimensions (school recognition and improved school performance); social dimensions (structural and social constructs such as gender/race/class) and intervention project dimensions (representation, development of self-confidence, positive STEM identities, affirming career choice, active learning methodologies and safe/counter space) (Reznik et al., 2023). The authors note that although a counterspace was not in the original conception of the project, a 'counterspace' developed. As the projects progressed, participants started to share stories of isolation, experiences of microaggressions, discrimination and stereotypes (Ong et al., 2018; Reznik et al., 2023; Solorzano et al., 2000). The authors note several strategies employed within the intervention projects that led to the participants creating a counterspace, which included: developing self-esteem and confidence by co-designing project activities considering their expertise, interests and experiences; incorporating interdisciplinary team research and diverse representation through collaboration with key experts and links to universities; fostering academic recognition by improving dialogue with family and school communities; and improving school outcomes by embedding research and evaluation as intrinsic to the project activities and including the opportunity for participants to safely debate inequalities, bias and stereotypes (Reznik et al., 2023). Although the authors list the five dimensions and the strategies within the project activities, no mention is made of any synergistic qualities such as the interconnected nature of the seven tenets for DEI and project-based learning listed by Bell (2019). Another important consideration within the Reznik et al (2023) study is that the projects happened outside of school as an extra-curricular activity and 93% who responded to the survey questionnaires described a prior interest in science and technology with their favourite subjects being math, chemistry, history, physics and biology.

However, another study in the USA which examined counterspaces for diasporic communities had an extra interpretation to their conclusions. Whilst acknowledging the positives of the counterspaces in reworking exclusionary discourses to prevent the 'othering' of marginalized students, the authors also note how the requirement for such 'safe spaces'

highlights how the education system needs to decolonize pedagogy and curriculum (Shirazi, 2019). In essence, Shirazi has taken an intersectional viewpoint by acknowledging how power and oppression embedded within the education system are creating the marginalization of intersectional communities.

Counterspaces offer the opportunity to improve the number of underrepresented students entering and persisting in STEM. Studies suggest that creating a safe space in which marginalised individuals can connect to others and challenge dominant narratives can aid in the development of a science identity by fostering a sense of belonging, countering the dominant narratives created by an unequal education system. Ultimately, counterspaces present an opportunity to broaden the participation of under-represented marginalized communities into STEM education by nurturing connectedness, relatedness, and aspects of wellbeing (Strayhorn, 2018).

2.4.4 Intersectionality and Impacts on Sense of Wellbeing

It has been documented that experiencing discrimination can impact a person's sense of wellbeing (Roy et al., 2023; Tinner et al., 2023). In the USA, Slaughter-Acey et al. (2023) took an intersectional approach to data from the Eating and Activity Over Time (EAT) 2010-2018 longitudinal study of diverse young people aged 18-25 (Slaughter-Acey et al., 2023). The results revealed that having an intersectional identity was associated with worse mental and emotional health, which included showing depressive symptoms, feeling stressed, and having low self-esteem and self-compassion (Slaughter-Acey et al., 2023). The study demonstrated a compounding effect on cognitive and emotional health for those who experienced multiple forms of discrimination, such as appearance-based teasing, financial difficulties and food insecurity, alongside discrimination related to their race, class, and gender (Slaughter-Acey et al., 2023).

Using data from 2008, 2010 and 2012 General Social Surveys (GSS), Cormack et al. (2018) took a Critical Race Theory, kaupapa Māori and intersectional lens to the aggregated data. The GSS is a national-representative survey undertaken every 2-years in Aotearoa New Zealand, by Statistics New Zealand. Carried out among adults aged over 15-years of age, the surveys ask a range of questions regarding social and cultural factors, human rights and health. Sampling occurs through a three-stage process and participant numbers included in

2008 (n=8721), 2010 (n=8550) and 2012 (n=8462). The response rates to the surveys were 83%, 81% and 78% respectively. Questions within the surveys included stepped responses to experiencing discrimination or mistreatment and if a participant replies 'yes', then frequency questions and setting questions follow. Ethnicity data was collected and categorised as Māori, Pacific, Asian, European/Other. Socioeconomic disadvantage was also calculated based upon questions such as employment status, educational qualifications and household income (a full list of questionnaires and responses is available online) (Statistics New Zealand, 2025). Whilst the GSS survey utilises several self-related wellbeing variables, Cormack et al (2020) selected one measure for each of the three descriptors of general health, mental health and wellbeing domains. Using random effects meta-analysis to produce pooled effects from all three surveys, the authors sought to observe the patterning forms of discrimination of the last 12 months, frequency of experiencing multiple forms of discrimination and the association between experiences of multiple discrimination events and self-related health, mental health and life satisfaction (Cormack et al., 2018). Results suggest Māori and people from Pacific and Asian ethnic groups were most likely to self-report experiencing higher prevalences of discrimination and multiple forms of discrimination than other ethnicities (Cormack et al., 2018). Experiencing discrimination was correlated to higher levels of self-reporting poorer physical health, mental health and greater life dissatisfaction (Cormack et al., 2018). However, the authors note the limitation to the intersectional lens of their study due to the nature of the original survey data. For example, they were unable to determine whether reported forms of discrimination occurred at a single time point, such as experiencing mistreatment due to a combination of ethnicity and gender.

Seeking to understand the experiences and wider impacts of discrimination for Māori communities was the aim of the *Whakatika* 2021 survey. Utilising a kaupapa Māori methodology, being by Māori and for Māori, the *Whakatika* survey is part of a wider research programme funded by the Health Research Council of New Zealand investigating Māori ways of healing, recovery, wellbeing and intergenerational trauma. Spanning a one-year period between February 2019 to 2020, researchers attended 22 events across Aotearoa New Zealand and conducted in-person digital surveys with 2073 Māori respondents all over the age of 16. Regardless of age or gender, most of the respondents (93%) self-reported that discrimination had an impact on them daily. A similar proportion, 96%, also reported that racism had been an issue for their wider whānau (family). Many of the survey respondents (89%) also thought they were less likely to be helped in a shop due to their Māori identity.

Regarding expressing their Māori identity, participants conveyed being comfortable 'everywhere' at 64% but were most comfortable in safer spaces such as the marae (43%), home (42%) or Iwi events (41%). In contrast, only 23% recorded being comfortable to express their Māori identity in educational settings. Feedback included Māori saying they often called out discriminatory events, but along with feeling furious, they often felt shame and humiliation when they were treated unfairly (Barnes & McCreanor, 2023; Smith et al., 2021). However, the most common response was to retreat to places of safety such as with whānau, friends and the marae (Smith et al., 2021). Other support frameworks noted in the survey include an intergenerational cultural focus which helps to reinforce the uniqueness of Māori identity, such as giving a child a Māori or tūpuna (ancestor) name and teaching traditional Māori customs such as harvesting and preparing kai (food).

The *Whakatika* survey provides valuable insight into the lived experiences of Māori who are having to navigate and process exposure to everyday racism. However, the findings are similar to those presented by Cormack et al (2020) with their approach to integrating data from the General Social Survey (GSS). Responses are given on an individual nature as one event in time and do not consider how multiple identity factors such as ethnicity, age, gender, sexuality, and disability can combine to cause harm or help to a person (Tinner et al., 2023).

Using data from the Youth19 survey, Roy at al. (2023) used an intersectional approach to determine the mental health and wellbeing of young people from the following groups: rainbow rangatahi (young) Māori (n=154), rangatahi Māori with a disabling condition (n=435), Pacific rainbow young people (n=103), Pacific young people with a disabling condition (n=293) and Rainbow young people with a disabling condition (n=333). Participants were aged 13 years and above, resided in the Northland, Auckland and Waikato regions of Aotearoa New Zealand, and attended one of 45 mainstream schools and four Kura Kaupapa (Māori immersion). The authors discuss that Rainbow young people with a disabling condition had more challenging home environments, worse school relationships, a greater frequency of cigarette smoking and far poorer mental health scores and outcomes when compared to Pākehā (New Zealand European) with no disabling condition (Roy et al., 2023, p. 28). Young Māori with a disabling condition had lower scores for family, school and community environments indicators, alongside reporting poor mental health scores. Also, young Māori with a disability acknowledged greater use of cigarettes and marijuana, higher socioeconomic challenges, and higher levels of ethnic discrimination by health providers

compared to Māori without disabilities (Roy et al., 2023, p. 28). To expand the intersectional lens, Roy et al (2023) recommend further surveys include other regions of Aotearoa New Zealand, especially rural communities, and incorporate other indicators such as socioeconomic position, refugee status and ethnic minorities. A limitation to this study is that the Youth19 survey was conducted with students on a school day and misses representing data from young people who were unable or unwilling to attend school (Peiris-John et al., 2024). The authors conclude with recommending further studies and analysis to include a broader range of young intersectional voices (Roy et al., 2023).

There is a growing body of literature highlighting an increased risk of poorer health outcomes and a sense of wellbeing for those with an intersectional identity. One explanation for detrimental outcomes for those with multiple social-group identities who experience discrimination is identity conflict (Settles & Buchanan, 2014). Rather than multiple identities being in harmony with each other, they are incompatible or in opposition. When identities are in conflict, such as 'Black' identity with 'woman' or 'woman' and 'scientist', negative outcomes include higher rates of depression and lower self-esteem (Nielson et al., 2024). For those residing in Aotearoa New Zealand, current data report the groups most at risk of experiencing discrimination are Māori, Pacific peoples and Asian ethnic groups. Limited intersectional data from the region indicate that multiple identity factors, particularly for those in the disability and rainbow communities contribute an additive negative effect. Māori communities self-reported a reaction to discrimination is to retreat to spaces of safety, while other responses include embedding intergenerational cultural identity. However, the respondents in *Whakatika* who described utilising intergenerational cultural resources also highlighted the negative stereotypes this could create for their communities. Examples included self-reporting receiving inadequate help from customer services whilst on the telephone as they were easily identifiable due to their Māori name (Smith et al., 2021).

Stereotyping and Anxiety

Negative societal narratives about learners' academic ability are consistently associated with heightened anxiety, diminished academic self-efficacy, and weaker engagement in secondary classrooms (Chen et al., 2025; Zhou et al., 2025). These effects are particularly evident in high-stakes assessment environments, where anxiety often precedes avoidance behaviours such as procrastination, incomplete coursework, and in severe cases exam non-attendance

(Dhawan, 2024; Dutt et al., 2025). The emerging pattern suggests a broader mechanism in which stereotyping cues erode perceived control and belonging, triggering emotional and cognitive responses that interfere with learning and with participation in assessment. Large-scale quantitative work supports this interpretation. Using latent profile analysis with a sizeable high-school sample, Zhou et al. (2025) identified distinct engagement–anxiety configurations and showed that academic self-efficacy mediated these relationships, indicating that visible participation can mask psychological withdrawal. Two complementary reviews converge on the same conclusion for adolescents: academic anxiety reliably undermines motivation and drives self-protective study strategies, including avoidance of demanding tasks (Li & Palaroan, 2024; Rani, 2025). These findings imply that anxiety is not merely a by-product of poor preparation; rather, it functions as a mediator between negative identity cues and disengagement.

The link between anxiety and exam avoidance is particularly well evidenced in secondary settings. In a cluster randomised controlled trial across three secondary schools, a universal classroom programme combining cognitive-behavioural strategies with test-taking skills reduced test anxiety and improved coping relative to a waitlist control, consistent with anxiety operating as a barrier to approach behaviours (Dutt et al., 2025). A systematic review focused on adolescent exam anxiety documents behavioural consequences that include procrastination, strategic withdrawal, and refusal to sit assessments (Dhawan, 2024). Subject-specific research in senior secondary mathematics mirrors this pattern: a survey plus achievement-test design shows that higher mathematics test anxiety predicts lower performance and greater likelihood of withdrawing from assessment tasks (Yarkwah et al., 2024).

Mechanistic accounts explain these outcomes through cognitive load and attentional disruption. When students internalise consistent stereotypical messages, perceived control diminishes and perceived stakes rise, amplifying worry and rumination; working-memory resources are then diverted away from problem solving, sustaining a cycle of avoidance (Zhou et al., 2025). Observational and experimental work in evaluative contexts shows increased mind-wandering and task-related interference under such conditions, further reducing persistence on complex tasks (Jordano & Touron, 2017). Although a recent registered meta-analytic critique reported mixed evidence for delayed attentional disengagement from threat, the broader evidence base still implicates low control and high

worry as central drivers of anxiety-linked disengagement in school settings (Watson et al., 2025).

For ethnically diverse students, persistent exposure to racial or ethnic stereotypes contributes to chronic and psychological distress, which in turn can impair cognitive functioning and academic performance (Zhou et al., 2025). Anxiety linked to stereotyping is not only associated with poorer mental health but also with disengagement from school and reduced academic motivation, reinforcing the cycle of avoidance behaviours described earlier (Watson et al., 2025). In some cases, these pressures lead to disidentification, where students distance themselves from the threatened group identity as a coping strategy, a process associated with lower belonging and weaker academic persistence (Benner et al., 2018; Zhou et al., 2025). Further evidence suggests young people who encounter daily ethnic/racial stereotyping have a higher association with disidentification and that disidentification contributes to more negative daily mood (Yip & Lee, 2016). For adolescents who experience stereotyping as part of their intersectional identity, the cumulative stress can manifest in diminished well-being and academic underperformance (Azmitia, Garcia Peraza, Thomas, et al., 2023). However, Azmitia and colleagues (2023) caution that some intersectional research risks reinforcing deficit narratives by focusing disproportionately on negative outcomes, such as the criminalization of Black boys and young men in the U.S.A, which often shifts blame to families and communities. With the focus located within socioeconomically underprivileged communities, research is deficient regarding academically and professionally successful Black youth and communities (Azmitia, Garcia Peraza, Thomas, et al., 2023), noting that such intersectional research could highlight areas of resistance and resilience (Kolluri, 2023). In Aotearoa New Zealand, these dynamics intersect with systemic inequities and cultural misrecognition. Mixed-methods research in secondary mathematics classrooms demonstrated that teachers often hold lower expectations for Māori and Pasifika students than for peers with equivalent prior achievement and that deficit explanations for attainment are common (Turner et al., 2015). A recent narrative review synthesising international and Aotearoa New Zealand evidence concludes that expectation climates exert a powerful influence on student outcomes, with high-expectation teachers producing substantially better achievement than low-expectation teachers (Rubie-Davies & Hattie, 2025). Aotearoa New Zealand work on school belonging similarly shows that culturally anchored, mana-affirming environments are associated with stronger engagement among Māori learners across clusters of schools (Highfield & Webber, 2021).

The literature outlines a clear pathway of how stereotyping cues can diminish perceived control and sense of belonging, leading to heightened anxiety that drains cognitive resources and triggers avoidance behaviours, particularly in assessment contexts. For Māori learners, these effects are often amplified by expectation climates and cultural exclusion (Rubie-Davies & Hattie, 2025; Turner et al., 2015). Although the dominant pattern links stereotyping to anxiety and avoidance, some studies note that these experiences can, under certain conditions, foster resilience and adaptive coping. Adolescents who receive strong social support or who develop robust self-regulatory strategies sometimes respond to identity-based challenges with increased determination and persistence rather than withdrawal (Becker & Börnert-Ringleb, 2025; Jagiello et al., 2024). Relational pedagogies that emphasise trust, reciprocity, and culturally affirming relationships are frequently cited as contexts that enable such resilience for Māori learners (Bishop et al., 2009; Highfield & Webber, 2021).

2.4.5 Intersectionality Developing Education Research

Promoting that all children and adolescents have the right to a quality education, the United Nations International Children's Emergency Fund (UNICEF)'s 2022-2025 strategic plan highlights the importance of education centred on equity, inclusion and social justice (UNICEF, 2022). The strategic plan places the emphasis of social justice on education and educators to create an inclusive culture by promoting values of respect and equality (Rentzi, 2024; UNICEF, 2022). To prepare teachers to address social justice and create educational spaces of equity and inclusion will require an intersectional approach to understanding multiple complex intersecting identities and systems of power and oppression (Pugach et al., 2019; Rentzi, 2024). Similarly, one of the aims of STEM education is to increase the number of under-represented students in the STEM pipeline by centring on social justice (Bell, 2019; Hasanah, 2020). Recommendations by Cochran et al. (2020) include STEM education researchers taking an intersectional approach to understanding the perspectives and experiences of under-represented groups. They hoped that intersectional STEM education research could identify praxis and processes that would mitigate oppressive and discriminatory forces in STEM education (Cochran et al., 2020). However, although there is a growing body of literature on adolescent intersectional identity and effects such as academic outcomes and wellbeing, there is still no defined developmental model of adolescent intersectional identity (Azmitia, Garcia Peraza, Thomas, et al., 2023). Such a

model would have to consider that as young people navigate from adolescence to adulthood and gain an understanding of social categories and identities, they may not understand how they intersect (Azmitia, Garcia Peraza, Thomas, et al., 2023; Gonzalez, 2018; Rogers et al., 2017). For example, developmental studies have documented that children as young as four can differentiate between wealth and poverty and by ages 7-11 can start to overlay this difference with other beliefs such as social class (Mistry et al., 2017). As adolescents navigate into adulthood, they can become aware that social categories such as social class can have an impact on experiencing discrimination (Robnett et al., 2018). However, socioeconomic inequality is linked with intersectional social barriers and systems of discrimination which can be more difficult to articulate, especially within interview situations (Azmitia, Garcia Peraza, Thomas, et al., 2023; Juan et al., 2016; Mistry et al., 2017).

Therefore, any framework or recommendations would require researchers to consider this complexity and refrain from prompting any artificial responses. Also to ensure staying true to the foundations of intersectionality, research must take into account identity development within the interlocking systems of power, privilege and oppression (Velez & Spencer, 2018). A key component for researchers understanding adolescence intersectional identity development within a phenomena such as STEM education should include how to convey the nuance and uniqueness of each intersectional experience. One proposal is to centre intersectional identity development within interlocking social systems by using relational thinking.

2.4.6 Relational Thinking

To ensure that intersectionality is cemented into critical social theory and activism, Collins (2019) proposes that relationality or relational thinking is a fundamental requirement. At the heart of relational thinking is the understanding that identity and other power systems are interdependent and mutually construct one another (Collins, 2019). Currently, three methodological modes are used to understand intersectional relationality: additive, articulation and co-formation (Bentley et al., 2023; Collins, 2019).

Additive

When Crenshaw (1989) used the word intersectionality to highlight the experiences of Black women, she was combining two categories: race and gender. This disrupted and challenged

the fundamental logic of the segregation of dominant categories. Additive frameworks combine other fields of study and create a new term or framework with their findings, which can assist in discovering what has been missing from previous studies. For example, when Crenshaw (1989) added race to gender, the result helped researchers discover what had been missing from studies that had previously excluded either of these categories. Additive relational thinking can be used to draw attention to the micro (individual) and macro (socio-structural) levels of positionality (Atewologun, 2018; Reisen et al., 2013). However, issues with this approach include interpretive communities disagreeing on the meaning of categories, such as class and gender, which can lead to disagreement regarding the meaning of new terms, for example, *heteropatriarchy* (Collins, 2015; Masquelier, 2022). Also, researchers may inadvertently privilege one category or add categories without any account for transformation from the singular categorization. Ultimately, an additive framework needs to consider how adding categories can change perspectives while accounting for intersectional nuance (Collins, 2019).

Articulation

Using the work of Halls (1980), who identified how language and context can be used to understand complex interrelationships and power dynamics, Collins (2019) introduces the relational idea of articulation. Articulation takes a holistic approach and is reflexive, a core tenet of intersectional research (see section 3X). As a relational approach, articulation is founded upon the premise that society is dynamic with multiple power structures, each with their own shifting power dynamics. Combining categories as a new whole or 'articulation' constantly changes (Hall, 1980). The essential factor is considering how language (articulation) is used to explain this new whole, which should bring new ideas into focus. Language influences the discourse on which society, culture and policy are debated and changed (Bentley et al., 2023). Centred within social justice and critical social theory, one could argue that this is the foundational principle of intersectionality. A key challenge from this approach is that no priority can be given for how the difficulties may be articulated together (Collins, 2019; Hall, 1980).

Co-formation

The final relational approach Collins (2019) presents is co-formation. This is centred on removing categorical thinking and requires a researcher to use holistic analysis. To enable co-

formation, researchers and scholars must consider the mutual construction of categories such as race and gender as inhabiting their own unique co-formed phenomena (Collins, 2019). Co-formation renders the idea of categories redundant and shifts the focus onto the essence of the interconnectedness and interdependence of things. This approach resonates with decolonial and Indigenous methodological approaches, which embrace the interconnectedness and interdependence of reality (Bentley et al., 2023; Weeks, 2021). However, co-formation can be challenging within Western methodology as it can be ill suited to traditional ontological approaches designed to deconstruct and categorise to make sense of things (Bentley et al., 2023). Co-formation can be the most challenging intersectional relational form to consider, as what we understand to be fixed categories are simultaneously co-forming.

Another consideration with all three methodological modes of relational thinking is how to describe the interlocking social systems. Aiming to give clarity on how to convey the power systems involved within relational thinking has been introduced by Ken and Helmuth (2021) by focusing on the term 'mutual constitution'. The authors analysed 379 articles in women's studies journals utilising the terms intersectionality and mutual constitution to determine a consensus in the use and definition of the term. Findings demonstrated that whilst there was agreement that mutual constitution did not allow for a binary or an additive approach there was widespread disagreement whether mutual constitution was synonymous with intersectionality. Drawing upon methodological tools from feminist historians, literary critics and other humanists, two recommendations are given to alleviate the complexity of this issue. The first recommendation is that intersectional scholars create a shared definition of 'mutual constitution' based upon the concept that multiple sets are 'mutually constituted and only exist because they enable each other and are accomplished together' (Ken & Helmuth, 2021, p. 593). The second recommendation is without a consensus; researchers must define how the term 'mutual constitution' is used and demonstrate its presence or absence in their reporting. Based on their own research the authors note the difficultly to accomplish this level of specification. They go on to direct readers to research which offers an alternative, using the term 'depend upon,' highlighting how systems of oppression that are 'dependent' on each other require the maintenance of boundaries which confer privilege to others (Ermakoff, 2017; Ken, 2010). Using the term 'depend upon' acknowledges that the 'dependence' of interlocking systems of oppression can be changeable, long-lasting or temporary.

Aiding in the development of intersectional research, all approaches of intersectional relationality stimulate our thinking and denote the complexity of understanding the nuance of intersectional lived experiences. When Collins (2019) concluded the chapter on relationality, she challenged researchers to continue the discussion on how to centre relational thinking to ensure cementing intersectionality as a critical social theory. Regardless of which approach researchers and scholars use, relational thinking has moved intersectionality beyond the realm of feminist and critical race studies. It has created a decolonising space to indigenise discourse, embed new ways of thinking and promote social justice (Masquelier, 2022; Weeks, 2021). When researchers use relational thinking to convey how identity develops within interlocking social systems, intersectionality could be viewed as a broader social structural framework with identity and social justice at its core.

2.4.7 Challenges with intersectional research

Critics of intersectionality are concerned that the framework is ambiguous, lacks defined goals (Harris & Patton, 2019) and continues to reduce individuals to specific demographic factors, which risks excluding some people (Kelly et al., 2021). Scholars debate whether intersectionality is a theory, heuristic device, concept, or analytical tool (Collins & Bilge, 2016). Another criticism is how intersectionality has been used to study identity development without analysing the systems of power and privilege (Harris & Leonardo, 2018; Kelly et al., 2021). Highlighting the variation, Harris and Patton (2019) reviewed over 97 studies focused on Higher Education research that used the term intersectionality and identified four themes:

1. Buzzword: Intersectionality is used as a buzzword without focusing on its tenets. Harris and Patton (2019) found 42 articles that used intersectionality only once, and the number of times the term was mentioned increased over time.
2. Mis/Definition and Mis/Application: When mis/defining, the articles took social identity into account while failing to connect to the intersecting structures of oppression. Mis/application was an additive framework from a place of mis/definition. These studies used multiplying identity categories without performing structural or power analysis. This led to ideas of adding to identity, which then assumed you can remove identity.
3. Using as a framework: 38 articles used intersectionality as a framework. These articles often used qualitative methods and additional frameworks, such as Critical Race Theory.

4. Framing racially minoritised groups: 29 articles used intersectionality to frame their study within the remit of a minoritised group, 23 of which included race and gender. These articles analysed the intersections of these identities and focused on aspects of power and privilege.

Any study that uses intersectionality needs to stay true to the tenets of its foundations within Black feminist theory and analyse structural powers at the intersection of identity (Crenshaw, 1989). Intersectionality superseded other theories, such as double jeopardy, as it goes beyond a traditional additive and reductive identity construct model (Harris & Patton, 2019). When intersectional studies do not analyse and account for structures of power, their aim as a cornerstone for social justice is limited (Collins, 2015). Without a definitive understanding of how to conduct and analyse intersectionality, there is a risk that the resulting narratives can create erroneous definitions and erase their grounding in the Black feminist movement (Collins, 2019). However, a counterargument is that by defining intersectionality research and methodologies in narrow terms, we risk limiting its potential.

2.4.8 Intersectionality and this study

Intersectionality, and its qualitative methodology encompassing a person's actual lived experience whilst critically reflecting on one's own epistemological standpoint, places it within phenomenological studies (Metcalf et al., 2018; Syed, 2010). Intersectionality research within education can give a voice to students based on their identity developed from their lived experiences (Sparks, 2017; Tefera et al., 2018). Within this study, participants narrated how they experienced interdisciplinary project-based STEM education within the Aotearoa New Zealand, mainstream English-medium education system.

2.4.9 Intersectionality Summary

Intersectionality is an evolving theory that aims to explain how experiences of discrimination and oppression can be intersecting and interwoven. It gives voice to those who experience prejudice and bias in systems that serve to actively and passively uphold normative constructions of power, such as white supremacy, patriarchy and ableism (Collins & Bilge, 2016; Collins, 2015; Crenshaw, 1991).

Recent research highlights that intersectional discrimination is strongly associated with heightened anxiety, diminished academic self-efficacy, and disengagement from learning (Dhawan, 2024; Zhou et al., 2025). Anxiety often precedes avoidance behaviours such as procrastination, incomplete coursework, and exam non-attendance, functioning as a mediator between negative identity cues and reduced participation (Dutt et al., 2025; Watson et al., 2025). For Māori learners, these dynamics are amplified by expectation climates and deficit assumptions, making mana-affirming, high-expectation contexts especially critical (Rubie-Davies & Hattie, 2025; Turner et al., 2015).

Educational strategies that mitigate these effects include relational pedagogies and culturally sustaining practices that foster belonging and agency. Counterspaces, described as safe environments where marginalised students can challenge dominant narratives, have been shown to reduce anxiety and strengthen persistence in STEM pathways (Ong et al., 2018; Reznik et al., 2023). These approaches align with intersectionality's emphasis on relationality and social justice, offering practical pathways to disrupt inequities in education. Relational pedagogies that emphasise trust, reciprocity, and culturally affirming relationships are also cited as contexts that enable resilience and persistence for Māori learners (Bishop et al., 2009; Highfield & Webber, 2021).

Integral to maintaining the fundamentals of intersectionality and minimising the risk of inadvertently reinforcing prejudicial tropes and stereotypes by deficit theorising, researchers are encouraged to use relational thinking, ensuring to convey the development of identity within interconnected and interlocking social systems.

To sum up intersectionality, Collins (2015) listed six guiding assumptions:

1. Identities are best understood together rather than in isolation.
2. Interlocking systems of power shape identity categories.
3. Interlocking systems organise society and undergird material and experiential realities.
4. Social inequalities differ based on time and culture.
5. Social locations of individuals lead to unique perspectives on their and others' locations within social inequalities.
6. Social inequalities are inherently unjust and inequitable. (p. 14)

This list was later summarised by Collins and Bilge (2016) who state that to take an intersectional approach one must consider “inequality, relationality, power, social context, complexity, and social justice.” (p. 25). These aspects inform this study.

Understanding these principles sets the stage for synthesising the literature reviewed in this chapter. The following section provides a chapter summary that integrates insights from STEM education, Māori educational experiences, and intersectionality.

2.5 Literature Review Chapter Summary

This chapter reviewed the literature regarding STEM education, how Māori are performing in an education system designed by and for Pākehā, and the theory and framework of intersectionality.

The literature indicates that STEM education can create the opportunity for a pedagogical shift, reframing how we can teach Science, Technology and Mathematics in schools. STEM education has evolved from teaching the four subjects as discrete entities to an integrating holistic approach where the whole is greater than the sum of its parts (Fiteriani et al., 2021; Wilson, 2020). Barriers to teaching integrated STEM in high schools include curriculum alignment and traditional knowledge acquisition due to assessment requirements. Another compounding factor is the challenge of aiming to create an authentic STEM education experience through pedagogical approaches such as project-based learning within traditional school timetable structures (Wilson, 2020). When paired with project-based learning, STEM education can develop students' 21st century skills and create positive learning environments. STEM education utilising project-based learning can aid in fostering the development of inter and intra-personal skills due to providing a collaborative working environment, ultimately improving student-teacher and student-student relationships which have been found to improve academic outcomes. To encourage equitable project-based STEM education and improve the number of under-represented and marginalised students going into STEM, it is recommended that educators focus projects on one of the seven tenets of social justice and equity (Bell, 2019).

Together, these findings suggest that authentic project-based STEM not only integrates disciplinary knowledge but also develops relational thinking, reasoning about connections

among ideas, people and contexts, thereby aligning cognitive, social, and cultural aims of learning (Banks & Barlex 2020; Bybee, 2015). For Māori learners, these relational dimensions are particularly significant because they align with culturally grounded pedagogies that prioritise whanaungatanga and ako, creating mana-affirming environments that support engagement and achievement (Highfield & Webber, 2021).

Māori have been stigmatised and suffered inadequate learning experiences whilst trying to achieve within a Pākehā educational system founded on colonial policies (Hetaraka, 2022). For example, the science curriculum continues to be based upon traditional 'Western' science. Even within Kura Kaupapa, from year 9 students learn the same content as set out for English-medium mainstream schools (Stewart, 2011b). This has resulted in a dichotomy whereby Māori students' academic performance is better in Kura Kaupapa, except for Science and Maths, where they continue to underperform (Stewart, 2012). Historically, when reviewing why Māori are academically underperforming, conversations have used a deficit theorising model that includes socioeconomic issues. However, the reasons are now understood as more complex and require taking into consideration the historical power systems which arose from colonisation and deprived Māori of their language and culture (Ka'ai-Mahuta, 2011; Stewart, 2023). Trying to counter historical injustices, educational policies have included cultural reforms, but these have had limited success. A recent policy change provided educators with the opportunity to include mātauranga Māori into science education, however, the surrounding dialogue continued to 'other' Māori knowledge systems with many citing them as inferior to traditional 'Western' knowledge. Māori continue to self-report experiencing bias, discrimination and oppression and for Māori wāhine (women) the potential to experience a discriminatory event is increased as they inhabit an identity at the intersection of being Māori and wahine (woman).

Intersectionality provides a framework for understanding these layered experiences. Research shows that multiple forms of discrimination are linked to heightened anxiety, reduced academic self-efficacy, and avoidance behaviours, which undermine engagement and achievement (Dhawan, 2024; Zhou et al., 2025). For Māori learners, these effects are intensified by expectation climates and cultural misrecognition, making relational and mana-affirming pedagogies essential (Rubie-Davies & Hattie, 2025; Highfield & Webber, 2021). Counterspaces and culturally sustaining practices offer additional strategies to foster belonging and resilience (Ong et al., 2018; Reznik et al., 2023). Viewed together, relational

approaches (relational pedagogy, counterspaces, whānau partnerships) and relational thinking (making connections across ideas, identities, and contexts) offer a cross-cutting strategy to reduce anxiety, strengthen belonging, and enable equitable participation in STEM education (Highfield & Webber, 2021; Lee & Lee, 2025; Tolbert et al., 2024).

The next chapter outlines the methodological approach of this study, detailing how principles of kaupapa Māori methodology, interpretive phenomenology, and an intersectional lens, each grounded in relational principles, were combined to capture the lived experiences of seven Māori wāhine in Year 11 (age 15-16) enrolled in a project-based STEM education class.

Chapter 3 Methodology

3.1 Introduction

The impetus for this inquiry resulted from observing that Māori wāhine were not choosing senior science subjects in my school. Taking a new pedagogical approach utilising interdisciplinary project-based STEM, I wanted to investigate:

1. How do young Māori wāhine experience project-based STEM education?
2. What are the challenges to succeeding in STEM at an English-medium High School?

Educational research refers to attempts to gain an understanding of an educational process with a view of improving its outcomes. The process should be critical and reflexive, with rigorous data collection methods, the analysis of which can help advance knowledge towards improvement (Ayiro, 2012). This study aims to be educational.

This chapter establishes the research paradigm, methodology and methods used to conduct this study and is divided into the following sections: 3.2 considers the paradigmatic lens that guided this study and my position as a researcher. Sections 3.3 and 3.4 examine phenomenology and a qualitative research approach, which were adopted to underpin data gathering. Section 3.5 documents the methods selected for this study, the processes used for Story Sharer participation and how the Story Sharer pseudonyms were developed. Section 3.6 describes the procedures used for data collection, and 3.7 details the data analysis. In the final section, ethical and cultural issues related to this study are considered alongside the quality assurance of the methods employed. The chapter concludes with an overview.

3.2 What Informed the Research Paradigm

As a scientist now working in educational research, during this study, I have been on a transformative journey to understand the meaning of methodology. Understanding methodology and the diverse philosophical, epistemological, and theoretical perspectives possible for educational research helps support the idea that we have justifiably used an appropriate and productive research process (Cohen, 2013; Gray, 2013). In this section, I take you on my methodological journey, which was both educational and reflective and reminded me always to be open-minded (Kincheloe, 2005).

3.2.1 Ontology

Ontology is centred on the philosophical viewpoints of the nature of reality and the theory of existence (Lee, 2012). The word ontology is derived from two Greek words: “onto”, which means the existence of being, and “logia,” which translates to study or science (Collins, 2015). The foundations of two opposing perspectives are formed through the different ontological philosophies: realism and relativism. My initial training as a scientist led me to see the world as a realist who views reality as a law of nature, a reality that exists outside the subject and is waiting to be found (Gray, 2013; Heidegger, 2008). As a scientist, I was taught that evidence was vital in pursuing truth and that scientific methods were the solution to methodological rigour. Moving from a scientist to a science teacher and education researcher led me to a different view as a relativist. I found utilising a scientific methodology grounded in a quantitative research approach was limited within a classroom environment (Lyu, 2024). The dynamics of the classroom environment required an approach with more nuance that meant I could understand diverse student backgrounds and perspectives whilst recognising my own positionality. I became somebody who believes that reality can come to light through an individual’s experiences and interpretations (Crotty, 1998; Gray, 2013; Heidegger, 2008). This transformation in my ontological position for this study means I have taken a relativist perspective, as I am enquiring about the experiences of the Māori wāhine within the STEM class. The philosophical perspective of a relativist acknowledges the subjective nature of reality constructed based on individual and cultural perspectives, suggesting that no objective reality exists independently of human experience and interpretation (Gray, 2013).

3.2.2 Epistemology

Epistemology is a philosophy concerned with the theory of knowledge and explains the relationship between the knower and the respondent (Lee, 2012; Stroud, 2011). Again, there are different epistemological viewpoints based on the various philosophies of constructing knowledge. Realists and objectivists view reality as something waiting to be discovered and knowledge is governed by nature's laws. In opposition to this would be the subjectivist, who would consider knowledge as something individuals interpret (Stroud, 2011).

Again, I transitioned from my positivist epistemology based on experimentation and observation of the real world as I took an interpretivist epistemological approach to this study. This study aimed to understand the how the participants made meaning and

understanding through their interactions and experiences (Ward, 2015). As a teacher and researcher, I would work alongside the participants to understand their perspectives (Ward, 2015).

Interpretivists view truth and knowledge as being constructed, not discovered; it is a world where participants construct meaning differently, even concerning the same phenomena (Crotty, 1998; Gray, 2013). Although this can lead to multiple conflicting accounts of the world, they are all seen as equitable in their value (Crotty, 1998; Gray, 2013). This study is grounded in a constructivist view as this epistemological stance links harmoniously with the world of the classroom, where teachers and students often construct meaning together. I view constructivism as a spiral of continual change, with people reflecting on their experiences and interactions, leading them to grow in complexity, naturally sitting within my philosophy of curiosity as I continually look for new challenges, different ideas, and experiences to enable myself to increase in complexity.

3.2.3 Axiology

Derived from the Greek word *"axia",* axiology is concerned with studying values (Gray, 2013). My philosophical approaches are entwined with my ontological and epistemological stance. I fully participate in the research process and bring my own experiences. These experiences inform my worldview and have helped me develop my values. Reflecting on my values is imperative to preventing harm to those who are 'powerless' (Lee, 2012). My values are most evident within my teaching philosophy, within which I strive to encapsulate four central tenets, which are:

Student-centred. The student is at the heart of teaching and learning.
Evidence-based. Data is used to guide and inform pedagogical practice.
Equity. I am using a classroom to promote fairness, equity and social justice.
Cultural considerations: I must ensure that I am aware of my power and privilege as a non-Māori working with Māori in a colonised country.

Throughout this study, I was always mindful of my obligations to Te Tiriti o Waitangi. This founding document enabled me as an immigrant to settle in Aotearoa New Zealand and call this country my home. I am mindful that I live in partnership with Māori and not as a coloniser and recognise Aotearoa New Zealand as their ancestral lands. I ensure that all

teaching and learning in the intervention and the accompanying research for this study must be mana-enhancing (ensuring to strengthen a person's sense of self-worth, power, and influence, and fostering their wellbeing), understanding that young people can recognise what is right for them and require support to express their own voice. I strived to ensure this by following my values and placing the participants at the centre of the study. I listened to their stories, which provided the evidence to change practice. I ensured all participants were respected and provided with what they needed to achieve.

3.2.4 My position as a researcher.

Positionality as a researcher encompasses beliefs about reality (ontology), knowledge (epistemology), and values (axiology), all of which contribute to how I have approached this study. Beliefs are influenced by parts of fixed identity, such as ethnicity, and those that are fluid, such as political views. Ultimately, these beliefs can affect data collection and analysis (Creswell & Poth, 2018; Gray, 2013).

Reflecting on my positionality, I am mindful that as a child I had two loving parents, and we lived in a low-socioeconomic area and rented a council (state) house. At age 11, I passed the County's standardised test, known as the 11 plus, and was admitted to a state Grammar school. By year 9, I was disengaged from my studies and left school and home at 16. However, I took an opportunity to re-enter education in my early twenties and five years later graduated with a post-graduate master's degree in science. This educational opportunity was the turning point in my life as it gave me choices, including escaping a problematic relationship. My experiences engendered a view that education can provide opportunities grounded in social justice. I was also appreciative that science was the subject which had provided the opportunity to return to education. Initially this biased my opinion that science was a subject which was accessible to everyone. This highlights the position of privilege I inhabit as a cis-het white woman. After spending time in Aotearoa, New Zealand, and the observations I made in my sciences classes, I have learned that traditional science classes are not always equitable.

I tell these stories because these experiences influence my worldview. I understand that young people sometimes struggle to make good choices even when presented with opportunity. However, I believe education can enable choice, be an enabler for social justice,

and be a conduit to improve people's life chances. This worldview has influenced the decisions I have taken with my career. For example, once I trained as a teacher, I worked in low-decile (see section 1.2) schools or with students excluded from their classes. I was grateful for the opportunity to become a Head of Science at a co-educational, low-decile, predominantly Māori and Pasifika school. Intertwined with this perspective is my curiosity, which led me to develop the curriculum from traditional STEM subjects into interdisciplinary STEM education and further explore how to encourage more Māori wāhine to study STEM.

However, understanding that I am tangata Tiriti (a non-Māori person here in partnership with Māori), I must continue to question, learn, and grow in this space. I must also be mindful to not colonise the narrative shared with me by Māori wāhine.

3.3 Theoretical Perspectives

Much like paradigms, theories provide a way of looking at the world and understanding human interactions. Paradigms are grounded in significant assumptions about the world, such as what is real and how we create knowledge, whereas theories describe more specific phenomena (Gray, 2013).

3.3.1 Interpretivism and its links to Phenomenology

From a theoretical perspective, the interpretivist, or what has also been called post-positivist, takes an opposing view to a positivist. Interpretivism leads us to understand that there are no direct one-to-one relationships between subjects and objects, but an interpretation of the world (May, 2002). There is an assertion that natural reality, the laws of science and the fundamentals of social reality are different and, therefore, require different methodologies to explore them (Alexakos, 2015; Gray, 2013). There is an understanding that the social sciences, such as educational research, deal with the thoughts, feelings and actions of the human individual or the collective, in contrast to the natural sciences, which are concerned with data on what can be observed either in the natural state or through experimentation, from which truth and knowledge can be drawn (Crotty, 1998).

The interpretive perspective relates to methodologies that lend themselves to collecting qualitative data. It can allow a researcher to understand better the multifaceted complexities of the nature of a person and how they think, feel and act in certain situations (Alexakos,

2015). Interpretivism means you must first understand your interpretations of the world to make sense of other people's unique viewpoints (McGovern, 2017). However, because interpretive research is contextual, subjective, and heavily impacted by personal views and values, it allows some positivists to argue that the data is biased and unreliable (McGovern, 2017). This can be problematic when trying to create findings that could be used in a generalisable manner (Kim, 2003). Just because something is true in one situation or context does not mean it will be true in another. Interpretive studies can also be time-consuming, requiring the researcher to observe, describe, interview and collect data about a complex social situation (Crotty, 1998; Kim, 2003; McGovern, 2017).

Phenomenology, which can be described as an approach to research within interpretivism and its anti-positivist stance, is grounded in people's experiences of social reality (Gray, 2013; Littlejohn & Foss, 2009). The advantages of phenomenology, like interpretivism, lie in the ability to collect rich data that can aid in helping to understand the experiences of the individual or a group (Mayoh & Onwuegbuzie, 2015). You can look at changes over time, understand peoples' meanings, adjust to new ideas emerging, contribute to developing new theories and gather natural rather than artificial data (Scott, 2014; Tesch, 1990). Again, the subjectivity of the data can lead researchers into difficulties and raise questions about the reliability and validity of approaches and information (McGovern, 2017). Along with these questions, the data is often not generalisable, and samples can be small, which leads to questions about whether they are typical. It can be challenging to prevent researcher bias, and participants need to be able to express and articulate themselves (McGovern, 2017; Scott, 2014).

However, referencing my research questions, I was drawn to constructivism's epistemological stance and its links with phenomenological interpretivism. These ideas set the scene for me to gather rich data for this investigation. This was possible because this methodological perspective meant the Story Sharers could express their own lived experience and clearly articulate their position without any pretext or judgment.

3.3.2 Kaupapa Māori and Critical Race Theory

As a non-Māori researcher, I acknowledge that my epistemology, ontology, and methodology mainly originated from Western and European scholars (Jones, 2012). If I want the research

to be about Māori and for Māori, I must find and work within a Māori worldview (Cram, 2006). This worldview is known as Kaupapa Māori. In this section, I address the philosophies of Kaupapa Māori, how I followed those philosophies within this research and analyse the distinction between following the principles of Kaupapa Māori research and performing Kaupapa Māori research.

Since the early 1990s, critical race theory has been used as a methodology to investigate racism in education. Along with highlighting how people of colour still experience racism, independent of laws and policies, critical race theory challenges the European stance of epistemology (Smith, 2013). Critical Race Theory challenges historical Eurocentrism, hegemony, and colonial ideas that state that the only legitimate knowledge and knowers of truth are in the Western world (Almeida, 2015). This has resulted in many of the theoretical contributions from Black, Indigenous, People of Colour (BIPOC) scholars being reduced to "stories" (Almeida, 2015). An example can be found in Aotearoa with the continuing discourse surrounding the introduction of mātauranga Māori into the science curriculum (section 2.3.4).

Parallel to this challenge to conventional practice is the increase in the 'decolonisation' of methodologies. When decolonised methodologies are used, they undergo fundamental changes that enable the insertion of Indigenous principles so that research practices can play a crucial role in asserting Indigenous people's rights and sovereignty (Smith, 2013). One such decolonised methodological approach is the Kaupapa Māori theory.

One translation of Kaupapa Māori is 'Māori ideology' (Jones, 2012). Although it is hard to define Kaupapa Māori as a methodology under 'Western' constraints, it is a research approach that can provide a philosophy (or methodology) to guide Māori researchers (Jones, 2012; Pipi et al., 2004). Kaupapa Māori has been argued as a valid approach underpinning research in many disciplines, including clinical psychology, health, and education (Bishop, 2011; Brewer et al., 2014; Pipi et al., 2004). As Kaupapa Māori research evolved, it focused on analysing power structures and social inequalities (Bishop, 2011; Pipi et al., 2004). It is linked to a research stance of 'by Māori, for Māori, with Māori' (Cram, 2006). At its essence, Kaupapa Māori itself is decolonising as it prioritises Māori knowledge and ways of knowing, and it requires researchers to reflect on their own beliefs that have evolved from their colonial position of knowledge and power (Brewer et al., 2014; Pihama et al., 2014). Ultimately, any

Kaupapa Māori research must be transformative and benefit Māori (Bishop, 2011; Cram, 2006).

As with any philosophical statement, this can be open to interpretation and has led to debates regarding a guide for researchers to ensure they follow Kaupapa Māori principles in practice. Bishop (2007) summarised these debates with five essential concerns that must be answered before the research process begins:

- **Initiation.** How did the research process begin, and whose interests determine the outcomes?
- **Benefits.** Who will gain from this research, and will anyone be disadvantaged?
- **Representation**. How will Māori be represented, and will the research adequately depict social reality?
- **Legitimacy.** What authority is claimed for the text?
- **Accountability**. Who are the researchers answerable to, and who has control? (pp 3-4)

As a non-Māori researcher, I can identify with these guidelines as they transform Kaupapa Māori into a format I can relate to. However, I also have a problem with this. I believe a dichotomy can be created by describing the principles in this manner, resulting in a 'recolonisation' of the Kaupapa into a European form. The premise of Kaupapa Māori is to identify and justify Māori knowledge and worldview. It is, therefore, my preference that for this research, I follow the seven Kaupapa Māori practices that were defined by Linda Smith (1999):

- **aroha ki te tangata**: A respect for people.
- **kanohi kitea**: The seen face; that is, present yourself to people face-to-face.
- **titiro, whakarongo, korero**: Look, listen, speak.
- **manaaki ki te tangata**: Share and host people, be generous.
- **kia tupato:** Be cautious.
- **kaua e takahia te mana o te tangata**: Do not trample over the mana (pride, authority) of the people.
- **kaua e mahaki**: Do not flaunt your knowledge. (p120)

There are many debates about whether non-Māori can conduct Kaupapa Māori research. Arguments remain that being Māori and identifying as Māori are critical to Kaupapa Māori

research (Jones, 2012; van Halderen, 2023). However, Smith (2013) remarked that non-Māori can be involved in Kaupapa Māori research but only when accompanied by Māori and whilst ensuring the researcher can position themselves as non-indigenous (p. 186). It is also argued that non-Māori are obligated through te Tiriti to support Māori research (Jones, 2012; van Halderen, 2023).

I am not Māori and cannot do Kaupapa Māori research. However, as somebody who was able to become a citizen of Aotearoa due to the signing of te Tiriti, I must uphold and follow Kaupapa Māori research guidelines and values. Throughout this study and the implementation of the STEM programme, I have sought counsel from Māori within the same organisation, the local Iwi Ngāti Tamaoho, whilst following the guiding practices set out by Smith (1999). I continue to reflect on my personal views and opinions to ensure acknowledgement of my position of power and take steps to address them (Smith, 1999). I listened and engaged in kōrero (talk) with the participants, their whānau and the community, and these participants continue to own the knowledge that was created. I continue to be guided by and follow Kaupapa Māori principles, ensuring as much as I can that this project is for Māori and with Māori.

3.3.3 Research Paradigm and Theory Summary

I took a relativist ontological perspective for this investigation, while the epistemological framework was linked to constructivism and phenomenological interpretivism. Phenomenology and Kaupapa Māori both relate to the philosophy of the importance of the individual experience, which can be transmitted through storytelling. I endeavoured throughout this inquiry to follow the principles of Kaupapa Māori while ensuring I reflected on my position of power. Working within my values as a teacher and position as a researcher, I endeavoured to enact a study that would ensure positive outcomes for the participants involved and future students. Ultimately, the common thread through all the perspectives that influenced my research paradigm is creating transformative change that can increase equity and a sense of social justice.

3.4 Informing the Research Approach

After investigating the chosen research paradigm for the study and reviewing my philosophical standpoint on educational research, the following section discusses the research approach.

3.4.1 Phenomenological Research

Max Van Manen's hermeneutic phenomenological research approach concerns the empirical (through the collection of experience) and reflective (through the analysis of their meaning) (Stolz, 2023). The overarching aim of this research approach is that phenomenological concepts can be employed to make sense of the phenomenon being investigated (Gray, 2013). At its heart, Van Manen phenomenology is about lived experiences, the nature of those experiences and their interpretation (Stolz, 2023). What resonates for me is that hermeneutic phenomenology is about meaning and encapsulates not only words and actions but emotions and sensitivities. This can enable a researcher to gain a richer and deeper meaning of a participant's experiences. Van Manen described how this can contribute to understanding the 'essence' of the phenomenon, which can be multi-layered and multi-dimensional (Van Manen, 1990). Summarising, Van Manen (1990) listed six research design steps for a hermeneutic phenomenological study:

1. Selecting a phenomenon that is of personal interest.
2. Exploring an actual lived experience.
3. Reflecting on the essence through exploring significant themes.
4. Describing the phenomenon by interpretations.
5. Ensuring a robust pedagogical link is maintained.
6. Providing balance by interpreting parts as well as the whole of the data. (pp. 30-31)

I have used these six steps to guide the design and conduct of this study. The phenomena and research questions were developed from my observations as a head of science in my school. As a woman scientist, I was concerned about why Māori wāhine were not choosing science subjects to study post-year 11. After changing pedagogy to a project-based problem-solving STEM class, I wanted to understand the experiences of the Māori wāhine involved in this intervention. Transcribing and interpreting the themes from the narrative data (section 3.7.4) whilst using an intersectional lens (section 3.4.3) ensured I described parts and the whole of the data.

An Iterative Approach in Phenomenological Educational Research

An iterative approach within phenomenological educational research involved repeated cycles of data collection, reflection and analysis to uncover the essence of the participants' lived experiences. This cyclical process allows researchers to refine their understanding by revisiting emerging themes and interpretations, ensuring the interpretations remain grounded in the participants' perspectives and remain within the principles of kaupapa Māori methodology. Iterative engagement with data enables researchers to 'see afresh' and deepen their insight into the phenomena. In educational contexts, this approach is particularly valuable for exploring complex constructs such as identity, learning and cultural engagement, where meanings evolve through interaction and reflection (Van Manen, 2023).

The iterative nature of phenomenological research also supports methodological rigor by enabling researchers to validate and adjust their interpretations in response to participant feedback and contextual nuances. This can foster the dynamic interplay between researcher and data and enhance the authenticity of the findings, an approach which is especially effective in educational settings where the lived experiences of students and educators are shaped by diverse cultural, social and institutional factors (J. A. Smith et al., 2022). The iterative phenomenological process in educational contexts can support meaningful pedagogical insights and decisions.

3.4.2 Qualitative Research

I used qualitative data to explore my phenomenon of interest and complement the phenomenological approach to this research. The qualitative research approach differs from the quantitative approach. Qualitative research can adopt various theoretical perspectives, methodologies, and data collection methods, including observations, interviews, and questionnaires (Denzin & Lincoln, 2013). However, I consider the fundamental difference between quantitative and qualitative research lies in the role of the researcher. In a qualitative approach, the researcher works within the research and alongside the participants, whether in a community, organisation or individual (Denzin & Lincoln, 2013). This enables a holistic view of the research and allows the participants to construct their reality from their perspectives and worldviews (Hyett et al., 2014). It opens the doors to a world that others may not experience or know existed. Within this framework, theoretical perspectives such as critical race theory have developed, enabling the narratives of people subjected to

discrimination and inequality to be heard and recognised. The quantitative 'purists' may argue that this creates issues of objectivity and raises questions about the reliability and validity of the data (Onwuegbuzie & Leech, 2005). However, qualitative research information can be collected from real-life situations and settings (Hyett et al., 2014). This gives a genuine context to the data, which can involve understanding how and why things have happened from the standpoint of people's worldviews, experiences and emotions (Gray, 2013; Hyett et al., 2014). The complexity of the data allows for robust analysis, revealing new or deeper information about societal issues (Scott, 2014).

I found this approach appealing for finding responses to the research questions and looking deeper into the experiences of the Māori wāhine in the STEM class. This study required in-depth interviews and emerging narratives to encourage the participants to articulate their viewpoints. As the teacher and the researcher, I reflected on my standpoint and acknowledged how I constructed my reality and interpreted the findings. The researcher being immersed in the research is a distinctive characteristic of a qualitative research approach (Pandeli et al., 2022).

3.4.3 Intersectionality

Complementing the qualitative and phenomenological research approach, I applied an intersectional lens to this study. Intersectionality helps highlight the perspectives of social groups that have previously been ignored (Crenshaw, 1989). This framework sits within this study due to the nature of the questions posed and holds with my values of wanting to create knowledge and opportunity for social justice. Intersectionality achieves this by recognising that we interact with the world through multiple intersecting identities (Crenshaw, 1989; Sen, 2006). As a research approach, three primary principles are employed within a qualitative context to achieve an intersectional lens (Theriault & Daniel, 2014):

Frame the Research Process as an Open Empirical Question.

Crenshaw's explanation of intersectionality contends that previous research explored individuals' identity experiences through the lens of one category, such as gender, to exclude other identity experiences, such as ethnicity, religion, or sexuality (Crenshaw, 1991; Nash, 2008). This has resulted in people's diverse and unique experiences being amalgamated. Crenshaw exemplified the problem with this amalgamation of identities by describing the

different experiences of white and African American women within the justice system, highlighting that African American women experience bias at the intersection of both gender and race (Crenshaw, 1991). This study aims to understand how young Māori wāhine experience interdisciplinary STEM education and what the challenges are to succeeding in STEM at an English-medium secondary school?

Using a phenomenological methodology with an intersectional approach enabled the Story Sharers to describe their lived experience. This was achieved by having open empirical questions, whereby the Story Sharers were not pre-judged or prioritised into any one identity category, enabling them to feel free to express themselves. When analysing the data, remaining open and reflexive meant I could understand the contrasting responses that would otherwise have been amalgamated. While analysing thematic data, I could account for the nuances of the individual.

Intersectionality Connotes a Dialectic of Similarity and Difference

By recognising similarities and differences, new connections can be made that might have been overlooked when participants are viewed through the lens of one identity (Sen, 2006; Theriault & Daniel, 2014). This became more apparent to me as the study progressed. I realised that although the Story Sharers were all Māori wāhine, their identities were multiple and fluid. This contributed further to ensuring the individual accounts were to be as important as the themes of the group. Enhancing our sensitivity can provide a deeper connection and understanding of the social world and raise opportunities for social justice (Mazzei & O'Brien, 2009). Using open empirical questions led to various responses, many of which I had not considered as a researcher or a teacher. These responses were used within the research and the classroom to improve academic outcomes and enhance the social justice aspect of the project. Included in this was how the responses challenged my thinking and who I am as a teacher and a researcher.

Deploying The Similarity and Difference Dialectic in Developing Rapport

Using an intersectional approach, researchers can build rapport with the participants. Mazzei and O'Brien (2009) suggest that scholars can bond with their participants through reflexivity and understanding how a participant expresses a range of multiple and fluid identities. This results in a fuller understanding of the social world being studied. Ensuring the Story Sharers could voice their experiences without blockers, such as confining their responses through

closed questioning, enabled me to understand them better. It could be argued that building rapport and explaining who we are through an intersectional reflexive approach is a matter of ethical responsibility (Edith, 1997).

I have used an intersectional approach throughout this study. I used open empirical questions to ensure the Story Sharers' multiple fluid identities and experiences were expressed, and no one identity was given preference over another. This ensured the narrative analysis (section 37.2) could account for the group's responses and the nuance important to an individual's experience. I have also been reflexive of my own multiple identities to discern differences and similarities, which helped to build rapport with the Story Sharers. Taking an intersectional approach enabled me to unpack the 'messiness' of interpreting another individual's lived experience, which has enhanced my ability to build relationships, made me consider my positionality and values and improved my understanding of social justice (Theriault & Daniel, 2014).

3.4.4 Research Approach Summary

I used interwoven aspects of phenomenological, qualitative, and intersectional research approaches for this study. I have used a phenomenological approach to understand the experiences of the Story Sharers and a qualitative approach to gather rich data that would not have been possible using a quantitative method. Using a qualitative and intersectional approach made it possible to maintain the principles of Kaupapa Māori methodology, such as being the seen face, understanding the importance of storytelling, and building rapport with the Story Sharers. I used an intersectional lens to ensure that whilst I gathered the narrative of the group, I also focused on the nuances of the individual. This interwoven research approach captured the essence of the stories the young Māori wāhine shared about how they experience project-based STEM education and the challenges to succeeding in STEM in an English-medium High School.

3.5 Research Design

This section describes the aspects of the research design. It includes explaining the STEM class project and introducing the Story Sharers and the pseudonyms they chose to enable reporting their data.

3.5.1 The STEM Class Project

The interdisciplinary STEM class initiative utilised a project-based, co-constructive and whānau pedagogical approach. The students enrolled in the class gained their NCEA Level 1 credits by completing achievement standards aligned to their projects. This section covers the background, philosophy, and teaching and learning criteria.

Background

In 2016, I trialled a new science class at a low decile (socioeconomic disadvantaged community), co-educational high school (ages 13-18) based in a large urban area. The school has a significant proportion of students who identify as Māori (exact proportion withheld due to privacy considerations). I used project-based, problem-solving interdisciplinary STEM as a pedagogical approach to engaging students deemed at high risk of not achieving their National Certificate of Educational Achievement (NCEA) level 1 science credits in year 11 (age 15+). Due to its success, in 2017 I was asked if the STEM class initiative could become a significant component of the Alternative Programme, a school initiative to improve outcomes for students at risk of not completing their NCEA Level 1. After the successful integration in the Alternative Programme, I embarked on the study with the 2018 class.

Aotearoa New Zealand offers flexible qualifications through the National Certificate of Educational Achievement (NCEA) which has a selection of Achievement Standards that provide credits at levels 1 to 3 (approx. 15-18 years old). Learners can work towards internally assessed achievement standards and/or traditional examination-based standards within each subject. Students must gain 80 credits at level 1, and 60 credits at level 2 and 3, and these levels typically correlate to a student's progression through the senior high school years 11 to 13 (ages 15-18) although students can study multi-level courses. Each year, 20 credits can be carried over to the subsequent year. To pass Level 1, 2 or 3 students must pass ten credits at Level 1 Literacy and Numeracy. In addition, to gain University Entrance (UE) students must achieve 14 Level 3 NCEA credits in three University Entrance approved subjects alongside reading and writing credits at Levels 2 and 3. The Achievement Standards set out the criteria for competency in each subject and offer the availability to pass at an Achieved, Merit and Excellence level. Students who complete a subject with 14 or more credits, including three from an external exam, at a merit or excellence level can receive a subject endorsement. Learners who achieve 50 or more credits in a Level 1, 2 or 3 course at Merit or Excellence level gain a certificate endorsement. This structure enables educators to

create flexible courses by offering a variety of standards in engaging contexts using a variety of pedagogical approaches (NZQA, 2025)

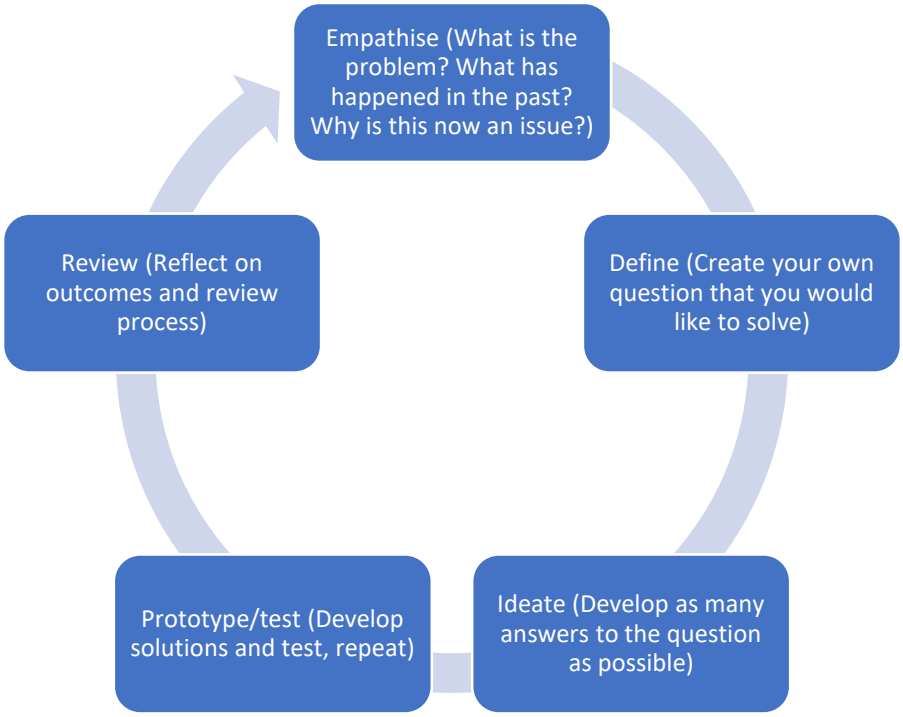
Within the Alternative Programme, the STEM class pedagogical approach used project-based problem-solving in the context of growing food. Using projects enabled the inclusion of mātauranga Māori (Māori knowledge), as the programme incorporated traditional Māori growing methods alongside modern hydroponic and aquaponic techniques. The initial driving question for the STEM project was, 'How can we use biochar to increase the yield of tomatoes grown in hydroponics?'. This question was developed through a co-construction process involving the 2017 class alongside the 2018 cohort. The students in this study were in year 11 (15+ years old) and completed their NCEA achievement standards by doing project work. This was in contrast with the traditional methods of being taught an NCEA achievement standard and then being examined for knowledge.

Philosophy

The cultural philosophy of the STEM class was based upon the foundations of the *Te Kotahitanga* programme (section 2.3.1) (Bishop & Berryman, 2010; Bishop et al., 2009). To embed a mana Māori (Webber & Macfarlane, 2020) approach, the STEM class embedded aspects from the *Effective Teacher Profile* through utilising co-construction, and centred relationships by employing a whānau format (Bishop et al., 2009). Extending learning opportunities included connecting with outside agencies, businesses, subject experts and taking education outside the classroom by exploring local facilities, including the zoo and an observatory. A central point was building students' intra-and inter-personal skills via relational teaching and collaboration (Tsybulsky & Sinai, 2022). To facilitate encompassing this philosophy, the students worked in groups to complete a design thinking process for the STEM projects, which facilitated a constructivist learning model whereby students created solutions to the driving questions (Rhinow et al., 2012).

Figure 3.1

Continual Design-Thinking Process



Within this context, learners had to empathise (with the problem), define (create their own question to solve), ideate (create as many ideas and solutions to their question), prototype (make models and design their solutions), test, and review as depicted in Figure 3.1 (Larmer et al., 2017; Rhinow et al., 2012). To embed kaupapa Māori into the process, the empathise phase provided the opportunity to explore the driving question through the lens of past, present and future. As students developed their own solutions, they were encouraged to incorporate mātauranga Māori models, creating space for culturally grounded innovative approaches (Mercier, 2018). When students explored mātauranga Māori options, outside expertise in this knowledge was sought.

Scaffolding was used to support the students at each step and facilitate the project-based learning process. Figure 3.2 depicts the project flow for the teacher in synchronicity with the student's progression. This model is adapted from the 2017 *Buck Institute for Education PBL Starter Kit* and links to pages 52 to 103 (Larmer et al., 2017).

Figure 3.2

Facilitation of the Design Thinking Process

Note. Adapted from *Buck Institute for Education PBL Starter Kit* pp. 52 –103, reproduced with permission.

To enable the time needed to facilitate authentic project-based learning and develop transformational teaching and learning (Hipkins, 2008), the STEM class was conducted over

an extended learning period rather than the traditional timetable of five 55-minute daily lessons spread over the week. Issues with fitting this into the traditional school timetable resulted in the class running with one 55-minute lesson at the end of a Tuesday and then four consecutive 55-minute lessons from the Wednesday morning, finishing at lunchtime.

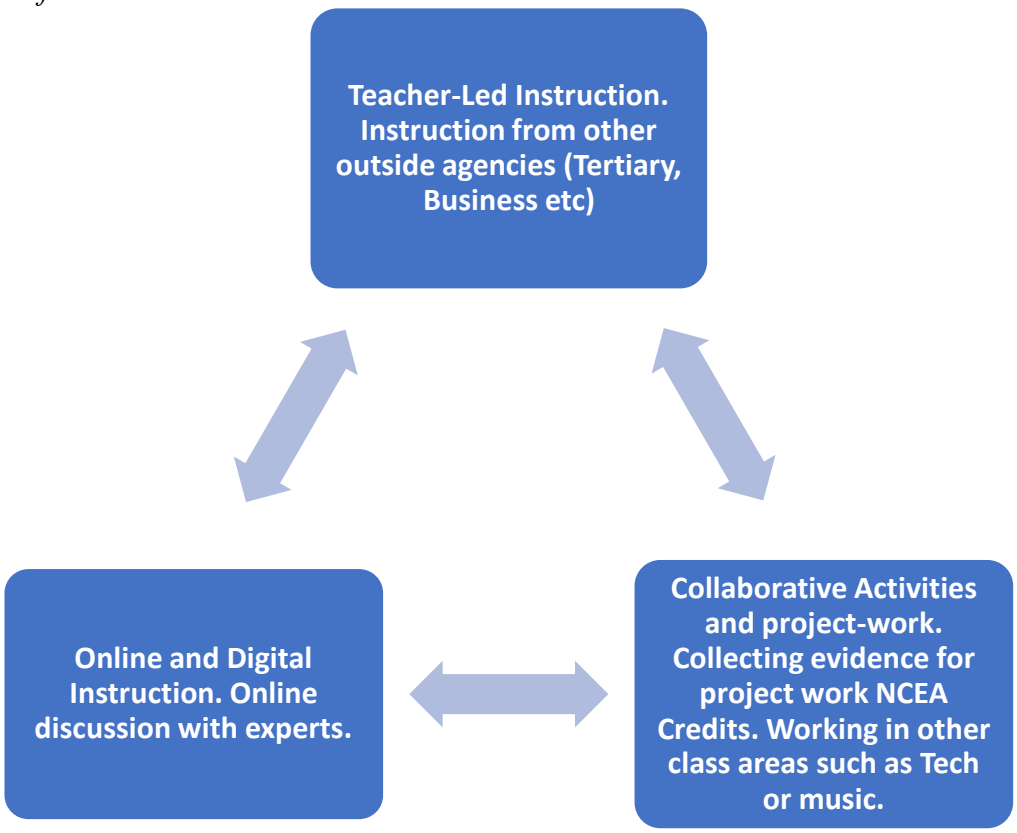
At lunchtime on Wednesday, to extend the whānau philosophy, shared lunch was available for the class. Food was provided, and sometimes students would bring food, and often, the food that had been grown was utilised. During this time, students could discuss their projects and report any issues and successes to the rest of the group. It was also used as an opportunity to co-construct with the students as they discussed how they would like to adapt to the STEM class. The STEM class extended learning period and process created opportunities to incorporate experiments whilst discovering and utilising knowledge in an authentic STEM-integrated environment.

Teaching and Learning

Before commencing the project-based learning process, all students had to complete a health and safety course. Utilising an NZQA Level 1 Unit Standard (Appendix 4), the students completed this part of the STEM course before moving on to project-based learning. This Unit Standard was delivered through traditional instruction, inquiry and a mini project to enable the students to gain insight into the new learning process in a guided manner.
A station rotation learning model was used to facilitate the multifaceted requirements of the class (Larmer et al., 2017). A process of teacher-led instruction would rotate to students engaging with their projects or individual digital learning. This enabled switching between teaching the class and facilitating individual and group learning as required. Figure 3.3 is adapted from the *Buck Institute for Education PBL Starter Kit* (2017) and depicts the station rotation model (Larmer et al., 2017).

Figure 3.3

Rotation of Workstations



Note. Adapted from Buck Institute for Education PBL Starter Kit, reproduced with permission pp 52-103.

Students' design solutions included using multiple techniques to make biochar, developing a kiln, using worm teas for hydroponic nutrients, and learning traditional Māori growing and gardening methods. Some students took the opportunity to create and perform waiata (songs) for use when harvesting the produce. These projects enabled students to gain a variety of science, technology, mathematics, agriculture/horticulture, and education for sustainability NCEA achievement standards alongside Level 1 literacy and numeracy credits (Appendix 4). Whilst the Health and Safety Unit Standard was a mandatory component, all other achievement standards were selected based on the project themes. An additional benefit to this style of assessment choice was the requirement to 'unpack' or understand the requirements of a Standard alongside students. This provided additional agency to the students' and facilitated another facet of co-construction. Students' projects were recorded and tracked using digital devices (Chromebooks) and platforms (Hapara). This enabled flexibility

in teaching, learning, resource allocation and monitoring of work in alignment with evidence requirements for NCEA achievement standards.

To ensure all ākonga could choose to continue a STEM pathway, projects were developed for the NCEA Level 1 Chemistry and Physics externally assessed achievement standards. These were created using resources from University of Auckland at STEM Online NZ (The University of Auckland, 2025). However, these had to be developed in advance and did not utilise the design thinking process.

3.5.2 The Story Sharers

A convenience sampling method was used for this inquiry (Gray, 2013). This is not because I determined it was the most effective sampling method for the study but because the students assigned to the Alternative Programme, and therefore de-facto the STEM class, were all chosen by the Senior Leadership Team (SLT). Students were placed into the Alternative Programme by analysing their prior attainment in e-asTTle literacy and numeracy test scores achieved at the end of year 10 and their attendance data. The SLT had chosen these benchmarks to indicate students requiring extra support to achieve their NCEA Level 1 in year 11, including preventing from withdrawing completing Level 1 studies early. Of the 21 co-educational leaners all of whom were Māori who were placed into the Alternative Program I invited the seven Māori wāhine from this cohort to participate, and all consented to be in the study.

Recognising that this study uses Māori wāhine narrative and wanting to uphold the principles of Kaupapa Māori methodology, I aimed to protect the mana of the participants. To do this I had to recognise my position of power within the dynamic of this study, decolonise the methodological process and foster the same agency for the participants as co-construction and the whānau learning approach was providing within the STEM class. A first step was recognising that the word ‘participant’ highlights a power dynamic, whereby the participant provides information, and the researcher frames the research questions (van der Riet & Grant, 2009). Whilst introducing the research to the group and their whānau and the importance of pseudonyms, there was also a discussion to collectively agree that moving forward the term Story Sharers would be used. We collectively agreed that those involved with the study were sharing their stories and discussing what they deemed important.

The Story Sharers were all registered with the school as Māori and identified as Wāhine (women). Three of the seven Story Sharers had been students at the school since year 9 (the usual start year for secondary education), and four started during year 10. All except one student (Maddie) lived within the school zone (area of enrolment boundary). The school was a decile 1B (the lowest rating), which indicated the low social inequality of the community it served. There were three Story Sharers on the schools' financial hardship register. This register ensured that students in most need were recipients of any school donations, for example, when lunches were provided by the Eat My Lunch initiative.

Narratives from two Story Sharers were used as case studies in the findings (chapter 5). Kōwhai and Harakeke were chosen because they both started the school in year 9, had siblings in the school, were on the hardship register, had similar living circumstances, contributed a similar amount of narrative data, and attended the same number of discussion group meetings. Their only difference was living in different communities.

One Story Sharer left the Alternative Programme and STEM class after the first year of study at the start of 2019 and returned to the standard timetabled classes. I left the school at the end of term 1, 2019, and because of this, the Alternative Programme and STEM class were disestablished, and the students, including the Story Sharers, were returned to the standard classes and timetable. After I left, I continued to be in contact with the group. Two Story Sharers left the school during the 2019 school year, and four Story Sharers remained and completed their year 12 and NCEA Level 2 studies.

3.5.3 Pseudonyms

Of paramount importance within the ethical considerations for this study included ensuring the anonymity of the Story Sharers. Through this process, I was aware of two issues with securing the anonymity of the Story Sharers, the first being that Aotearoa New Zealand, has a small population and Māori are only 16% of that population. It could be possible to identify the Story Sharers, even using pseudonyms (Allen & Wiles, 2016). The second issue was a cultural one, as I was aware that Māori names denote whakapapa (family lineage), and it could be inappropriate to use pseudonymised data (Smith, 2013). With these issues in mind, I used the process outlined by Allen and Wiles (2016) and worked with the Story Sharers to

guide them in choosing their research pseudonyms (Allen & Wiles, 2016). This process started with the first meetings with the participants and their whānau when discussing consent for the study. I worked alongside my Māori colleague at my school to ensure I could broach this subject while maintaining mana (pride).

I clarified to the participants and their whānau the importance of protecting the anonymity of those in the study and the wider whānau they represented. Before the first discussion group, a meeting took place with the Story Sharers to discuss what pseudonyms are and how they are applied to the data, and I wanted to make sure they were comfortable with their chosen names. The final settlement of names was agreed on the 15th of October 2022. During this long process, the Story Sharers went through several iterations about the names they wanted. I had to guide them through several issues, including the Story Sharers choosing their 'favourite' names, which were easily identifiable to others. Next, the Story Sharers decided that the most suitable way to protect their anonymity was to make a list of European names and randomly assign them. I facilitated this but wanted to continue revisiting and checking their choices. I maintained contact with the Story Sharers after the study concluded and often conversed with them, especially during the COVID-19 pandemic. While writing the thesis, I returned to the Story Sharers and asked about their pseudonyms. The group responded by writing a list of native plants and flowers, which I randomly assigned to each Story Sharer, and they consented to the outcome. Names chosen were Kōwhai, Harakeke, Pohutukawa, Manuka, Piripiri, Kauri and Rātā.

I found this one of the most complex parts of the research process. It was an area in which I was acutely aware of my power and privilege and how I was walking in a Māori space. I am still not sure if this process of pseudonym generation is appropriate. However, it reminds me that although I am holding to the principles of Kaupapa Māori methodology as best I can, I am not and cannot 'do' Kaupapa Māori research.

3.6 Data Collection

The methodological approach to the research informs data collection. This study's data collection included semi-structured discussion groups and interviews, reflective journals, and data on learning outcomes.

Narrative data were collected and analysed over one year during the STEM programme (2018). This included five group discussions and a one-to-one interview with one Story Sharer. A final discussion group meeting (number 6) occurred at the end of 2019, but only two Story Sharers were present. At this point, they had not been in the Alternative Programme or STEM class for nearly a year, as I had left the school at the end of term 1 of 2019, and the programme was disestablished. Therefore, the data from discussion group 6 was not coded and has not been included in any quantitising data presentation. However, some quotes and responses have been used to detail the reflections. Table 3.1 documents the discussion group meeting dates and attendance.

Table 3.1

Discussion Groups and Interviews

Discussion Group number	Date	Term	Duration (recorded minutes)	Number of Story Sharers Present	Included in quantitising data
1	28/6/2018	2	27.18	4	Yes
2	30/8/2018	3	28.59	7	Yes
3	13/9/2018	3	28.01	4	Yes
Interview	27/9/2018	3	26.49	1	Yes
4	8/11/2018	4	28.38	7	Yes
5	26/2/2019	1	38.25	4	Yes
6	7/11/2019	4	76.12	2	No

Note: Discussion groups 1 to 5 and the individual Story Sharer interview were included in the quantitating data but not discussion group 6

Other data collected included observations I made and documented in my journal, school attendance rates and NCEA data registered within the student electronic management system KAMAR.

3.6.1 Semi-structured interviews

One of the aims of this inquiry was to determine the responses of young Māori wāhine regarding how they experience the STEM class. A questionnaire would gain some general feedback but would lack the opportunity to obtain in-depth narratives, thereby allowing participants to express their views and opinions based on their experiences (Fontana, 2010). Instead, I used semi-structured interviews as discussion groups, which allowed questions to be adapted to the responses (Gray, 2013; Walter, 2013). This enabled the Story Sharers to articulate their complex narratives and express what they believed relevant (Braun & Clarke, 2013). Semi-structured interviews encouraged deeper relationships with the Story Sharers, facilitating their connection to the research and being free to talk about the STEM class at any time throughout the inquiry.

I conducted all discussion group interviews, recorded them onto a digital audio file, and transcribed them afterwards. Transcription and analysis of the discussion group interviews were used to inform questions for the subsequent sessions. By following the Kaupapa Māori principles, I am optimistic that over the time of this inquiry, the power dynamics concerning my being the Story Sharers' teacher and researcher will have changed sufficiently to empower them to give complete responses. To enable power-sharing, I made time allowances for conducting the interviews, including contingency plans such as prioritising questions, flexibility to continue interviews at different times to allow further narrative discussions and the option of individual interviews (Appendix 1).

Advantages of Semi-structured Interviews

As this study is concerned with the experiences of Māori wāhine who were enrolled in a STEM class, I found several advantages to using a semi-structured interview process. These included preparing the open-ended probing questions before the interviews (Braun & Clarke, 2013). The ability to enable two-way conversations with the Story Sharers fostered good relationships and enabled the Story Sharers to be open about sensitive topics. Overall, this approach helped me to collect a rich data source that might not have been available through another approach.

Challenges with Semi-structured Interviews

However, there were issues with using semi-structured interviews. It was not easy to listen whilst interviewing and judge what was important, especially as I was the Story Sharers' teacher and as a non-Māori do not have a Māori world view. The process was very time-consuming, with needing to prepare, conduct, transcribe, and analyse the interviews. I was aware that I could be preparing leading questions, and after the first discussion group interviews, I started giving the Story Sharers the prepared questions a week before the meeting. This gave the Story Sharers time to think about their answers and discuss with me if they had any issues with the approach. I knew discussion group dynamics could be at play as the Story Sharers were in a group with their peers (Braun & Clarke, 2013). To help overcome this issue, I ensured that the story sharers could choose to have individual interviews. However, I hoped that by having discussion groups, the Story Sharers could create a support network to balance their power relationship with me.

Discussion Groups within Phenomenological Research

It has been postulated that using groups to gain narrative data within a phenomenological study is incompatible (Bradbury-Jones et al., 2009; Gray, 2013). Due to phenomenological links to interpretivism, group discussions can lead to contaminated data, and the researcher can fail to accurately describe the phenomenon (Gray, 2013). However, Bradbury-Jones et al. (2009) challenge this idea and believe focus groups can be relevant within a phenomenological study because they aid researchers in bracketing their assumptions when the participants in the group can challenge them (Bradbury-Jones et al., 2009). This enables the researchers to gain a richer and more precise understanding of the data (Bradbury-Jones et al., 2009). This aligns with my decision to use discussion groups, with the option of individual interviews (which one student took up), due to the potential of alleviating a layer of the power imbalance of being both teacher and researcher (Smithson, 2000).

3.6.2 Field Notes, Observations, and Journal

Memos, journals, and field notes complement data gathering within phenomenological research (Ramsook, 2018). The data collected in this manner enables researchers to record observations and thoughts about the data collection and analysis techniques whilst reflecting on the research process (Phillippi & Lauderdale, 2018; Ramsook, 2018). I kept field notes

and observations throughout the study to ensure I captured, analysed, and reflected on this journey. My field notes contain written records, observations, reflections, and photographs. As I was inquiring about the Story Sharer's experiences, my notes and observations focused on the STEM class, whilst my reflections considered the observational data, the semi-structured interviews and the data analysis process. The STEM class observational data was recorded as notes on the same day and, in this context, could be viewed as a field diary (Punch, 2012). It has been postulated that a real-time field diary is beneficial within phenomenological research as it gathers real-time data rather than recall (Punch, 2012). Once my thoughts and reflections were added, this diary became a more comprehensive field journal (Punch, 2012).

All data collected were added to a multimedia journal. This journal captured as much of the inquiry experience as possible and is held as a digital catalogue. For ethical privacy considerations, this site is restricted to my personal use, but I can return and add any extra comments or data in a real-time setting. When analysing the journal, I know it contains my journey; it is not raw data (Gray, 2013). I have saved and highlighted data that I have deemed relevant and is, therefore, constructed from my worldview. As the observational and reflective journal entries were focused on the STEM class, I found it a valuable tool to triangulate with the Story Sharer's feedback notes and narrative data.

3.6.3 Learning Outcomes Data

Learning outcomes data were continuously collected throughout the study. The data collected comprised baseline e-asTTle data, NCEA credits, attendance data, retention data, and STEM subject option choices. The data were compared to attainment in other subjects in which the Story Sharers were enrolled and to the year 11 cohort. All data were managed through KAMAR, the electronic student management and data entry system used throughout the school. Tracking each Story Sharer’s academic and learning outcomes is my responsibility as a researcher and a teacher.

3.7 Data Analysis

The qualitative data collected from the discussion group interviews and the individual interview had a concurrent first-stage analysis (Reason & Bradbury, 2001). This first stage analysis aided in the generation of future questions, which, in turn, ensured the highlighting

and discussion of any significant previous responses by the Story Sharers. I also recorded any insightful individual responses during the interviews as part of the field notes and journal. Although the narrative of each interview was recorded at the prearranged time, I also captured interactions, discussions, and debates outside these times. That was another reason I kept a field journal. The data were analysed using narrative analysis and a process of coding, which resulted in the themes that documented the Story Sharers' experiences.

3.7.1 Narrative Analysis

Narrative analysis is a qualitative method focused on interpreting human experiences and motivations by looking closely at people's stories (narratives) in a particular context (Gray, 2013). For this study, I used an inductive approach. I chose this approach to ensure preconceived ideas, ideals, or notions did not influence the data. Allowing the data to speak for themselves without a preconceived hypothesis, theory, or framework meant the data led the analysis. Such an approach sat within the requirements of a phenomenological study aiming to explore the experiences of the Story Sharers whilst using an intersectional lens and honouring the principles of the Kaupapa Māori methodology (Denzin & Lincoln, 2013; Smith, 2013; Thomas, 2003). Ultimately, an inductive approach enabled me to observe patterns and themes which emerged within the data and interpret the context of the shared stories.

Positives of narrative analysis

There are several strengths to using an inductive narrative approach to data analysis, including rich insight into human experiences (Gray, 2013). Alongside understanding the meanings and interpretations of a group, the individual is also essential, and this approach can give insight into the nuances and complexities of an individual experience (Thomas, 2003). This can reveal the value of an individual's interpretation of their experience compared to broader social and cultural factors (Thomas, 2003). I found this approach complemented using an intersectional lens whilst holding to Kaupapa Māori principles.

Challenges with Narrative Analysis

Going into this study, I became aware of some drawbacks of using inductive narrative analysis. The issues of subjectivity and interpretation concerned me, making me more aware of the reflexivity required as both a researcher, teacher and someone who is non-Māori

(Smith, 2013; Thomas, 2003). I also ensured I remained open-minded to prevent making assumptions. Reliability and generalisation are another issue with this approach (Denzin & Lincoln, 2013). Conclusions from this type of approach cannot be generalised or empirically verified as the findings are anecdotal and not suitable for the basis of a theory (Denzin & Lincoln, 2013). However, I was interested in telling the stories shared with me to understand the experiences of the Story Sharers better. I realised I had not fully appreciated the substantial time considerations required when analysing long-form data, primarily expressed as stories.

3.7.2 Familiarising with the Data Set

All the narrative data were collected through semi-structured discussion groups and interviews. I conducted all the discussion groups and interviews, which were audio-recorded and manually transcribed. Transcribing the interviews meant I had to listen to each sentence and interpret what was said line by line. This enabled several positive outcomes: I had to reflect on my positioning by listening to the playback of the meeting discussion; I observed data that were not obvious; and I could locate the following discussion group questions by seeking clarification of those interpretations. Coding the data also gave me an extra level of familiarisation with the narrative. It was how I ended up on a journey of discovery about the role of intersectionality in the Story Sharer's lives.

3.7.3 Coding

I used an inductive narrative analysis method to code the transcribed data. Inductive coding can be interpreted as a 'bottom-up' approach. You do not start with preconceived hypotheses or theories, so you develop the code as you analyse the data set (Denzin & Lincoln, 2013). Using the inductive approach meant I used a three-step process: observing the data, seeking patterns and, from those patterns, developing a theory or theme from which to describe the story or phenomenon (Denzin & Lincoln, 2013). The steps for the coding process included:

1. Breaking down the transcribed data into smaller samples (usually each discussion thread).
2. Reading that sample.
3. Developing codes for that sample, for example, coding the words used to describe racism.
4. Rereading the sample and simultaneously applying the codes

5. Reading a new data sample applying the same codes.
6. Making notes on where codes did not match or if extra codes were needed.
7. Developing the extra codes needed.
8. Recoding all the responses again.

To facilitate this process, I used the NVivo software package. This required uploading the smaller samples of transcribed data onto the NVivo software and highlighting words to be coded, for example, highlighting all the words associated with racism when discussing the blockers to learning in discussion group 2. On any occasion when I added a new code, split an existing code into two or changed a code's description, I reviewed how this change affected the coding of all the responses. Again, this was only manageable due to using NVivo, as I could go back to the highlighted transcripts saved within the software and re-highlight the transcriptions. After each transcription and coding, I would check whether I had interpreted the narrative correctly with the Story Sharers. Overall, even with using NVivo, this was an exhausting and time-consuming process.

3.7.4 Themes

Once the coding for each transcription was complete, themes began to emerge. Each Story Sharer's experiences were unique, but common messages were evident when they told their stories. The first themes identified happened within the first two discussion groups, particularly those conversations regarding experiences of discrimination and what 'blocked them from learning'. This was helpful to me as it was a valuable way to learn how to analyse, code, interpret, and theme the data. This was an iterative process whereby the data analysis and coding were constantly revisited, and the interpretation and themes were collated to demonstrate key ideas.

Another advantage of using the software package NVivo was the data analysis feature. Once the coding of the transcribed data was finalised, further data analysis could be performed including the production of bar charts of coding results. The NVivo software functions supplied graphs with the number of times words had been highlighted through the coding process. These data were transferred to a Google spreadsheet, which facilitated the quantitisation of the data by calculation of the percentages of narrative within each of the themes. For example, racism was calculated as 26% of the discussed narrative. This percentage was derived by dividing the number of words highlighted for racism by all the

highlighted words and multiplying by 100 (appendix 3). As mentioned in section 3.6 and Table 3.1, due to the lengthy period between discussion groups 5 and 6, the disestablishment of the Alternative Programme and STEM class during that time, and the final discussion group attended by only two Story Sharers, the transcribed data from that meeting were not included in any percentage calculations and were used for reflection purposes only.

Initially, I made pie charts and graphs from this data as this visual representation helped present the information to the story sharers for checking. Alongside this capability, the percentages highlighted nuances within the data, a critical component to maintaining the principles of kaupapa Māori methodology and utilising an intersectional lens. Another advantage of NVivo is that it can highlight a word with multiple codes, allowing me to analyse group and individual data. This feature was indispensable in enabling the intersectional approach to this study. However, this also created a problem when presenting the findings whereby parts of the narrative could demonstrate more than one area within a theme. For example, when the data were coded for racism, it could also be coded to illustrate a relationship or identity. This was useful for demonstrating the interconnected nature of intersectional narratives but simultaneously made it difficult to present the findings without duplication. I have noted in the research findings when I have needed to present data that could be placed in more than one theme, it has been reproduced in the area I believe best represents the story, whilst simultaneously trying to stay true to Kaupapa Māori principles. However, I am also reflexive of my positionality as this data has been placed based on my judgement and perspective. Once the themes were finalised, cogwheel diagrams were developed to represent the findings. These descriptive figures were presented to the Story Sharers at the subsequent discussion group interviews, during which they could give feedback on my data analysis.

3.8 Quality Assurance by Illustrating Trustworthiness

As a scientist, I am well-versed in the requirements for quality assurance within research. When teaching science, I have often reminded students that they need to ensure they can demonstrate their results as valid, reliable, and generalisable. These aspects of quality assurance are critical components of more traditional quantitative data methods, and without this standardisation, many call into question a study's credibility (Cohen et al., 2018). Using the same quality assurance principles from quantitative methods can be challenging with

qualitative data and has often been critiqued (Gray, 2013). The concept of trustworthiness was developed to overcome criticisms and enhance quality assurance of qualitative research (Rodham et al., 2015). To ensure trustworthiness, an inquiry must demonstrate the following components: credibility, transferability, dependability and confirmability (Cohen et al., 2018). This approach to research methodology was a steep learning curve and was a key component in shifting my philosophical approach.

Credibility

Credibility aims to determine if the findings accurately reflect the reality of the participants (Dodgson, 2019). Several aspects within a qualitative study can ensure this area of quality assurance: prolonged engagement, reflexivity, and triangulation (Ahmed, 2024). Prolonged engagement with participants can enable researchers to build rapport and deepen insights and nuances of the lived experiences (Ahmed, 2024). As a teacher and researcher, I had a unique insight into the Story Sharers' lived experiences. During lessons I would document observations in the STEM class which enabled me to ask probing questions during interviews. The developed trust led to the Story Sharers describing their stories in detail. Being reflexive ensures a researcher can bracket their biases and reduce distortions within the findings (Dodgson, 2019). Keeping a reflexive journal throughout the study has helped me position myself in this inquiry. I know the power dynamics of being the Story Sharers' teacher and my desire to ensure the STEM class's success. As the teacher, any inherent bias I had to ensure the academic success of the Story Sharers and STEM class was impossible to detach.

I have followed the principles of the seven Kaupapa Māori practices that were defined by Linda Smith (1999) because, as a non-Māori, I am interpreting the stories of Māori ākonga (students), and I do not live their experience. Using the various data sources to cross-verify and triangulate the findings reduces the potential biases present using one data source (Cohen et al., 2018).

Transferability

This aspect of quality assurance relates to the ability of the research findings to be 'transferred' to alternative contexts and situations (Bingham, 2023). Recommendations for how this can be achieved include thoroughly describing the research context, the participants,

and the research methods as the first component to confer transferability (Ahmed, 2024). Some aspects of these components have been challenging as they can conflict with ensuring the privacy and anonymity of the Story Sharers. The second component I have implemented is clearly articulating the sampling method. All the Story Sharers were Māori wāhine, from an area of economic inequality (the school being decile 1B), and the Senior Leadership Team evaluated all as needing extra support to achieve their NCEA Level 1 in year 11. The attributes used to determine the Story Sharers' enrolment within the Alternative Programme and STEM class are indicators that other schools may use, such as e-asTTle test results and attendance data.

Dependability

Dependability could be ascribed to the quantitative element of reliability as an aspect of quality assurance (Cohen et al., 2018). Qualitative researchers aim to demonstrate dependability by thoroughly documenting the research process and any decisions made during the study and providing an audit trail (Ahmed, 2024). To ensure compliance with this quality assurance component, I have kept careful records of all the raw data, including interview transcripts, field diary, field journal (includes reflections), key documents and my self-reflexive journal. Where possible, my decision-making has been detailed within the findings, such as the process that led to using an intersectional approach, which happened over time.

Confirmability

Different approaches, such as peer debriefing, member checking, and reflexive journaling, contribute to the data presented being impartial, objective, and free of bias (Salzano et al., 2023). By following these approaches, researchers essentially 'confirm' that the data presented are a true and accurate representation of the experiences. For this study, initially I would debrief with Māori colleagues within the same school, however over time this became problematic as I wanted to ensure the privacy of the Story Sharers. This was an added reason that I spent time discussing the interpretations of the data with the Story Sharers. Along with improving relationships, member-checking was essential for following the philosophies of Kaupapa Māori methodology by ensuring I was not recolonising the Story Sharers narrative. This was a tangible way to give agency to the Story Sharers while ensuring that I (as a non-Māori) had interpreted their narrative correctly. As previously stated, I have kept a reflexive

journal in which I have documented my personal views and recognised my biases. Due to life events requiring the need to take time away from study, the journal became disjointed, but it remained a valuable tool for reflection. Again, sometimes, the transparency needed to confer confirmability conflicted with the need to maintain the privacy and anonymity of the Story Sharers.

As this is a qualitative study, I sought to describe, interpret, and understand a social construct rather than seek empirical evidence to discover a truth. I have taken several steps to demonstrate the trustworthiness and quality of the research. I have included a detailed description of how and why the data were collected. I have endeavoured to illustrate why the narrative presented is more 'truthful' than other possibilities. Describing the research context, data collection and analysis whilst utilising reflexivity principles and member-checking clarifies how the narrative interpretations were constructed. Utilising these criteria has, I hope, increased the credibility and trustworthiness of the research. Ultimately, by increasing the trustworthiness of the research, I aimed to ensure I conducted what I would call 'quality' research.

3.9 Ethics

A researcher must use the most appropriate methodology to gain the desired insight posed by a research question. They are also responsible for ensuring they conduct their research with high moral vigour. I followed the ethical guidelines procedures set out by the University of Waikato (appendix 2) and gained consent for this study from all the participants and their whānau. To do this, I followed ethical codes and guidelines which have developed from four fundamental principles:

1. Avoid harm to others (participants and anybody else involved in the research)
2. Ensure that all participants have given informed consent.
3. Respect the privacy of participants and others involved in the research.
4. Avoid any use of deception. (Gray, 2013, p. 73)

As I researched in a high school where the participants were students I taught and under 16 years of age, I needed to ensure these principles were upheld to the highest standard. Avoiding harm can encompass many issues, from physical and mental to emotional. It can include anything from participants feeling embarrassed to mental distress to a disadvantage in

some way (Gubrium & Holstein, 2002). Some of these ethical considerations are also linked with the philosophy of Kaupapa Māori and bring about the requirements to safeguard the research principle being 'for' Māori rather than 'on' Māori (Bishop, 2011).

3.9.1 Privacy

The principle of privacy denotes not disseminating personal information to other individuals or organisations unless a rationale is provided, which includes how the data will be used, stored and kept private (Gray, 2013). I gained personal information for this research, such as names, gender, and age. To maintain privacy, I used an identifier within the data so that only I understood who had responded with information. However, there are several issues that I am aware of when protecting the privacy of the Story Sharers. This project took place at my school, which is easily identifiable as it was my employer; it is a relatively small school, the participants were from my year 11 class, and the focus is Māori wāhine. It is of concern to me that even though there are strict rules to protect research participants in Aotearoa New Zealand, the smallness of the country, along with the ease of identifying the school, there is a possibility that distinguishing comments could reveal any Story Sharers' identities (Tolich, 2016).

This has been difficult when writing the thesis as I have found it problematic to give enough details to convey the stories whilst explaining the data in a helpful way to other researchers. Trying to follow the principles and philosophies of Kaupapa Māori (story sharing), alongside presenting the findings for an academic audience whilst ensuring the privacy of the Story Sharers, has often been in conflict. The narrative shared with me was not limited to the STEM class but included intersectional challenges to succeeding, which included personal information. Trying to convey what had been shared without including information that would reveal personal information was difficult. Especially as this was an in-school study in which I was the teacher and researcher. Whilst limiting the data to ensure anonymity and privacy of the Story Sharers, I have found myself walking a tightrope between risking the integrity of the stories and reducing the academic rigour of the thesis. While ensuring I uphold ethical values and the privacy of the Story Sharers, as a non-Māori reflecting on the philosophies of a kaupapa Māori, I am still unsure if I have provided the data correctly. This is another example of the difficulty I find myself as a non-Māori working in Māori spaces.

Therefore, it was a priority to ensure the students and the whānau were aware of all their legal rights, how the data are stored and in what context the data are used (Gray, 2013). I have also assured them that all the raw data collected has been stored by myself in a locked cabinet and on multiple password-protected computer.

Another confounding issue is related to one of culture. This research followed the principles and philosophies of kaupapa Māori. As discussed above, it is essential to acknowledge that for many Māori, their names are highly significant to them and carry their whakapapa (genealogy) (Bishop, 2011). For this reason, some participants did not want to be anonymous and to be designated by a separate identifier such as a pseudonym. Because of this situation, I collaborated with Māori members within the school who helped guide me, the participants and their whānau through this part of the research process. The application of pseudonyms is explained in section 3.6.3. I am grateful to the Māori colleagues and Māori Iwi representative who sat on the school board of trustees who helped me navigate many of the difficulties I encountered during this study as tangata Tiriti. While I acknowledge the valuable contribution made by my Māori colleagues and Iwi representatives, their identities will remain confidential in this context.

3.9.2 Researcher and the Teacher

Respecting the principles and philosophies of kaupapa Māori, I am acutely aware of power and power imbalances (Bishop, 2011; Doucet & Mauthner, 2006). Through power imbalances, Māori have faced being subjected to research rather than benefitting from it (Bishop, 2011). Therefore, it is unsurprising that Māori are very cautious of non-Māori conducting research that includes many Māori participants (Cooper, 2012). It is here that I found myself in a challenging position. As a teacher, I recognise that I have a position of power when teaching students. My investigation placed me with the students I taught, who were also the participants in the research.

It is difficult to remove the power imbalance that exists in a classroom. Again, I used the facilitation and expertise of Māori colleagues to guide me through a method of co-construction, a common teaching practice from the Te Kotahitanga program (Ministry of Education, 2017d) already used in my teaching practice, so that any power imbalance was redressed. Also, I met and spoke to the whānau of the participants, ensuring that any concerns

or considerations were heard and acted upon. I acknowledge the extended time this process would require and scheduled the first discussion group for term two of the STEM class. This ensured the development of relationships before embarking on a situation that could cause discomfort to the Story Sharers or their whānau.

3.9.3 Gaining Consent Without Coercion.

While considering the previous ethical issues, I endeavoured to ensure that any consent to participate in the research was done without coercion. As the Story Sharers were under the age of 16, permission was sought from the Story Sharers and their whānau. Once more, I utilised the guidance of Māori colleagues and the New Zealand Association for Research in Education (NZARE) 2010 ethical guidelines (NZARE, 2010) to ensure that the school, the Story Sharers and the whānau knew all the ethical considerations. I did this by giving a complete description of the research, including the project and its aims, details of their right to privacy and how that will be achieved, their right to not participate and withdraw from the study at any time without fear of any consequences, maintaining consistent lines of communication, describing how information is disseminated and how 'good faith' will be preserved (Gray, 2013; Tolich, 2016).

3.10 Chapter Summary

This study focuses on data collected from young Māori wāhine enrolled in a project-based problem-solving STEM class from February 2018 to April 2019. The study design included semi-structured interviews, a one-to-one interview, and the collection of academic outcomes data. All research was conducted according to the University of Waikato's ethical procedures. Acknowledgement has been made where the delicate requirements to ensure anonymity and privacy have constrained the findings. An inductive narrative analysis of the transcribed data was facilitated by using the software package NVivo. A field diary was kept documenting observations made in the STEM class, a field journal emerged when reflections were added, and a self-reflexive diary was kept throughout the study. These documents aided in the data triangulation and increased the quality assurance of the findings. Through this reflexive and iterative process, themes emerged, and member-checking was used to ensure the interpretations. Trustworthiness was demonstrated by ensuring the research's credibility, transferability, dependability and confirmability. Aspects of this study emerged over time, such as utilising an intersectional approach, which has been documented in the findings.

Accordingly, the data is presented next in two chapters. Chapter Four concerns the Story Sharer's experiences in the STEM class. It includes their academic outcomes and documents their narratives associated with their experiences whilst studying STEM. Chapter Five is dedicated to the challenges of succeeding in STEM and is divided into three sections. Part 1 (Sections 5.1-5.3) includes descriptions of discriminatory events; Part 2 (Sections 5.4-5.13) concerns the Story Sharer's lived experiences regarding identity and relationships; Part 3 Sections 5.14-5.17) demonstrates how these experiences and events are interwoven into an intersectional framework. This is followed by Chapter Six, which discusses the findings.

Chapter 4 Experiencing Project-Based STEM Education

4.1 Introduction

The first findings chapter is concerned with how the Story Sharer's experienced their STEM class. This findings chapter presents the narrative data regarding the STEM class alongside academic data which includes NCEA results, attendance data and retention rates. The academic data was collected throughout 2018 and is compared to 2017 results. The attendance data was collected between terms 1-3 for 2017 and 2018 to ensure a fair comparison, as senior students have access to study leave during term 4. This quantitative data was also used to help the Story Sharers set their goals and aided in the development of questions for the discussion groups. The interview data used to calculate the percentage within each theme was collected over a one-year period, from the beginning of Term 2, 2018, to the end of Term 1, 2019 (Table 3.1). The Story Sharers' background can also be found in the Methodology chapter section 3.5.2.

4.2 Academic Data

The academic data in this section relate to attendance, retention, and academic achievement, which were recorded within the school's electronic student management system (KAMAR). Alongside these data are the interpretations of the narrative the Story Sharers used to describe their goals, achievements and their views of success.

4.2.1 Attendance and Retention

One of the goals set by the Senior Leadership Team (SLT) was for the Alternative Programme and the STEM class to increase student attendance and retention. When analysing the attendance data for 2017, only two of the Story Sharers had reached the school goal of a minimum of 80% attendance, and only one had reached the 80% target for science class attendance. Discussions during summer 2017/18 between the Senior Leadership Team (SLT), the Board of Trustees (BOT) and the Education Review Office (ERO) resulted in the school's attendance objective increasing to 85%. When communicated to the school community and staff, it had been determined attendance was a key requirement to improve student academic outcomes. A target of 85% was still below the 90% that the Ministry of Education had used to denote regular attendance in the 2017 report issued to government ministers (section 1.4). Only one Story Sharer reached the 85% school attendance goal in 2018. However, four Story

Sharers reached the target for attending their STEM class, and six Story Sharers improved their STEM class attendance compared to the previous year's science class. Table 4.1 documents the attendance rates of the Story Sharers in 2017 versus 2018 using terms 1-3 for fair comparison.

Table 4.1

Attendance Data

2017 Attendance (%)		2018 Attendance (%)	
School	**Science**	**School**	**STEM**
45	45	59	68
74	65	79	95
93	82	90	97
79	73	81	92
26	32	26	24
77	59	79	88
86	73	76	78

Note: Attendance data from the electronic student management system KAMAR entries. Data includes terms 1-3 in 2017 and 2018 for fair comparison.

Although the Alternative Programme did not improve the Story Sharer's overall school attendance, they attended their STEM class more often than the other Alternative Programme classes and more than their previous year's science class. One Story Sharer had an attendance between 24-32% in 2017 and 2018 due to not living within the school zone and the area of residence not having public transport facilities to the school. This was resolved in 2019, when they relocated within the school zone, as discussed in greater detail in section 5.2.2.1 Lived Experiences. Of note, the Alternative Programme made a positive impact on student retention. In 2017, 40% of students left the school during their year 11 studies once they reached the legal leaving age of 16. In 2018, the school reduced this number to 30%, while for the Alternative programme, this number was reduced to 16%.

4.2.3 Academic Achievements and Goals

Within the school all school students sit the traditional e-asTTle Literacy and Numeracy exams at the end of year 10 (age 14-15), and the results are used to determine any support

requirements to achieve NCEA Level 1 in year 11 (section 3.5.1). Within the Alternative Programme, the students could gain NCEA Level 1 Numeracy credits from their STEM, Maths, and Physical Education (PE) classes. However, NCEA Level 1 Literacy credits were only available from the NCEA achievement standards offered in the STEM class. There were no opportunities to gain Literacy or Numeracy credits from the Hospitality or Whakairo (carving) class. Table 4.2 lists the e-asTTle data for the Story Sharers at the end of year 10 in 2017. It also details the Level 1 and 2 NCEA credits students achieved at the end of 2018 alongside those achieved in the STEM class.

Table 4.2

Academic Achievement Data

e-asTTle (Yr10) Literacy (writing)	**NCEA Credits (Yr11) Literacy (/10)**	**e-asTTle (Yr10) Numeracy**	**NCEA Credits (Yr11) Numeracy (/10)**	**NCEA Credits (Yr11) Level 1 (/80)**	**NCEA Credits (Yr11) Level 1 STEM (/15)**	**NCEA Credits (Yr11) Level 2**
No data	Yes	No data	Yes	42	11	25
1P	7	No data	Yes	51	11	31
4B	Yes	3A	Yes	Yes	15	54
3A	Yes	3P	Yes	72	11(4 Merit)	31
No data	8	3B	Yes	31	15	22
3A	Yes	No data	Yes	55	17 (6 Merit)	36
3P	Yes	2A	Yes	39	11	29

Note: The Literacy, Numeracy and Level 1 and 2 columns with a yes reflect the data stored within the KAMAR system. Records convert from a number to a 'yes' once students reach the 10 NCEA credits required to pass that component. The Story Sharer with 17 NCEA credits from STEM gained 2 extra by swapping achievement standards to fit with project work. Two Story Sharers gained Merit level success in their achievement standards.

For reference, the e-asTTle results align with the NZ curriculum for years 4 to 12 (8-17 years of age) and have a corresponding range of levels 2P to 6B. Every e-asTTle number denotes a level of the curriculum being achieved, whilst the letters B (basic), P (proficient), and A

(advanced) indicate how often a student is achieving at that level of the curriculum and signal if the student is ready to move on to the next step. For context, the expected range for a year ten student would be between 4A and 5B.

Unpacking the Year 10 data, all the Story Sharers results reveal they were academically underperforming and did not achieve the expected level for their academic year. The highest score for literacy was a 4B, whilst all other results are level 3 or below. A 4B result would indicate the student was at a curriculum level expected for an intermediate student in year 7 to 8 (ages 11-12), whilst a score of 3 or lower denotes a curriculum achievement for primary school years 4 to 7 (ages 8-11). The five entries without data indicate that the Story Sharer did not sit the exam. This was common for the Alternative Programme students, as 40% of their e-asTTle results were missing.

To alleviate the pressure on the Alternative Programme students to pass their NCEA Level 1 in year 11, the Senior Leadership Team set the students a goal of passing the Literacy and Numeracy component of NCEA Level 1 and gain as many NCEA Level 1 credits as possible. The target was made with the aspiration that the continued engagement and retention of the students into year 12 would ensure their achievement of Level 1 by leapfrogging to their expected curriculum levels and achieving NCEA Level 2 by the end of year 12 (Section 3.5.1).

All the Story Sharers achieved the Numeracy target, but two did not achieve the Literacy target. One Story Sharer achieved NCEA Level 1, and another was eight credits short but successfully achieved this within the first four weeks of the 2019 school year. Three Story Sharers gained all the available NCEA credits in the STEM class, whilst four Story Sharers had either not completed or not achieved one of the STEM achievement standards. Of note, two Story Sharers each completed an achievement standard to Merit level (section 3.5.1), denoting the quality of the work they submitted. Sometimes the Story Sharers were released from the STEM class to take part in other subjects, such as music, to enable them to complete their projects. The STEM NCEA results do not include those NCEA credits. All the Story Sharers gained 20 or more NCEA Level 2 credits. These were achieved through three strands: 20 NCEA Level 1 credits being carried forward from their Level 1 results (section 3.5.1), completing NCEA Level 2 Outdoor Education credits during the Term 1 camp, and

performing in Kapa Haka (Māori performing arts). The Story Sharer with the least number of NCEA credits also had the lowest attendance.

Goals and Measuring Success

To ensure that the Story Sharers had settled into the STEM class and its new pedagogical approach, discussion group interview 1 took place during the second term on 28 June 2018. In this discussion, I wanted to establish and unpack the goals that the Story Sharers had set for themselves. The responses were focused on improving their attendance and achieving their NCEA requirements. To gain further understanding and discover if I could help the Story Sharers develop more tailored goals, I asked what they might want to do when they left school. The Story Sharers avoided the question and repeated their previous responses. For example, Piripiri said, "I'm just focusing on getting credits," and Rātā agreed. "I want to get my literacy and numeracy," Kōwhai added, "and improve my attendance." These responses matched the school objectives set by SLT but were not tailored to the student's needs. During discussion group interview 4, the last of the school year, I revisited the goals from discussion group interview 1 and asked what the Story Sharers felt they had achieved over the year. Highlighting the important role of relationships, the two most common replies demonstrate that the Story Sharers' most crucial measure of success was improved student-student relationships, whilst the least identified was gaining NCEA credits. This was illustrated when the first reply all the Story Sharers agreed upon was, "I made friends." It was only when I revisited their NCEA credits goals that Rātā responded, "Oh yeah, and I have my Literacy and Numeracy." Pohutukawa added, "And my attendance has improved." An analysis identifying which achievements were mentioned most often resulted in the following list:

1. Made Friends (7/7)
2. Bonded as a group as a reference to the whānau model (6/7)
3. Stayed in school (retention and "didn't get kicked out") (5/7)

5= Finishing work (4/7)
5= Gaining NCEA credits (and/or Literacy and Numeracy) (4/7)

At the first meeting of the 2019 school year, I returned to the question of goal setting. I was pleased to discover the Story Sharers had set their own goals. Once again, they were fixed on

academic achievement, but these were future focused goals recognising a desire to stay at school and proceed to achieve their NCEA Level 2 and 3. Manuka started the conversation and said, “I got new goals; my goal is to finish (NCEA) level 1, 2 and get level 3 next year.” Kōwhai and Piripiri nodded in agreement. I asked if that meant they were planning on staying for their level 3 year (in 2020), and all three answered “yes”, but Manuka added, “But I wanna focus on levels 1 and 2.” These responses differed from the first discussion group interview in 2018, as the Story Sharers expressed excitement and optimism with their answers. I acknowledged the change and mentioned how previously they had intimated that they would want to leave school at the end of year 11, and Manuka added, “Yeah, it’s a change” and “that’s why I’m doing my work.” It was encouraging to hear the Story Sharers wanting to continue to the end of Year 13 and achieve NCEA Level 3.

4.3 The Story Sharers discuss experiencing STEM education.

This section presents the narrative data regarding how the Story Sharers experienced the STEM class. The pedagogical approach used in the STEM class was centred on project-based problem-solving and utilised a co-construction and whānau format (section 2.2 and section 3.5.1). This was a change from the traditional instruction the Story Sharers had experienced in their previous science classes. To explore how the Story Sharers experienced the STEM class, data collection included five semi-structured discussion group interview and one individual interview. There was a follow up discussion group interview at the end of 2019 used for reflection purposes. The Methodology chapter, section 3.7, details how the transcribed narrative data from the discussion group and individual interviews were analysed using NVivo software, whilst section 3.7.4 explains how the percentages were calculated.

When discussing their experiences in the STEM class, analysis of the all the narrative data revealed four essential themes: Relationships (30%); Type of work (27%): Work completion (25%); and Structure (18%). Percentages have been included to demonstrate the connections within the Story Sharer narrative. The themes had an interconnected nature which made presenting the data difficult. To represent the interpretations as accurately as possible, data are presented within the theme I believed best described the Story Sharers experience.

4.3.1 Relationships

While discussing their STEM class experiences, the Story Sharers discussed the student-student and student-teacher relationships. Figure 4.1 denotes this as a focus for 30% of their STEM class discussions.

Figure 4.1

STEM Class Relationships

The theme of improved relationships emerged from the first discussion group. During the first interview, the Story Sharers mentioned how they felt their approach to studying had benefited from improved student-teacher and student-student relationships. The Story Sharers referenced both the whānau format and the extended learning period as being a conduit to improving relationships. Wanting to understand more about how this improved relationship had occurred, I asked if they were more tolerant of each other because they spent a lot of time together, and they agreed. I was encouraged by these comments as one of the pedagogical constructs of the STEM class was to work as a whānau group, with everybody helping each other and being supportive. Examples of those discussions included Piripiri describing how it was important to have all, “the people in the same class.” This was confirmed by Harakeke who added, “Yes, like we’re always together.” When checking to clarify if the improved relationships were specific to the STEM class, Kauri added: “We’ve bonded better by being in here.” The theme of relationships was further validated during discussion group interview 4 when the number one achievement the Story Sharers listed was making friends, followed by how well they had bonded as a group. Discussions regarding relationships highlighted the interconnected nature of their responses, as it was the extended learning period (structure) of

the STEM class that led to the students spending five consecutive periods together rather than spread over the week.

It was not just relationships with friends that were important to the Story Sharers, but also the relationship with their teachers. A positive student-teacher relationship aided in the Story Sharers' motivation to attend class and achieve academically. To achieve a positive relationship, teachers needed to help and support them with their learning whilst developing trust. During discussion group interview 2, Kauri described how a teacher could build a positive relationship with her saying, "[teacher should] help us" and "[teacher should be] interested in us learning." This building relationships through support was a theme that stayed with the Story Sharers throughout the study. For example, at the last discussion group interview (number 6) held in November of 2019 after the STEM class had been disestablished, Manuka said, "I really like teachers supporting me" and added, "It makes me feel better." When Manuka said it made her 'feel better,' I hoped it created positivity by improving her sense of wellbeing, as this was an important theme for the Story Sharers (section 5.1.4).

The Story Sharers were clear on the detrimental effect a poor student-teacher relationships had on their school experience. Consequences included refusing to complete class work, not attending class or school and sometimes choosing alternative subjects even to the detriment of their goals. How the Story Sharers experienced poor student-teacher relationships was raised at the first discussion group interview by Harakeke. She described how the relationship with her previous science teacher had been detrimental to her achieving, saying that she "went off task" and "started wagging [truanting]." Giving an example of how deeply problematic a poor student-teacher relationship can be, I asked if the Story Sharers loved a subject but did not like the teacher, what would they do? Piripiri responded, "I reckon I wouldn't end up doing [subject]," so I asked if the relationship with the teacher was more important than the subject, even their favourite subject, and all replied, "Yes." Piripiri added, "If I don't know them, I wouldn't [do the work]; I need to get to know them." Relationships were a theme intertwined throughout the six-discussion group interview and data related to this theme are presented further in Chapter Five, section 5.2.2.

4.3.2 Work Completion

The following two themes, work completion and type of work were calculated at 27% and 25%, respectively. The closeness of these themes is compelling because the two replies were usually given in unison, making it difficult to distinguish between the data. For example, the Story Sharers would discuss the enjoyment at the type of projects they embarked on alongside the satisfaction of completing work.

One key goal for all the Story Sharers was achieving their Level 1 NCEA Literacy and Numeracy requirements. It was encouraging that 27% of the Story Sharers' narratives regarding their experiences in the STEM class were dedicated to the ability to complete work, as depicted in Figure 4.2. The theme of work completion is further validated when considering the results the Story Sharers had achieved by the end of Year 11, which can be found in Table 4.2.

Figure 4.2

STEM Class Work Completion

At discussion group interview 4, the final one of 2018, when asked what they were proud of, the joint 5th most repeated answer was achieving NCEA credits and how finishing tasks gave them a sense of achievement. For example, during discussion group interview 4, when asked what positives they could take away from the year in the STEM class, Kauri told me, “Finishing [subject]”. This initiated a conversation between Kōwhai and Rātā, where they started to list the NCEA level 1 internal achievement standards they had completed and how

they had enjoyed gaining their credits. I found this conversation interesting as it highlighted the diversity of learning in the STEM class (Appendix 4). Manuka added that she was proud to have completed her Numeracy credits, while Rātā summed up how the work completion (and the type of work she had completed) had given her a different feeling when she added that her most outstanding achievement was “finish work I’m proud of.”

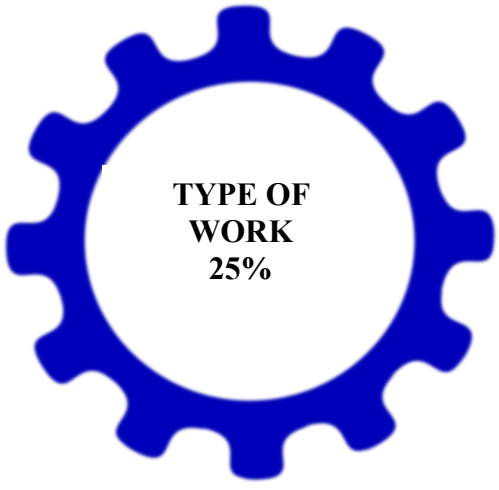
It was heartening to hear the Story Sharers being optimistic about their achievements. This was especially important because they had all started the STEM class with underperforming results in their Literacy and/or Numeracy year 10 e-asTTle tests. When Rātā said she had finished work, she was ‘proud of’ when she had not completed her NCEA Level 1, it gave me hope that she would achieve her objectives of finishing her NCEA Level 1 the following year.

4.3.3 Type of Work

The work the Story Sharers completed differed from that of a traditional science class. As depicted in Figure 4.3, the Story Sharers discussed this type of work in 25% of the narrative for their STEM class experience.

Figure 4.3

STEM Class Type of Work



The STEM class pedagogical approach was based on project-based problem-solving (section 2.2 and section 3.5.1). Students were given a question or topic and, after completing a design thinking process, devised, tested, revised, and produced their solutions. Students could work individually or in groups, and NCEA Achievement Standards were tailored to their projects.

The students had to be taught how to engage with this pedagogical approach as it was a change from their previous learning methods. When asked about the STEM class, the Story Sharers all agreed they enjoyed the learning approach, and how it differed significantly from their previous science classes in years 9 and 10. However, during discussion group interview 2, when I asked what they thought about this type of work, the Story Sharers also thought it was "a lot easier." Harakeke added, "'cause in our other class we just got given work and not explained what to do whereas in this class you help us with what to do." I found this an interesting interpretation of how they experienced the STEM class as the Story Sharers were provided with the same teaching support structures, such as scaffolding the design process (section 3.5.1), as used in previous science classes with other teachers. However, when asked if the Story Sharers would like more challenging work, none wanted the level to change as being able to 'achieve' was important. Whilst the Story Sharers enjoyed the project-based learning approach for completing internally assessed NCEA achievement standards, they were not prepared to attempt completing project work which would then be examined externally.

Another insightful interpretation of the STEM class pedagogical approach was how the Story Sharers did not understand what STEM was or that science was included within it. This revelation came about during the first discussion group interview when I asked a pre-prepared question whether being in the STEM class had changed their understanding of things outside of the classroom. The Story Sharers could not make a link, for example Piripiri stated, "Those health and safety forms." The health and safety forms were part of the Term 1 teaching to develop the Story Sharer's mindset of planning and completing project work. Thinking the question may have been too broad, I reframed and enquired if they could equate the STEM class with helping them in their other subjects, such as Maths. Piripiri's response demonstrated that they were struggling with this concept, as she said, "depends if we do science in the other classes" and Harakeke added, "maybe in like sports, because we do it outside." Delving further, I asked if the Story Sharers had learned any skills in their STEM class; they all replied 'yes,' but when I asked what those skills were, Rātā responded with how they could 'grow plants.' I decided to digest these responses and move on with the interview. At the end of the interview, my final question shed light on the situation. I asked if they had any improvements for the STEM class and Manuka replied, "more [science]

experiments," Pohutukawa and Harakeke added, "probably just [science] experiments." The STEM class students agreed with this feedback.

I was concerned when the students could not link aspects of interdisciplinary STEM to STEM subjects as there could be potential consequences with the students being able to complete the knowledge requirements for the NCEA achievement standards. Consequently, I devised a set of experiments that could be extrapolated into a real-life context which the students could use and discuss with others. The students were about to start work on an outside gardening area, including installing worm farms. The worm farms would be fed different foodstuffs, and their worm teas would be collected and analysed through chromatography before being used in experiments for growing tomato plants in soil and hydroponics. A simple chromatography experiment was performed, and this knowledge was further developed into a session on tie-dying t-shirts that the students could wear as a uniform when out in the garden. Figure 4.4 shows a photograph of the simple chromatography experiment and the resulting tie-dyed shirts. From that point onwards, I ensured that the aspects of the subjects within STEM and their projects were linked.

Figure 4.4

Chromatography Class

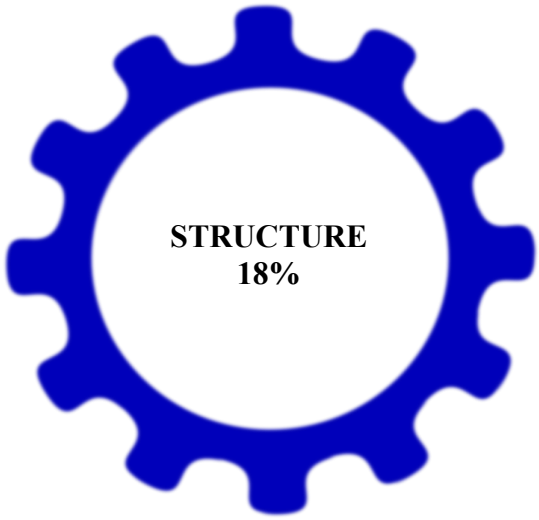
In term 3, in discussion group interview 3, I wanted to check that my growing confidence in project-based learning was the best pedagogical approach for the students. I asked the Story Sharers if they liked the project work in the STEM room, and they all replied, "Yeah." I asked why, and Kauri added, "You understand how we work."

4.3.4 Structure

Students in the Alternative Programme and STEM class were structured into a separate timetable from the rest of the school. The Story Sharers focused 18% of their narrative regarding their experiences of the STEM class on their class structure, which included the format of the day, the extended learning period and timetabling, as displayed in Figure 4.5.

Figure 4.5

STEM Class Structure



The school's traditional instruction model included dividing five daily lessons of 55 minutes over the course of a week. Sometimes, this changed due to other events such as school assemblies. From a prior STEM class pilot, which I had carried out over the previous two years, it became apparent that to facilitate authentic in-depth project-based transformational learning, the students needed to attend class for an extended learning period. Ideally, as trialled previously in 2017 STEM class, this would be a whole school day, but due to complications with timetabling, the final design meant students had to attend the STEM class during the last 55-minute lesson (period 5), after lunch on a Tuesday and for four 55-minute lessons (periods 1 to 4) the following day. Only one other class ran the whole day which was on a Friday. The remaining courses in the Alternative Programme ran as double lessons (two 55-minute), and no other subject used project-based problem-solving as their pedagogical approach.

The Story Sharers approved of the extended learning period used in the STEM class by using words such as ‘cool’ and saying it was ‘way better than before.’ They were clear that although the format worked for STEM, it would not be better for their other classes. Harakeke commented, “For science [STEM], that’s ok” when Manuka and Piripiri added, “I like the four hours” and “Yeah, the four is ok, but the whole day, nah” this was in reference to another Alternative Programme course that ran for all five periods on a Friday. Upon further questioning as to why there was a preference for the longer learning period, one particular response by Manuka stood out for me when she said, “We have longer time, so we are not worrying about assessments that we didn’t do [from another class], we can get stuff done.” I had never considered the extra pressure students' felt when they had not completed work from a previous class. Kōwhai commented that having a longer lesson also helped reduce the number of different subjects and teachers that the Story Sharers were experiencing:

> “We have four periods of one subject, so we can do something kick back [easy] in one period and then get back to the other subjects. That’s what I like about it, but with the normal [traditional] class, I couldn’t do that as it was a different class every hour. I was seeing too many teachers' faces, and I was just getting sick of it.”

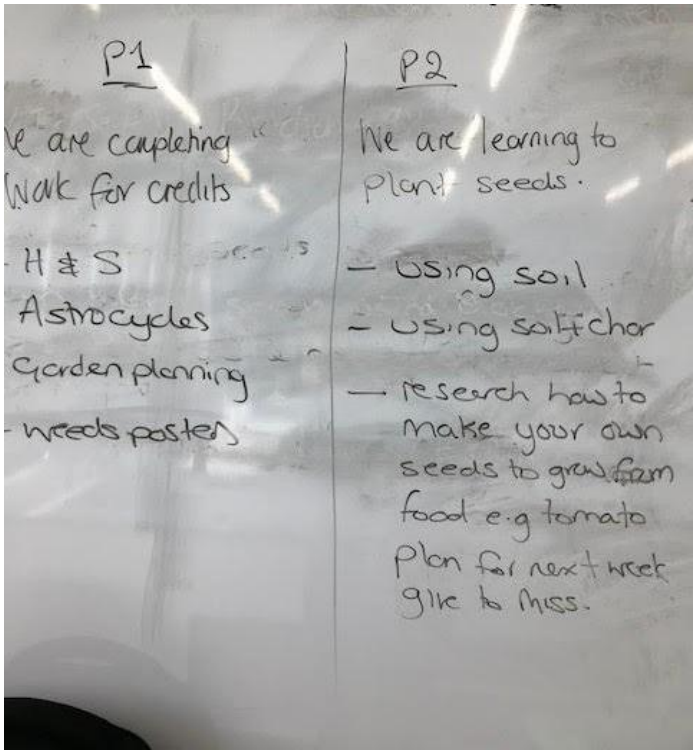
I had not considered the positives of students having the flexibility to work in a manner fitting to their motivational needs. As the Story Sharers’ teacher, I reflected on this comment because I knew my behaviour had changed. If the students seemed relaxed when they entered class, I did not feel pressured to ‘push’ the students to complete tasks as another three periods (three hours) were available for work completion. Kōwhai’s comment highlighted how reducing the number of teachers the Story Sharers interacted with on a given day combined with an improved classroom environment through a reduction in ‘pressure’ could improve student-teacher relationships.

The extended learning period created an extra co-construction opportunity, a core tenet of the philosophy of the STEM class. For example, the students co-constructed the STEM class routine which included the single 55-minute lesson on the Tuesday becoming a time when students reflected on their work, completed any work from the previous week and refined their planning for the next day. The following day, the first two hours would be devoted to completing the required NCEA work. After break, students used the first hour working on project work, liaising with experts and being taught subject-specific knowledge. The final hour also included a period of reflection on completed work and preparation for the following

week's class which enabled them to enter the STEM room ready to start. Figure 4.6 shows a photo of the whiteboard with the first two hours listed for the extended learning day.

Figure 4.6

Example of the STEM Class Co—Constructed Structure



Note. The extended learning period was divided for each hour like the traditional timetable and planning for each hour co-constructed with the students.

There were also opportunities for students to be released from the STEM class to participate in other subject courses to help fulfil their projects, such as visiting the technology department or music. Having a routine helped plan and maximise students' time, but the routine was always flexible. As time progressed and students became familiar with the requirements and expectations of the class, they became more involved in co-constructing how the day would run. It was surprising how quickly the students developed this opportunity and would always plan with great thought and purpose. While co-constructing the routine, students requested to go to the school library and asked if it could become a regular event, which I happily facilitated.

4.5 Summary of the Story Sharers Experiencing the STEM class

Chapter Four has examined how the Story Sharers experienced the STEM class within the context of the Alternative Programme. These Māori wāhine were selected for the programme based on indicators of academic underperformance, including low e-asTTle Literacy and Numeracy scores and patterns of irregular attendance. Despite these challenges, the majority successfully attained their NCEA Level 1 Literacy and Numeracy requirements. This outcome represents a substantial academic shift, with several students progressing from curriculum levels typically associated with Years 7 or 8 to meeting Year 11 expectations, demonstrating accelerated academic development within the STEM learning environment.

Although the Alternative Programme did not yield a marked improvement in overall school attendance, the Story Sharers attended the STEM class more consistently than any other subject, including their previous science classes. The programme also contributed to improved student retention, surpassing the school's target. By the conclusion of the 2018 academic year, all Story Sharers expressed a desire to remain in school, continue in the STEM class, and pursue further education into Years 12 and 13, signalling a notable shift in educational aspiration and sustained engagement.

Four interrelated themes emerged from the Story Sharers' accounts of their STEM class experience: relationships (30%), work completion (27%), the type of work (25%), and the structure of the programme (18%). While these themes are presented discretely, they were frequently discussed in tandem, underscoring the interconnected nature of the pedagogical design. The STEM class was underpinned by a co-construction model and a whānau-based learning approach, which collectively fostered a sense of belonging, mutual support, and collective responsibility. The collaborative nature of project work, situated within a culturally responsive framework, strengthened peer relationships and cultivated a learning environment grounded in reciprocity and relationality.

This relational foundation was further supported by the structural design of the class. The extended learning period which comprised of five consecutive periods, enabled sustained engagement with authentic, meaningful project work. These tasks were not only completed but were described by the Story Sharers as work they were "proud of." The structural continuity of the class reduced the cognitive and emotional demands associated with

transitioning between subjects and teachers, contributing to a calmer, more predictable learning environment. The perception of increased teacher availability and reduced fragmentation of the school day further enhanced students' sense of wellbeing and capacity to engage.

STEM project-based learning is inherently grounded in relational thinking. It requires learners to engage with interdisciplinary knowledge, collaborate meaningfully, and situate their learning within real-world and culturally relevant contexts. Although the Story Sharers did not initially articulate how their STEM learning connected to other subjects, this was not indicative of a lack of relational thinking, but rather a reflection of their unfamiliarity with this pedagogical approach. As students who had not previously encountered relational learning, they required support frameworks including explicit scaffolding, guided reflection and contextualised teaching to make sense of the integrated nature of their learning. Their academic outcomes and increased engagement suggest that relational thinking, embedded within STEM project-based learning, can significantly enhance educational achievement, affirm identity, and foster a deeper sense of belonging for Māori learners.

Collectively, these pedagogical and structural features coalesced to create a learning environment that was relationally rich, culturally sustaining, and academically enabling. The most significant factor identified by the Story Sharers was the quality of relationships, particularly peer relationships that could be described as friendships, which served as a foundation for engagement, persistence and success. These findings affirm the critical role of relational pedagogies in supporting learners who have historically been marginalised within mainstream educational settings.

Whilst this section outlined the Story Sharers' preferences for the STEM project-based learning pedagogical approach, which they considered meaningful and aligned with their ways of learning. Their narratives also conveyed enduring barriers to their success, including describing systemic inequities, cultural disconnection, and experiences of discrimination. These challenges are explored in the next chapter.

Chapter 5 The Challenges to Succeeding in STEM

5.1 Introduction

This chapter explores the challenges faced by the Story Sharers and is organised into three sections: Section 5.1 documents the Story Sharers experiencing discrimination; Section 5.2 describes their lived experiences; and Section 5.3 presents how, as the study progressed, it became apparent that these experiences were interwoven, interconnected, and intersectional. In each section, alongside the group data, Kōwhai and Harakeke give in-depth accounts. These two Story Sharers were chosen as case studies due to the similarity in their circumstances and narrative contribution to the study (section 3.5.2). Presenting these two narratives and including the calculated percentages (section 3.7.4) provides a nuanced intersectional perspective and exemplifies the diversity of the Story Sharers' responses. Displaying the data in this manner maintains the principles and philosophies of kaupapa Māori methodology by presenting the data as stories, reducing the homogenisation of Māori data (when researcher is non-Māori) and highlighting the importance of the individual perspective.

5.2 Experiencing Discrimination "Makes Learning Hard"

This section documents the Story Sharers discussing what "makes learning hard" which included their experiences of discrimination and the impacts on their sense of wellbeing. The issue of discrimination was raised during the first discussion group interview by Rātā who initiated the conversation by stating "learning is hard" and describing what 'blocked' their learning. After this first interview, at all subsequent conversations, the term 'blockers' was used interchangeably with 'making learning hard'. The theme of discrimination was discussed throughout all the discussion group meetings and analysis of group narratives and percentages calculated (section 3.7.4) identified three themes: Racism (26%), Stereotyping (34%) and the impact on their Sense of Wellbeing (40%). The Sense of Wellbeing emerged during the discriminatory events discussions, but it became a broader theme as it encapsulated events linked to those described in lived experiences, which could account for its larger percentage. The Impacts on Sense of Wellbeing theme has been added to the discrimination section because the Story Sharers ascribed this theme because of experiencing discrimination and it 'made learning hard' which 'blocked' them from achieving.

In contrast to other areas, data in this section has been recorded in ascending order, as this was the sequence in which the themes were discussed and highlights the progression of the conversations. Due to the intersectional nature of the narrative, data could be entered into multiple themes. Again, to prevent duplication, findings are presented within the theme which I felt best described the story.

5.2.2 Racism: "Everyone Hates Māori."

Having been made aware during the first discussion group interview that a blocker to succeeding in STEM was because 'learning was hard', I wanted to probe further and discover if this blocker was why Māori ākonga (students) were not choosing STEM subjects such as Maths and Science. However, the initial replies to the 'blockers' to choosing STEM were not centred on learning but their experiences of racism. These events were pervasive and experienced in multiple locations including in their local community, in school, in online forums and social media sites. The discussions which exemplified how the Story Sharers experienced racism was started by Kauri's response to my question on what was 'blocking' them from choosing STEM subjects; she said "Because people are putting it on them that Māori ain't good enough". Piripiri added, *"*Yeah, that's why people ain't doing it" and Manuka interjected, "Yeah, everyone hates Māori".

The Story Sharers continued by giving accounts of how they experienced racism in their local community, describing how they are 'judged'. Details included being followed in the two-dollar store and being refused entry into shops. For example, Piripiri stated, "You always get followed in the two-dollar shop". Pohutukawa corroborated this by adding, "I got told to wait to go in, and he was really rude". The Story Sharers continued to recount their stories of racism and how it was a wider issue than in their locality as this dialogue between Manuka and Harakeke demonstrates:

Manuka: "Yeah, even white people [are racist],

Harakeke: "Why is it in our own country we get judged?".

The other Story Sharers agreed with Harakeke's statement, with Manuka remarking, "I feel like everyone is racist here".

Taking a wider perspective, the Story Sharers acknowledged that their experiences of racism were not confined to their community or their country. The Story Sharers described how there

was racism outside of Aotearoa New Zealand, including in countries where they had read new reports regarding racism directed at Indigenous communities in Australia and America. Confirming how these stories impacted their world view, when asked if they thought Māori would not be 'judged' in other countries, Kauri replied, "Not necessarily". Seeking security, all the Story Sharers replied affirmatively that they felt safer in their school because of the large proportion of Māori students. There was also agreement that they felt safer in their local area as it had a larger Māori demographic.

Analysis of all the discussion group meetings demonstrated that Story Sharers discussed racism as 26% of their narrative. However, most of the conversations about this distinct macro aggressive racism centred around their perception of being identified as Māori. Moreover, further discussions regarding how the Story Sharers experience racism were interwoven within other themes, such as their relationships, and these have been discussed within the relevant section 5.2.2. Racism was not the only form of discrimination that the Story Sharers described as making learning hard. They explained how they were the victims of stereotyping in their communities, online, and at school.

5.2.3 Stereotyping: "Other People Thinking You Can't Do It."

Alongside racism, the Story Sharers discussed how they experienced being stereotyped. Conversations regarding being stereotyped arose in response to being asked if anything else 'blocked' their learning, and Kauri replied, "Other people thinking you can't do it." When identifying stereotyping as a blocker, the Story Sharers discussed how this experience was centred around their academic performance, as distinct from their Māori identity. Analysis of the Story Sharers' narrative from all discussion group interviews showed stereotyping was mentioned 34% of the time. The Story Sharers gave examples of how they experienced stereotyping by peers on social media pages and by staff in the school.

The first experience of stereotyping the Story Sharers described was the negativity they received due to attending their high school. Many of the comments they described were on social media and were directed at the Story Sharers for attending their school with a narrative that the school is for the 'dumb kids'. This was especially evident on a social media platform that the Story Sharers called "Confess pages". Because I did not understand this response, I asked if they meant pages on Facebook. Rātā agreed and gave an example saying, *"*Where

people talk kaka [horrid] about you" adding "and they tag you in and say, 'look what this person said about you'". I appreciated the clarification from Rātā because the being 'tagged' remark indicated that this was a complex problem for the Story Sharers. Even when trying to avoid these social media pages, others wanted them to ensure they viewed the comments. While discussing the negative comments about their school, the next group the Story Sharers identified as stereotyping and telling them they "can't do it" were teachers.

Framing to understand how teachers would 'block' the Story Sharers from succeeding, I asked how teachers were making learning hard. The Story Sharers gave an example of an interaction between themselves and a teacher. It started with Kauri mimicking the teacher's voice and saying, "You aren't going to go anywhere". Then Rātā elaborated by saying, "[that teacher] says, 'Look at you. You're going to do nothing and be nothing'. [That teacher] always says that". Manuka agreed by saying, "Yeah, they say it to everyone". Then Harakeke said, "Last year, I got it really bad". Rātā and Harakeke recounted their interaction with the same teacher:

> Rātā: "[that teacher] used to tell the whole class that, '[mimicking the teacher's voice] look at yous, you ain't gonna go anywhere.'
>
> Manuka: "And oh yeah, and [That teacher would say] 'You're always going to fail.'
>
> Rātā: "Yeah, just because you ain't got no pencil. You can't even organise yourself."

I was starting to build a picture of the experiences the Story Sharers were discussing. When they were at school, it was a place they had discussed as making them feel safe due to the demographics. Yet, by attending the school, their online community said they must be 'dumb', and some teachers reinforced these negative tropes. The Story Sharers heard they 'can't do it' and would 'always fail'.

This commentary saddened me, and understanding the emotional labour the Story Sharers were experiencing by sharing this information, I wanted to know how they were feeling. Harakeke stated, "I don't care," and Manuka added, "I think, fuck you!". When Manuka swore, I knew she was deeply hurt and angry. The Story Sharers continued discussing the profound effect experiencing stereotyping and racism had on them. This started when Harakeke spontaneously commented "It's rubbish" and "Racism. It makes you feel rubbish."

5.2.4 Impact on Sense of Wellbeing: "It Makes You Feel Rubbish".

As noted, the Impact on Sense of Wellbeing theme has been placed within the section of experiencing discrimination because the Story Sharers denoted how their responses to discriminatory events was 'making learning hard'. The theme of impacts on sense of wellbeing unfolded when the Story Sharers explained there were 'other things' that blocked them, including 'negativity' and their sad feelings. Expanding, Rātā described the depth of feeling 'negativity' caused when she said, "There's heaps of negativity, like the people talking about you [this was in reference to the stereotyping] and like you could be suicidal and think about that instead of your work and have heaps of weight on your shoulders". I reflected on this comment and to ensure I had captured the narrative I reframed my question and asked whether the impacts of discrimination on their sense of wellbeing was a 'blocker' which was influenced by the events of racism and stereotyping they had discussed. They all replied, "Yeah" and I realised that the impacts on their sense of wellbeing was interlinked with their experiences of discrimination.

When I reflected on this aspect of the discussions, I realised the impact of experiencing discrimination had gone deeper for the Story Sharers and they had internalised this discourse. Repeating many of the discriminatory tropes, they routinely articulated negative feelings and perceptions about themselves. For example, during the first discussion group interview, when talking about settling into the STEM class, there were indications of how stereotyping had made them introspective and negative about their academic abilities and sense of belonging. Comments included: "I thought we were here because we're all dumb."; "I ended up being told [by SLT] we're all here because we haven't planted ourselves in the school."; and "I actually thought it was "'cause I was dumb."

The Story Sharers' negative perceptions of their academic abilities were deeply entrenched and persisted. At the end of the 2018 school year, although most Story Sharers had completed the NCEA Level 1 Literacy and Numeracy components, along with other internally assessed achievement standards, they consistently declined the opportunity to sit external examinations. Furthermore, they also rejected the option to complete the required learning through a project-based approach. At the last discussion group interview at the end of the academic year in 2018, Kōwhai asked if she had to sit an external exam. I confirmed there was no external exam, but having acknowledged their conversation congratulating all the NCEA Level 1 credits they had been awarded, I asked if any of the Story Sharers would like

to sit an external exam the following year. All the Story Sharers refused and Kōwhai added "no, never". The Story Sharers were aware that although this was not a barrier to completing their NCEA Level 1 or continuing into the Year 12 STEM class, continuing to refuse participating in external exams could hinder their ability to continue into tertiary study and STEM careers.

Analysis of all the Story Sharers' narrative data determined that impacts on their Sense of Wellbeing was mentioned 40% of the time. This indicates that the Story Sharers' Sense of Wellbeing is a broader theme impacted by macro and micro aggressions, including discrimination they can identify, such as experiencing racism and stereotyping, and other events linked to aspects of their identity and relationships (which are explored further in sections 5.2.1 and 5.2.2).

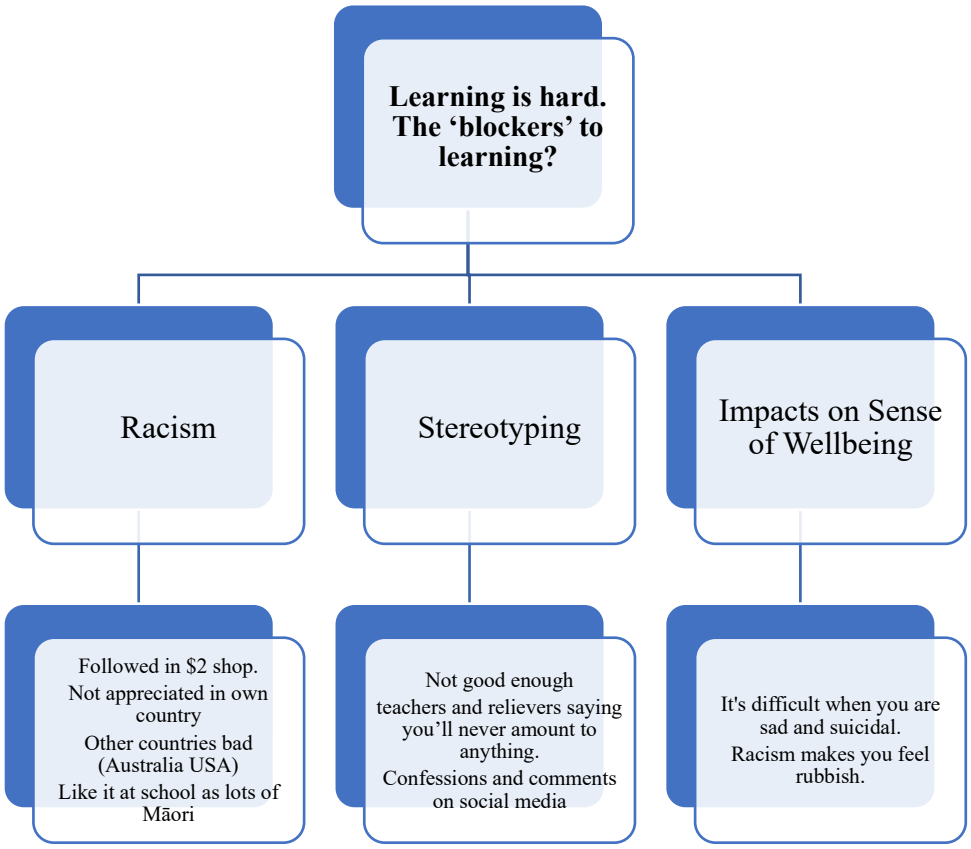
I was now gaining a deeper awareness of the challenging experiences the Story Sharers were having to navigate. Stories described how they were being stereotyped by their friends (including on social media), by teachers, and apace with this, they were also being racially profiled trying to buy items in the two-dollar shop. While analysing the data from discussion groups 2 and 3, I realised it was becoming challenging to isolate these themes as they were crossing over and interwoven. This was the start of my journey to understanding the intersectional aspects of the Story Sharers' narratives. When checking with the Story Sharers, I would show diagrams to aid in describing how I had interpreted the themes. Over time, this changed from a flow chart to interconnected cogwheels. The following section details how that process evolved.

5.2.5 Describing Discrimination as Interconnected Cogwheels.

Analysis of the transcribed discussion group 1 and 2 data revealed the three themes of racism, stereotyping, and the impact on their Sense of Wellbeing. To synthesize these, I created the flowchart detailed in Figure 5.1. This flowchart was presented to the Story Sharers during the discussion group interview 3 and all agreed the flowchart represented their narrative.

Figure 5.1

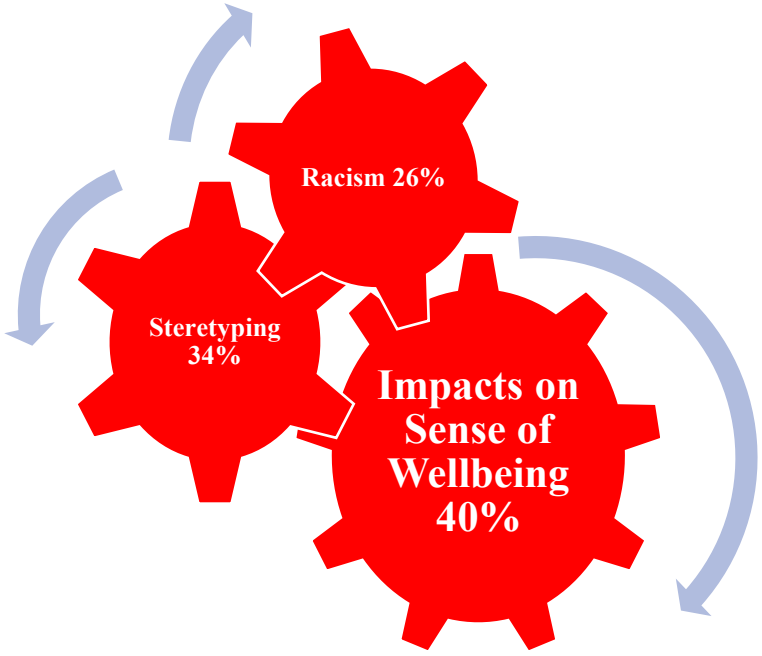
Flowchart of 'What makes learning hard.'



After being presented with the flowchart, the Story Sharers continued to share their stories of discrimination and the impact it was having on their sense of wellbeing. It became increasingly evident that the students rarely experienced any form of discrimination in isolation. For example, they discussed the stereotyping associated with attending their high school and how they received comments directly from friends and peers about this and how it made them believe they must be 'dumb'. However, this was interlinked with experiencing racist views because being 'dumb' was because 'you're Māori' and 'Māori go to dumb schools.' This impacted the Story Sharer's sense of wellbeing, making them angry or upset and not wanting to attend class. I realised that the flowchart did not correctly represent the Story Sharers' experiences. The various experiences of discrimination were interlinked, interwoven and reinforced each other. I prepared a new graphic using cogwheels to show how, as one event occurred, it turned the cogwheel and interacted with the next cogwheel and so on, then they all turned in unison. This is represented in Figure 5.2 and reflects the start of my journey to understanding intersectionality.

Figure 5.2

The Story Sharers Cogwheels of Discrimination



I presented this cogwheel diagram to the Story Sharers during discussion group interview 4, and they all agreed it was an improved representation of their experiences. The question of 'what makes learning hard' was revisited during the subsequent group discussion interview 5 and reflexively in discussion group interview 6 to ascertain any changes.

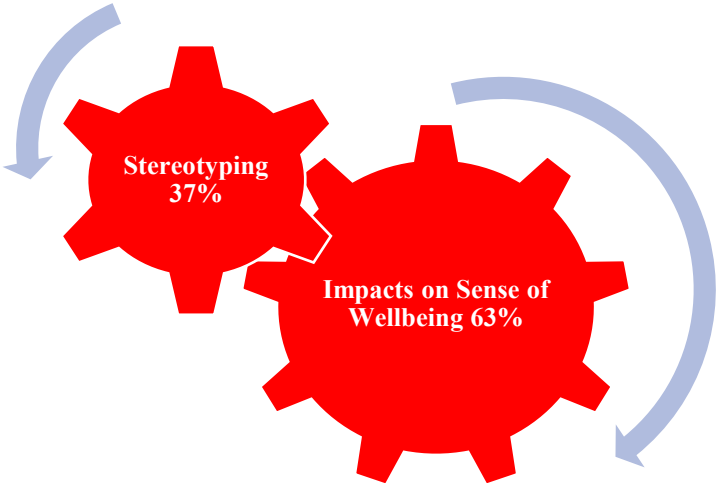
To gain a deeper perspective of the nuance and unique intersectional nature of the narrative, the next section unpacks the discriminatory events depicted by Kōwhai and Harakeke.

5.2.6 Kōwhai Experiencing Discrimination

Unlike the group data, when Kōwhai discussed what made learning hard, two main themes emerged rather than three which were Impacts on Sense of Wellbeing (63%) and Stereotyping (37%), as shown in Figure 5.3. The two cogwheels turn in unison for Kōwhai; stereotyping impacts her sense of wellbeing, and they intersect and turn together. Although stereotyping is comparable to the group's results, Kōwhai discussed the impacts on her sense of wellbeing more often and never identified experiencing racism as a 'blocker' to learning.

Figure 5.3

Cogwheels of Discrimination for Kōwhai



Kōwhai often discussed how her sense of wellbeing was impacted within the context of her Dad's unveiling and how this led to her affiliating with her 'gang' friends. It was the most significant contributor to blocking her learning at 63%. Yet, she never discussed impacts on her sense of wellbeing in the same context as the other Story Sharers, who discussed how they felt 'sad' or sometimes 'suicidal'. Kōwhai discussed how she was struggling with this part of her identity. For example, when talking about aspects of her 'gang' identity, she would use phrases such as "You can't be nice if you're gang." I also reflected on how much stereotyping Kōwhai had been subjected to with her 'gang' identity and how much this would have contributed to her questioning whether she was 'nice' and the impact this had on her relationships.

After I left the school after term 1 in 2019, there were eight months between discussion group interviews 5 and 6. This gave me extra time to analyse the data from discussion groups 1 to 5 when I noted Kōwhai had not discussed experiencing racism. In discussion group 6, I broached this observation, and Kōwhai replied:

> That's because racism is everywhere you go, like shopping and stuff. But you see, that turned normal for me, and that's what Matua [title for the head of the Māori department] was telling us. Stop doing that, it's not normal.

Kōwhai had normalised racism as part of her life and was now coming to realise that she did not have to accept it; she continued by giving an account of how she experienced racism in her everyday life, “Like you can walk into a shop and then someone will be like I was stealing and you’re actually going to buy something, and that’s fucking racist because how do you know what’s in my pockets?”

I was again reminded how hurt and angry Kōwhai must be to use this type of language. Kōwhai went on to describe how these experiences had started to make her question her assumptions of people when she explained how she and her family “didn’t like white people”. However, since completing the Alternative Programme and STEM class she was reassessing this view when she added, “But I tell them [family] now, you know there are actually some good white people, I met some okay!”

I have always been saddened to listen to the Story Sharers discuss how racism impacts their lives. However, it was only Kōwhai who discussed how experiencing racism had affected how she and her family had become distrustful and unwilling to create relationships with ‘white people.’ I wondered how this view had impacted her ability to form good relationships with her teachers, especially compounded by the stereotyping she had received. The discriminatory experiences that make learning hard for Kōwhai intersect and interlink with the impacts on her sense of wellbeing and stereotyping. Although Kōwhai encountered racism, she did not mention it until the last interview and only when prompted. For this reason, it has not been included in the analysis figures or the cogwheels.

Kōwhai’s discriminatory issues contrast with those described by Harakeke, who openly discussed the systemic and overt racism she has experienced.

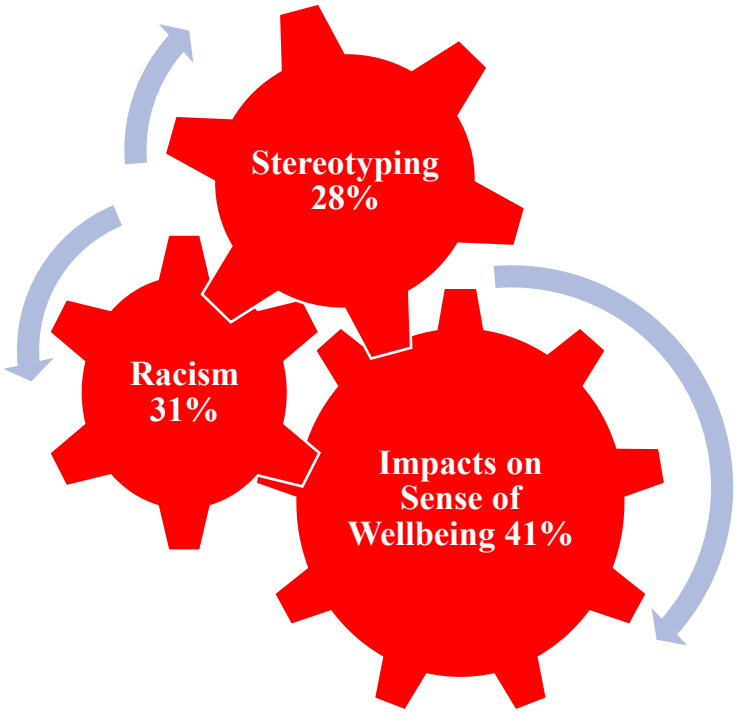
5.2.7 Harakeke Experiencing Discrimination

When exploring what makes learning hard or ‘blocked’ learning, Harakeke was a vocal contributor. Although her mentions of discrimination are like the group’s results, unlike Kōwhai, she recognised Racism, and it contributed 31% of her narrative. Figure 5.4 depicts Harakeke’s cogwheels of discrimination, representing how as Harakeke experienced a discriminatory event such as racism (31%), it was never in isolation and intersected and

turned the other cogwheels of stereotyping (28%) and impacted on her Sense of Wellbeing (41%).

Figure 5.4

Cogwheels of Discrimination for Harakeke



It was Harakeke who raised the subject of racism in the initial conversations, and she was precise with her language. When asked why Māori wāhine might not be going into STEM careers, Harakeke responded, 'because Pākehā says Māori people are dumb compared to Pākehā' and 'because Māori people got judged and told they can't do it'. Harakeke could recount her experiences of racism and how it impacted aspects of her identity and relationships. Harakeke talked about how racism could be linked to those events encountered by her whānau and how racism was intergenerational. She also discussed how, the racism and stereotyping she received affected her sense of wellbeing. However, she had internalised this narrative into believing she was 'dumb,' which made her feel 'rubbish.' Most of the dialogue that Harakeke shared regarding experiences of racism and stereotyping were within discussions about how it impacted aspects of her identity and relationships, and to maintain the authenticity of the conversations, those themes are explored further in sections 5.3.1 and 5.3.2.

5.2.8 Experiencing Discrimination Summary

Experiences of discrimination were a significant theme across the Story Sharers' narratives, with three interrelated subthemes emerging from the data: Racism (26%), Stereotyping (34%), and Impacts on Sense of Wellbeing (40%). These experiences were not isolated; rather, they were cumulative, interconnected, and often occurred simultaneously. The Story Sharers consistently described how discrimination, whether overt or subtle, impacted their emotional wellbeing and created barriers to learning, which they referred to as "blockers."

Examples of racism included being followed in local shops, being denied entry, and being told they "wouldn't amount to anything." Stereotyping was particularly evident in how others perceived their school as being for "dumb kids," and how teachers and peers made assumptions about their academic potential. These narratives were deeply personal and emotionally charged. The Story Sharers described feeling "rubbish," "sad," and in some cases "suicidal," with these emotional states directly affecting their ability to attend class, concentrate, and engage with schoolwork.

The internalisation of these discriminatory discourses had tangible academic consequences. Several Story Sharers reported withdrawing from assessments, including refusing to sit external exams, decisions that could significantly limit their access to tertiary education and STEM career pathways. These outcomes underscore how discrimination not only affects wellbeing but also disrupts educational trajectories.

Individual narratives further illustrate the complexity of these experiences. Kōwhai described how being labelled as "gang" led others to assume she was "bad" or "not nice," which negatively affected her sense of identity and belonging. Harakeke internalised racist messages to the extent that she believed being Māori meant she was "dumb." These examples highlight how discrimination operates at both interpersonal and systemic levels, shaping how students see themselves and their place in education.

Importantly, the discrimination described by the Story Sharers can be understood as intersecting, not simply additive, but mutually reinforcing across dimensions of race, gender, socioeconomic status, and educational context. These experiences did not occur in isolation, and their cumulative impact made it difficult to represent the data linearly. Following discussion group interview 3, further analysis revealed that a cogwheel model was a more

appropriate metaphor. This model illustrated how discriminatory events function like interlocking mechanisms when one cog turns, it activates others, compounding the impact and reinforcing negative outcomes, particularly on wellbeing. The cogwheels provided a visual and conceptual framework for understanding how racism, stereotyping, and emotional distress are structurally embedded and dynamically interrelated.

Experiencing discrimination was one of the earliest and most consistent themes to emerge in the discussion group interviews. It provided critical insight into the challenges the Story Sharers faced in engaging with STEM education and marked the beginning of a deeper analytical journey into intersectionality. These findings affirm that addressing discrimination in educational settings requires more than cultural responsiveness, it demands structural change, relational pedagogy and a commitment to equity that recognises the lived realities of marginalised learners

5.3 Lived Experiences

As the counterspace continued to evolve, the Story Sharers offered rich and layered accounts of their lived experiences. Analysis of data collected through five discussion groups and an individual interview revealed two interrelated thematic strands: identity and relationships. These themes were not presented in isolation; rather, they were deeply entangled, with participants frequently articulating how their sense of self was shaped by, and in turn shaped, their interactions with others. This dynamic interplay often compounded the challenges they encountered in the STEM classroom.

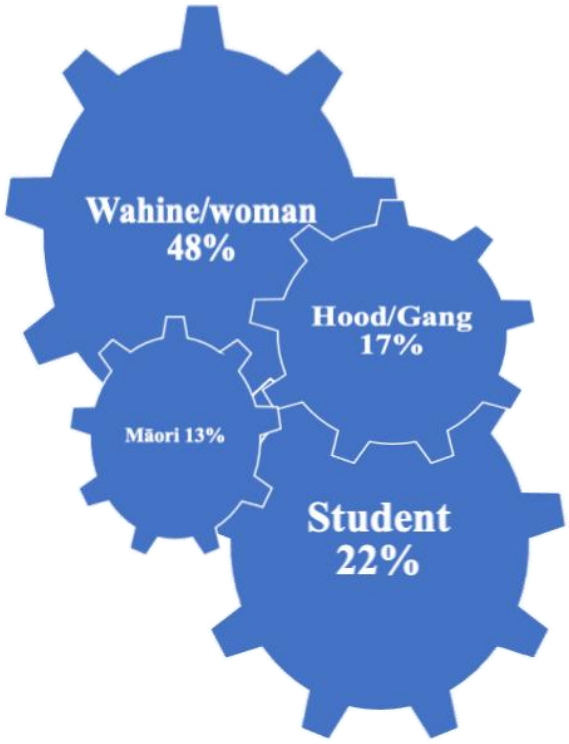
In instances where a relationship simultaneously revealed aspects of identity, the narrative was positioned within the theme that most authentically and transparently conveyed the participant's experience. It is acknowledged that the scope and framing of the study may have influenced the nature and depth of the responses. Nonetheless, this section maintains an intersectional lens, attending to the complexity and diversity of the narratives by presenting the stories of Kōwhai and Harakeke.

5.3.1 Aspects of Identity (Who I Am)

Aspects of identity concentrates on the Story Sharers' experiences surrounding how they described who they are. The four themes which emerged were: Wāhine/Woman/Girl 48%, Student 22%, Hood/Gang 17 %, and Māori 13%. These four themes resulted from analyses of the conversations whereby the Story Sharers self-identify, describe themselves or their identifying behaviours. These themes emerged by analysing certain words, such as hood (when meaning gang), cultural references to Māori identity (for example, using te reo Māori or attending kapa haka), how they behave as students in class and on school grounds and interchangeably using the words wāhine and woman or girl. For the group, the breakdown of this theme can be seen in Figure 5.5.

Figure 5.5

Aspects of Identity (Who I Am) for the Story Sharers



The analysis demonstrates that when discussing who they are, the Story Sharers spend nearly half their time talking about being Wāhine and, to a much lesser extent, being students,

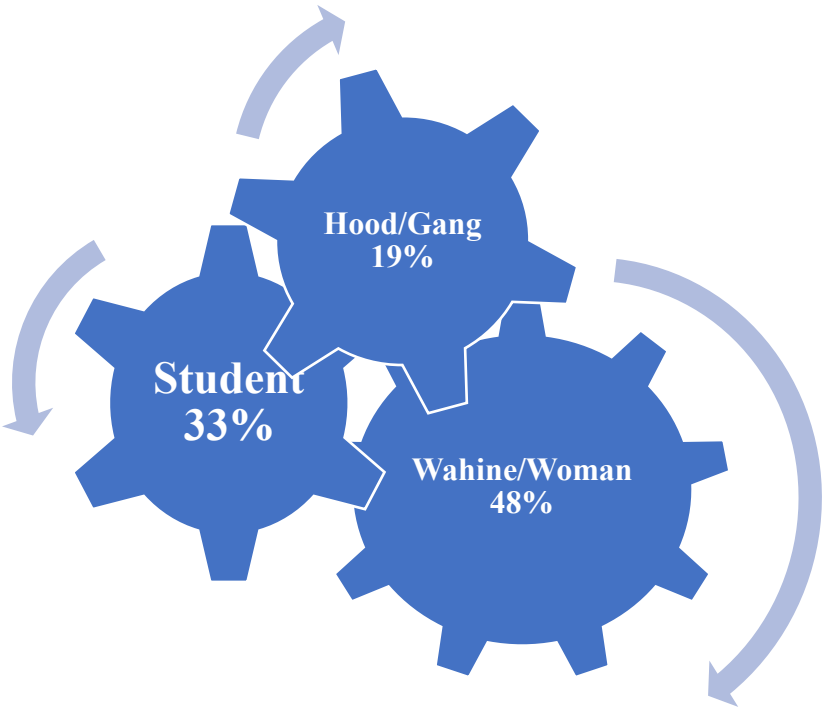
hood/gang, and Māori. To better understand the data, a closer look is taken at the stories given by Kōwhai and Harakeke.

5.3.1.1 Aspects of Identity Shared by Kōwhai

Kōwhai would often talk about her identity regarding how she saw herself and how she believed others, particularly teachers, perceived her. These descriptions revealed three themes: wāhine/woman 48%, student 33%, and somebody who was hood/gang 19%. Unlike the group, she did not self-identify or use any identifying words for being Māori, and Kōwhai's data is depicted in Figure 5.6.

Figure 5.6

Aspects of identity (Who I Am) shared by Kōwhai



The following sections recount Kōwhai's conversations to understand further how these three themes were described.

Being Wahine (Woman)

Kōwhai discussed being wāhine/woman/girl more than any other component of her identity (48%), and it was during discussion group 5, the first interview of 2019, that she discussed this aspect the most. In this interview, a conversation arose between Kōwhai and Manuka regarding an expression I had not heard the Story Sharers use before: "Man girl". This was in response to pushback against what could be viewed as stereotypical norms for a girl. All three of the Story Sharers present identified and agreed with this phrase. All three described how they were cautious choosing their clothing, especially outside of the home, due to the "judgment" they would receive. Kōwhai spoke about how being judged influenced her choices of clothing, as highlighted in this exchange:

> Kōwhai: "It's hard being a girl," and she continued "Anything a girl does will be judged, whether you're a boy or a girl, but I feel more comfortable as a boy." Manuka added "There's a dress code and stuff, you know how they wear a crop top and stuff, I can never do that." Kōwhai agreed but clarified she would only wear such clothing, like a crop top, at home. "Yeah, hard out, when I'm at home, I would."

In response to this exchange, I asked if it was the girls who judged them and Kōwhai replied, "It's not just the girls either, the boys too," and added, "I'm more comfortable the way I am." I took this conversation as an indication that Kōwhai was comfortable being a 'man girl' but also denoting a need to reduce judgement by distancing herself from her perceived ideas of what a stereotypical woman looks like.

As discussion group 5 continued, the theme of being a 'man girl' evolved, and it became clear that all three Story Sharers wanted to go into construction or have a career in building. I was excited about discussing how the Story Sharers were developing a STEM identity as Kōwhai explained what she wanted to do, "Yeah, I find that stuff really interesting; I want to be able to build shacks in the back." Kōwhai continued by describing how she wanted to explore this career as she believed the industry would provide an opportunity to become her own boss. Kōwhai believed that by being a 'man girl' in a 'man' type of job, she could manage her own company. However, this consideration was a counternarrative to combat the negative experiences that Kōwhai and her whānau had encountered with women who had been their managers. Kōwhai summed it up with this example, "None of them are nice. My Mum worked at a hotel, and I met her boss, and she was ultra-rude. When she came out shouting to

my Mum, I would've punched her head in." Kōwhai clarified this comment by adding how unacceptable being rude to her Mum was, "Don't look down on Mum, I'll beat your ass."

I was not shocked when Kōwhai described being protective of her Mum. When Kōwhai said this, the other Story Sharers agreed they would protect whānau (family). What I found interesting was that Harakeke recounted a similar story of another manager being discriminatory towards a whānau member, recorded in section 5.2.1.2. The Story Sharers agreeing with these stories gave me the impression that they had witnessed situations whereby whānau, particularly Māori wāhine had been treated disrespectfully, including by other women in positions of power. The Story Sharers' observations of their whānau encountering discrimination illuminated its intergenerational transmission and contributed to shaping their own perceptions and experiences of marginalisation. Such encounters elicited not only anger but also a desire among some Story Sharers to disassociate from elements of their wāhine identity, reflecting the internalised impact of sustained intergenerational discrimination.

Being Student

Kōwhai only spoke of her school experiences post-year nine, this being the same year she had started to find solace with her 'gang' friends after her dad's unveiling. Kōwhai described her turbulent relationship with high school and the school system, including how since year nine she had been excluded, sent to work experience, left this work for another school where she was subsequently excluded, and eventually returned to her previous high school. A result of being moved between schools due to exclusion resulted in one of the reasons for her complicated relationship with her current school as she lived outside of the school zone and was without accessible transport. Kōwhai's ability to attend school was contingent on the support of her whānau and friends, who not only provided practical assistance but also needed to have the financial means to cover transport costs. The result was Kōwhai had an average attendance rate of 20% which was a contributing factor in the difficult relationship with her teachers and the Senior Leadership Team (SLT). Kōwhai described how she was often 'growled' at by SLT, yet she discussed wanting to be a 'good' student. This meant when Kōwhai was in school, she would try to blend in and not gain the attention of her teachers or SLT. She told me, "I kept to myself." In discussion group 6, Kōwhai discussed how school practices were creating a positive change and went on to reminisce how she had hated being

singled out when she was in trouble. She said, “Even the teachers, they don’t put the kid in front of the whole entire class; that’s what I hated. I used to always get that, but they stopped that.” When Kōwhai was looking for reassurance that she was a ‘good’ student, she would signal the actions she was taking, such as saying, “I have been wearing my uniform today.” However, Kōwhai also wanted to maintain her friendships, especially with the ‘gang’ friends which were her support group. Maintaining her friendships whilst being a student was not always in harmony, but a change started to happen whilst she was in the Alternative programme and STEM class. This slowly enabled her to create a new friend group through the improved student-student relationships that become “a whānau”. This is an important development for Kōwhai who was vocal at identifying friendships as her most critical success factor. Kōwhai agreed that coming to school and doing well is how she can change and become a good role model for her whānau and her ‘gang’ friends. She wanted to show them that “School is normal.” At the last interview (discussion group 6), Kōwhai recounted how she had started to develop better relationships with her teachers, and this, in turn, was having a positive feedback effect, continuing to encourage her to do better with her studies and attendance.

Kōwhai was struggling to be the ‘good’ student she wanted to be. Kōwhai knew the behaviours she wanted to exhibit to be recognised as a ‘good’ student, such as attending class and wearing the correct uniform. Missing class due to her living circumstances resulted in being ‘growled’ at by SLT and teachers, which made her feel like she stood out, and she ‘hated that’ and just wanted to ‘blend’ in and ‘keep to herself.’ When Kōwhai could not blend in as a ‘good’ student, she decided to blend in with her ‘gang’ friends.

Being ‘Gang’

The least discussed identity theme for Kōwhai was hood/gang, but it was still close to 20% of her narrative. When she discussed what it was like to be ‘gang,’ Kōwhai would talk about the behaviours she would manifest when she was with her ‘gang’ friends. She would use words to describe these interactions such as ‘hood’ and ‘homies.’ Kōwhai used different words depending on whether these interactions were with her ‘gang’ friends in school or her local community. Kōwhai also discussed how her behaviour changed with her ‘gang’ friends, which occasionally included ‘smoking weed.’ Kōwhai discussed how she often got into trouble for breaking school rules when she was with her ‘gang’ friends in school. Kōwhai

recognised how this behaviour led to the discourse with herself and the school staff. Kōwhai could link the change in her behaviour to traumatic events that had happened in her past and how her relationships with her 'gang' friends had evolved from a sense of feeling happy and safe with those who looked after her. Yet, Kōwhai would contradict this when discussing her gang identity by telling me, "You can't be nice if you're gang."

Kōwhai could also recognise negative cycles of behaviour and gave an example regarding payday. Kōwhai explained that when she was paid, she would sometimes spend her money on 'weed.' Kōwhai said when she 'smoked weed' she would get to bed late and wake up late, and this resulted in her missing school, which she admitted had a detrimental impact on her learning, especially when this resulted in her being 'growled at.' However, Kōwhai found it challenging to break this cycle as some of her 'gang' friends also attended the same school, and it was difficult to ignore them. She said, "School is bad when all your homies are around." As Kōwhai progressed through the year, she expressed how she wanted to improve her opportunities and knew that her behaviour would have to change. Kōwhai told me that she understood that her friends might not want to change their behaviours, "I reckon they will hit rock bottom and it'll be too late, they'll wanna change, but it'll be too late. Luckily, I wanna change quickly."

When Kōwhai talked about her 'gang' friends, she always referenced how they had supported her, yet whilst describing herself as 'gang,' it was from a detrimental perspective. Kōwhai could explain cycles of behaviour that enabled her to 'blend in' and belong to her gang friends, such as 'smoking weed' and skipping school, but these behaviours were also making it problematic for her to be a 'good' student. Along with the 'growling' she received from teachers and Senior Leadership Team, Kōwhai internalised the stereotyping she was receiving, which made her believe she was 'not nice.' The consequence of this belief was that it negatively impacted her sense of wellbeing, which created a cycle that made learning hard. By the end of the study (2 years), Kōwhai had decided to separate her gang friends between community and school, enabling her to walk between the two worlds.

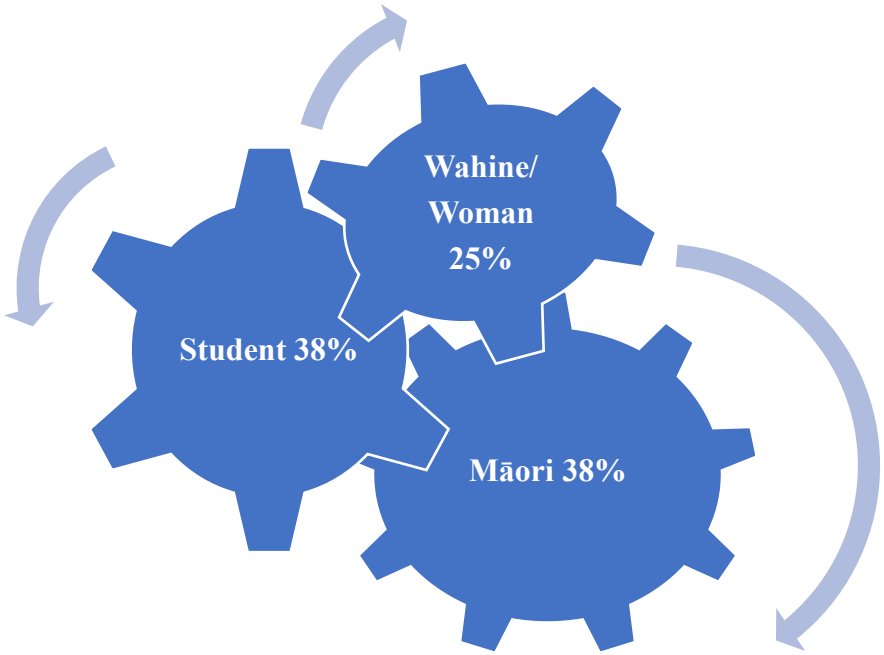
In contrast Harakeke recounted aspects of her identity which differed from the group's and Kōwhai's. For example, she did not use any identifiers to denote herself as 'gang' and put as much emphasis on her Māori identity as she did as a student. The next section follows aspects of Harakeke's identity story.

5.3.1.2 Aspects of Identity Shared by Harakeke

Harakeke devoted a significantly greater proportion of her narrative to her Māori identity than any other Story Sharer, with 38% of her contributions focused on this theme. In marked contrast, she made no mention of associations with the 'hood' or 'gang.' This stands out against the broader group data, where references to 'gang' appeared in 17% of discussions and Māori identity in only 13%. Kōwhai's narrative further highlights this divergence: she identified with the 'gang' at a slightly higher rate (19%) than the group average and did not reference any aspects of Māori identity until the final interview in discussion group six. These contrasts underscore the varied ways in which identity was expressed and prioritised among the Story Sharers, with Harakeke's emphasis on her Māori identity offering a distinct counterpoint to the broader group patterns. Figure 5.7 depicts the three main identity themes for Harakeke, which included being Māori (38%), student (38%), and Wāhine/woman/girl (25%).

Figure 5.7

Aspects of Identity (Who I Am) Shared by Harakeke.



Along with the discussion group interviews, upon her request, Harakeke gave a one-to-one interview, which took place between discussion group interviews 3 and 4. During the interview, Harakeke expanded on some of her responses from the previous interviews and recounted how she experienced being Māori. I realised she wanted to share this narrative away from the rest of the Story Sharers. The first identity theme explored is how Harakeke described herself as being Māori.

Being Māori

Harakeke self-identified as Māori and was grounded in her Māori identity, having spent her primary school years in a Kura Kaupapa (section 2.3.2). Harakeke was a fluent speaker of te reo Māori, could describe her whakapapa (family lineage), and she took an interest in Māori art forms, especially weaving. Harakeke could connect her love for numbers with weaving, and she discussed how her passion for weaving and numbers was intergenerational, saying "When I was five years old, my Great Nan passed away, and she worked with numbers too and liked weaving, and I like to weave".

Harakeke recounted the story of how te reo Māori had become important to her family and the barriers they had overcome to embrace their language. She retold the story of how her Mum had encouraged her to learn te reo Māori after her mother and Grandmother had been beaten for speaking the language:

> She [Mum] was brought up in a Pākehā world. Dad was Pākehā, and Mum was Māori and spoke te reo and got beaten. My Mum got her point of view changed by us, the younger generation, wanting to speak it. Nan's language was Māori, and [she] got beaten for speaking Māori, and now Mum wants to bring that Māori back out, for her kids to be able to speak it and not get a smack for speaking their own language.

However, Harakeke said she had also experienced discrimination for speaking te reo Māori. This happened when she transitioned from a Kura Kaupapa into a mainstream years 7 to 8 (ages 10-13) English medium intermediate school. At the end of year 8, before graduating to high school, the school recommended to Harakeke's Mum that she stay back a year. Harakeke retold her interpretation of that story; "When [my Mum] was told about going into high school, [the school said] I should be held back a year as I wouldn't achieve because I knew Māori [language] I'd be dumb because they [Kura Kaupapa] don't teach what Pākehā teach". This was the origin point for Harakeke internalising the dialogue that by speaking te reo

Māori and being Māori, she was ‘dumb.’ This narrative continued to impact Harakeke and how she felt about using te reo Māori as she said, “Even now I am looked at for speaking te reo.”

Racism was the second largest discriminatory experience for Harakeke, and she could describe how these events were intergenerational; she finished this conversation by telling me what her Mum had told her: “What was said to me is you; what’s said to you is me. We have always been connected”. Other underlying structural forms of discrimination impacted Harakeke’s confidence in her academic abilities that she did not identify in the discussions as a blocker. For example, in discussion group interview 1, Harakeke said that Maths was her favourite subject. She could link her love for numbers and mathematics with weaving, but her e-asTTle score for numeracy was 3P, the expected level for a year 6 or 7 student. However, the e-asTTle tests that Harakeke sat were written in English and test traditional Maths knowledge and do not include cultural contexts such as weaving. Harakeke was developing a STEM identity, which was interconnected with her Māori identity, but Māori art forms such as weaving and connections to numeracy were unrecognised within the schooling system. A challenge for Harakeke was trying to belong to a Pākehā education system and her solution was to try to hide her Māori identity.

Being Student

Harakeke spoke about being a student as often as being Māori. Considering how her experiences in intermediate school had resulted in a detrimental impact on Harakeke’s relationship with school, I was always encouraged to hear how she still wanted to achieve and be a positive role model. In the first discussion group interview, when asked if the Story Sharers enjoyed being in the STEM class, Harakeke replied, “I like being here because I saw my brother achieve in the Alternative Programme [and STEM class], and he went into year 13.” Harakeke wanted to follow in her sibling’s footsteps and ‘achieve.’ When asked what she would like to do, Harakeke replied, “Something with numbers,” and expressed an interest in either Real Estate or Accountancy. Her whānau had helped her understand the value of hard work, and Harakeke would recount the wise words, “Mum said I had to work for what you want.”

Harakeke liked to know she had worked hard and earned her NCEA credits. When asked to compare her STEM class to her Year 9 or 10 Science class, she described how she felt the work in STEM was easier and 'like year 9 work.' Harakeke did not think it was because she felt more mature or had more knowledge, but it "just felt easier." In response, I asked if this was a good thing, and she replied, "It is, but then it isn't because, for me, I like challenges." Harakeke did go on to clarify that although she liked a challenge, she still wanted to be able to achieve. I wondered to what extent Harakeke had been negotiating the tension between striving to be a good student and seeking greater academic challenge, especially given her history of underperformance. For example, Harakeke entered year 11 with a literacy e-asTTle result of 3A, which equates to the curriculum level expected in year 6 or 7; however, Harakeke was fluent in te reo Māori, but she had sat all her e-asTTle tests in English. I wondered whether she had sat the tests in English rather than te reo Māori because she wanted to hide her Māori identity because she wanted to ensure she was not perceived as 'dumb.' Yet these results strengthened the negative perceptions of herself, especially as the resulting discussions with teachers and SLT reinforced the stereotyping she had experienced. At the end of 2018, Harakeke's NCEA Level 1 results were second highest in the Alternative Programme, and she only needed eight credits to complete the qualification.

Being Wahine

Harakeke recounted being wāhine (woman) the least, only 25% of the time. However, Harakeke only talked negatively about her experiences of being wāhine; there is not one instance in her story that denotes being wāhine as positive. It was Harakeke who said., "Because men say women can't do stuff men can" as a response as to why she thought women didn't go into STEM jobs. Harakeke also described how she had to try harder than men to achieve the same: "So, women have to prove most people [mainly men] that they can do much more, like as much as men." Harakeke described the discrimination that women must overcome when she said, "Men can put women down" and "And women don't always get to have a say."

Just as Kōwhai had described a story of how a member of her whānau had been mistreated by her manager, Harakeke recounted a time when her caregiver was not believed when she revealed how a colleague was inappropriate towards her. Harakeke described the story of how her caregiver was informing her (male) manager of the situation, "When she said [what

happened], they didn't believe her, [he said] he's our best employee, and it's a lie, he's not like that". This was another example of a Story Sharer witnessing whānau, who were Māori wāhine, experiencing discrimination. In this instance, Harakeke's caregiver was not to be believed compared to a 'best' male employee, reinforcing stereotypical tropes about Māori wāhine. As Harakeke had told me about the connection she shared with her Mum, I was aware that these types of discriminatory events were overlayed and interlinked generationally.

Harakeke's expression of identity revealed the deeply intersectional nature of her lived experiences. When recounting instances of discrimination, she described how internalising deficit discourses led her to believe she was 'dumb,' not simply because she was Māori or wāhine, but because she was a Māori wāhine. Her aspiration to succeed academically was evident, yet her achievement data reflected a pattern of underperformance. This disconnect was not due to a lack of ability, but rather the cumulative impact of discrimination, which had led her to suppress her Māori identity. One manifestation of this was her decision to sit exams in English, despite being fluent in te reo Māori. Furthermore, although Harakeke demonstrated the ability to connect numeracy with Māori art forms, the education system's structural biases failed to recognise or value such culturally grounded ways of knowing. In navigating these tensions, Harakeke was engaged in a complex process of identity negotiation seeking belonging while walking between two worlds: te ao Māori and the Pākehā schooling system.

5.3.1.3 Identity Summary

Although the four identity themes of wahine, Māori, student, and gang are presented separately in the findings, they were never experienced in isolation. Rather, they were multiple, interconnected, and constantly intersecting. For example, Harakeke's reflections on being wahine were deeply entwined with her Māori identity, while Kōwhai's experiences of being wahine were more closely linked to her gang affiliation. Each Story Sharer's narrative revealed a unique intersection of identity, shaped by how they interpreted their experiences and which aspects of their identity were most affected. For instance, negative associations with gang identity were internalised through comments such as being 'not nice.' The cogwheel metaphor was used to visualise how these identity components not only intersected but also reinforced one another in dynamic and sometimes conflicting ways.

The findings suggest that the Story Sharers were able to articulate the behaviours associated with being a 'good' student and how these aspirations intersected with their identities as Māori, wahine, and, in some cases, gang-affiliated. However, these intersections were not always harmonious. For example, while a 'good' student is expected to achieve academically, the internalised stereotype that "Māori are dumb" created a dissonance that complicated their sense of belonging and their pursuit of academic success. This tension highlights an additional layer of complexity in how identity shapes educational engagement and achievement.

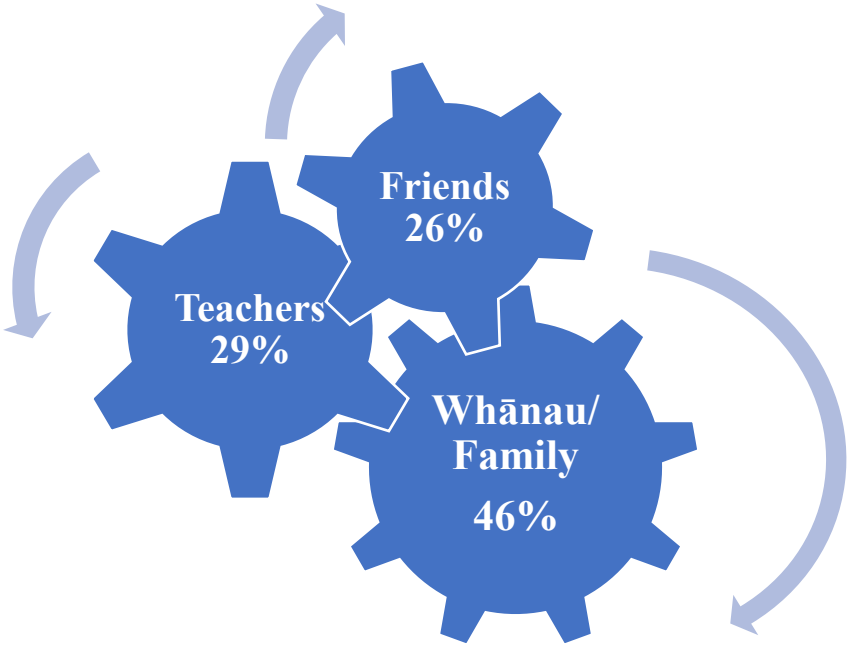
A critical dimension of how the Story Sharers constructed and expressed their identities was embedded in the context of their relationships. These relationships whether with peers, whānau, teachers, or community were not peripheral but central to how identity was experienced and negotiated. The following section explores the complexities of these relational dynamics and their influence on the Story Sharers' sense of self and belonging.

5.3.2 Relationships (Who I Am With).

Relationships included Whānau (family) 46%, Teachers 29%, and Friends 26%. The data were complex to analyse, as the Story Sharers would call people 'Aunty' or 'Cousin' when, from a non-Māori perspective, they were not related. As the study progressed, I better understood how interconnected the terms friends and whānau could be for the Story Sharers. Figure 5.8 depicts the breakdown data for the Story Sharers' theme of relationships.

Figure 5.8

The Story Sharers' Relationships (Who I Am With)



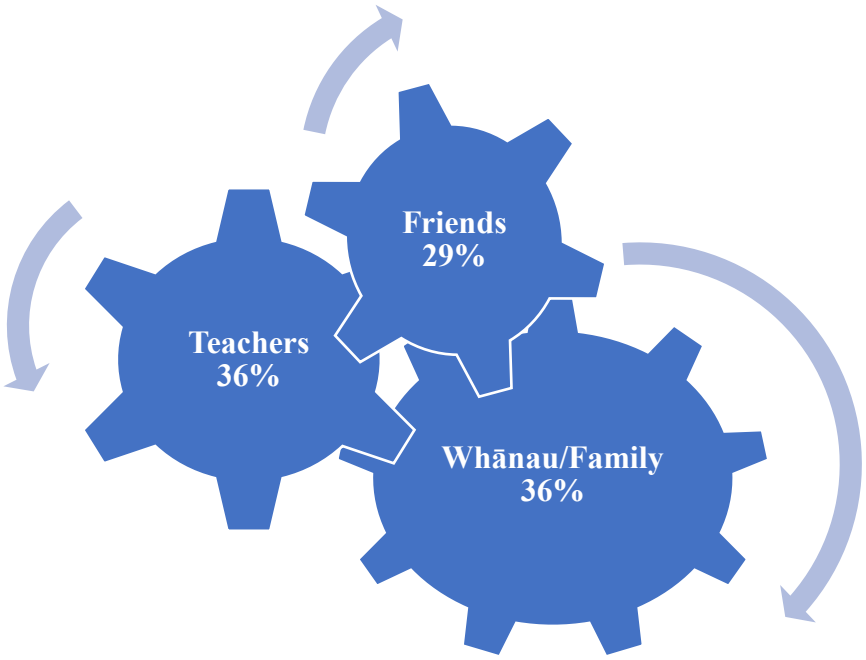
I found it interesting that the Story Sharers discussed their relationships with their teachers as often as with their friends. However, this could be because the questions were centred around the Story Sharers experiencing the STEM class, and while I asked questions as a researcher, I was also their teacher. Again, the data for Kōwhai and Harakeke are presented to continue the intersectional perspective and gain further clarity.

5.3.2.1 Kōwhai Relationships

Kōwhai discussed openly her relationships with her whānau (36%), friends (36%), and teachers (29%) and how these interlinked with aspects of her identity. Figure 5.9 depicts the percentage analysis.

Figure 5.9

Kōwhai Shares her Relationships (Who I Am With).



What follows is a description of how Kōwhai experienced her relationships, their effect on her, and how she has changed and challenged them. Over time, Kōwhai realises that with support she can control who she wants to be.

Whānau (Family)

Kōwhai frequently spoke of her strong connections with whānau; however, these relationships were not without complexity, and she was actively navigating the tensions and challenges they presented. She conveyed a deep sense of obligation to her whānau, particularly in her commitment to supporting her mother and striving to be a role model for others. What stands out is how Kōwhai's circumstances changed after she went to her Dad's unveiling when she was a year nine student. Kōwhai recounted the story to me.

> It all went downhill when we had to go unveil my Dad when I was year 9, and then I just started smoking [weed]. I got it from old friends... Not in a good space when I come back to school. I was already sad at home, so I don't want to be sad at school.

This event caused a disruptive interplay with Kōwhai's whānau, friends and teacher relationships. Once she started 'smoking weed' and socialising with her friends, relations

with her Mum changed. Her Mum was concerned and tried to support her through this time by allowing her to smoke at home, and Kōwhai described this story: “Mum doesn’t allow it [weed], but she knows that I’m doing it. When I was going out with friends, Mum would look for me. So, Mum said stay home so I can see you.” Eventually, relations with her Mum continued to break down, and Kōwhai and her siblings went to live with their aunt. Kōwhai had to make difficult decisions about her future, and she recounted this conversation.

> When I was living with my Mum, I had basically everything. I had my Mum, family, food, car, drugs, everything. I had it all. When we had to split from Mum, and all that shit went down. I had to pull my head in, and I went downhill last year, but then I got with Aunty, and she put my head in place.

Kōwhai recounted her conversation with her Aunty and how it helped her determine the needed changes:

[Aunty] “You’ve got school. Are you worried about making money or your Mum?” [Kōwhai] “I’m worried about both” [Aunty] “you gotta choose one.” Kōwhai explained her decision: “I chose money because I know Mum’s alright as she has support from all of us.”

Again, I was reminded of some of the difficult decisions the Story Sharers had experienced due to socioeconomic disadvantage. After these events, Kōwhai explained how she continued to be motivated by her Mum. She said, “The thing that gets me up in the morning is my Mum.” Kōwhai proceeded by discussing how she had developed a deep sense of responsibility to her whānau, including being a good role model and passing on her knowledge, as she explained, “It’s like a rule that’s been around for centuries, miss. Whoever is younger than you has less knowledge than you, which means you need to teach them.”

A sense of responsibility of being a good role model for whānau and in some instances friends by passing on knowledge from the oldest to the youngest had been a strong theme for the Story Sharers. However, within whānau there had been disruptions caused with this tradition by the introduction of technology. Kōwhai described how her previous experiences as a child would teach you to be yourself and develop social skills and resilience, but in the digital age, those things had now changed:

> Wi-Fi that’s killed a lot about our play, our time outside too. They [family] always on the PlayStation, they’re on the Wi-Fi. And if you see the Wi-Fi, go on, you see everyone run downstairs and staying up all night, and it does my head in. Yeah, Wi-Fi kills it. Fun was getting outside, hurting our legs because we fell off a bike or grazing

> our legs ‘cause we ran and fell on the concrete. Those are the small things; you never see people walking around with grazes, and if you do see them with grazes, [it’s because] they play sports.

Kōwhai continued to describe the consequences of digital technology and how it had created social issues for families:

> They always on the Wi-Fi and they just sit there and if they do play [outside], they end up crying because they get hurt. That’s why they get excluded from playing with the family and in general... Heaps of things have changed nowadays.

Kōwhai continued to reflect on how the changes had impacted whānau life:

> I’ve seen heaps of mean as changes, like good changes, but when life was good, we were unhappy with it, and then we wished for more, and then we got more, but we got more problems on the side of it.

Kōwhai finished by describing the responsibility of being an older sibling: “When you are the oldest, the youngest will follow you” and “It’s really hard being the oldest.”

When Kōwhai reflected on her childhood recounting memories of playing outside and observing changes in whānau dynamics it became clear that this was the first time she had shared any details about her life prior to Year 9 and the significant event of her father’s unveiling. These reflections revealed her aspiration to be a positive role model and to pass on her knowledge to younger members of her whānau. However, fulfilling this role was challenging. Kōwhai was navigating a rapidly changing social environment in which technology had disrupted traditional family structures. Although she belonged to the generation often referred to as digital natives, her early childhood was largely free from digital technologies. As a result, she was negotiating a sense of belonging and identity as a role model within a context that differed significantly from her own upbringing.

In addition, Kōwhai described how her relationship with her mother became increasingly strained after her father’s unveiling. This moment marked a turning point, as she began to seek connection and comfort among her gang-affiliated peers, further distancing herself from her whānau. Eventually, Kōwhai moved in with her aunty and was faced with difficult decisions. She concluded that prioritising financial stability, what she referred to as "money," was ultimately in the best interest of both herself and her mother. Despite these challenges, whānau remained central to Kōwhai’s identity. Her mother continued to be a source of inspiration and motivation, encouraging her to get up each morning and keep going.

Kōwhai had described how she perceived herself as ‘not nice’ with her ‘gang’ identity and the juxtaposition this had created with her school relationships. Yet Kōwhai discussed her relationships with her teachers (36%) as often as she described her whānau (36%). Considering Kōwhai's complex history with the school, I was interested in how she viewed those relationships.

Teachers

Kōwhai would discuss how her relationships with her teachers, especially since being in the STEM class, had changed into a more positive influence on her life. In turn, this also facilitated the changes in how she perceived herself. This positivity improved her wellbeing and acted as a positive reinforcement cycle, and Kōwhai continued trying harder to improve and do better. During the last interview in 2019 at discussion group 6, Kōwhai reflected on her school experiences and shared the new positive interactions she was having:

> That is something that has changed Miss; I walk around and say, ‘Hi Miss,’ and they [teachers] are like, ' Hi,’ whereas before they were wary about who I was. When I was here in year 9, we [the principal] had a bad clash. Obviously, now he says hello to me. I’m a normal kid; I’m not from the hood anymore. I like that type of stuff, Miss.

I responded to this dialogue by asking what had happened to help with the positive changes, and Kōwhai reinforced how meaningful the improved relationships with her teachers were:

> I think it was the teachers. I was able to talk to them more. And now I just get, ‘Hey Kōwhai, how are you?’ and I’m like, ‘I’m great, Miss going hard in school,’ and they were like, ‘so lovely to still have you here.’ So, I can talk to teachers now, whereas before, I never heard that.

Relationality with her teachers was a core motivator for Kōwhai as she continued to discuss how teachers she had not met before reinforced her positive mindset by acknowledging her. She said, “[that teacher] someone who’s never talked to me, but they’re saying I’m doing great, so I must really be doing great!”

The positive reinforcement cycle this created made Kōwhai more committed to attending school and completing her work. She described how the cycle of doing her work and the positivity from the teachers fed into each other: “When I got so excited, when I asked how much of my work is done, there’s only four crosses; the rest are ticked, you know.” This was regarding the ticks [completed] and crosses [unfinished] NCEA credits that students could

view on their student records. Kōwhai continued, “Yeah, I can count the crosses now, whereas before, it was a...er...yuk.” Kōwhai concluded, “That thing changed my negativity to positivity, and it's huge positivity.” This was an interesting comment, as teachers had been encouraged to share the work completion results with the students. Kōwhai had noted how when she was struggling with work completion this had been a disincentive for her.

Due to this change in outlook and increased trust, Kōwhai started to change her behaviours as she developed more empathy for the teachers and was now managing to interpret interactions from their point of view. Situations that would have previously led to confrontation had changed as Kōwhai was now able to stop herself from getting angry as she realised the teachers were trying to help her. For example, she said:

> It’s cool because whenever a teacher growls at me, I’ll be like, ‘What do you mean? I’m right here.’ And then, wait a minute, why do you growl at me? Okay, this person is trying to help me. Sorry, okay, yep, I’m listening.

As well as the empathy she had for her teachers, Kōwhai also recognised when a teacher wanted to extend her learning and gave an example of this type of interaction:

> If Miss is trying to turn stuff on me [give extra work], I’ll be like ‘Look, Miss, okay. I can’t do everything. So, like you need to give it to me separately, please bit by bit,’ and I tell all my teachers, and they’ve just given me bits and pieces or else if they know I can do it, then they just gonna give me all of it and then I get pushed a lot.

But Kōwhai had noticed more than just the change in relationships with the teachers. She had seen the role modelling by those teachers. Teachers had started to make positive changes within the school, making Kōwhai feel safe. She said, “It was the other teachers, too. They’re role-modelling.”

Kōwhai spoke of the role modelling in classroom behaviour management and how teachers cared for her through their actions. This included Kōwhai reflecting on the shared lunch that was provided within the STEM class, she said, “And that’s how we knew you looked after us because it was something we liked, but it was also healthy.” She continued to give a description of how such behaviours lead to becoming treated as whānau, “Well, I could probably call you Aunty,” and “Well, you act like an Aunty.” Being given whānau status happened because Kōwhai recognised she was being treated like whānau. At the final discussion group 6, when Kōwhai had spent a year with her aunt, I asked if she had been able to separate her school life from her home life, and she said, “Yeah, and my attendance will

show the truth, miss, it'll prove that I have been trying my hardest." By referencing her improved attendance, Kōwhai was signalling to me that she was a 'good' student.

The relationships Kōwhai had with her teachers had improved over time. The better her relationship with the teacher, the more she attended school and the more work she completed; teachers would congratulate and encourage Kōwhai to continue this behaviour, creating a positive reinforcement cycle. Kōwhai looked to her teachers to role-model the behaviours that made her feel appreciated and cared for, in the same way that Kōwhai herself wanted to be a good role model. When the teachers started giving Kōwhai positive feedback, she began to feel like she was 'good,' which meant she was no longer 'gang' or 'not nice'. At this point, Kōwhai developed the confidence to reveal and explore her Māori identity.

Friends

Although Friends is the least discussed relationship for Kōwhai, it still accounts for nearly a third of her relationship data (29%). Throughout Kōwhai's narrative, there is a theme of her struggle between wanting to be with her friends who bring her comfort and support and how those same friends can lead her to exhibit behaviours that have negative consequences for her relationships at school and home. During discussion group 4, the final interview of 2018, there was a turning point when Kōwhai said her achievement was "making friends" and continued to add "and didn't get into any fights." This signalled that she had made new friends and was learning to traverse and walk between two worlds, school and 'the hood.' Kōwhai gave insight into her new perspective of living in the 'hood' when she said:

> Living in the hood is really hard, Miss. It's not like gang bang and all that, but it's hard to see not only your own family struggling but your neighbours struggling, everyone else struggling. It's really sad, to be honest. When you wake up to go to school and look out at neighbours and go 'oh mate' because there's just heaps of kids just hanging around not going to school, it's really sad".

Kōwhai never clarified what she meant by struggling. When I responded to her comments by asking what motivated her come to school when her friends were 'in the hood', Kōwhai paused when Manuka interjected and said, "I reckon for me staying at home [community] is pointless," and Kōwhai agreed by saying "and that's why Miss." By the final discussion group (number 6) at the end of 2019, Kōwhai described how she had continued to make

changes to the relationships with her friends when she said, “I sort of cut myself off from that to get straight for school.”

Kōwhai recognised that distancing herself from her ‘homies’ at school also meant shedding the ‘gang’ identity that had previously shaped how she was perceived. This shift was not simply a matter of peer group change; it represented a deliberate act of self-redefinition in response to the stigma and stereotyping she experienced within the school environment. As she began to disassociate from the ‘gang’ label, teachers’ perceptions of her shifted, evidenced by more positive interactions and a noticeable change in how she was treated. Reflecting on this transformation, Kōwhai stated, “I’m not the kid from the hood anymore.” Her decision to “cut herself off” from her gang-affiliated peers in order to become a ‘good’ student illustrates her growing capacity to navigate two distinct social worlds: the ‘hood’ and the school.

This de-identification from the gang was not only a personal turning point but also a strategic response to the layered discrimination she faced. It added another dimension to the complexity of her identity development. As she moved away from the gang identity, Kōwhai began to explore aspects of her Māori identity, an identity she had previously concealed. This process revealed the extent to which she had internalised racism, describing it as something that had become ‘normal.’ The internalisation of such deficit discourses had contributed to a fragmented sense of self, compelling her to suppress her Māori identity in order to conform and belong within her peer group. Although Kōwhai was officially registered as Māori at school, it was only at the conclusion of this study that she explicitly self-identified as Māori. This moment marked a significant shift in her journey toward reclaiming her cultural identity and resisting the stereotypes that had shaped her educational experience.
Like Kōwhai, Harakeke also identified with the same three relationship themes; whānau, peers and school but the significance and expression of each differed in important ways. Her story is shared next.

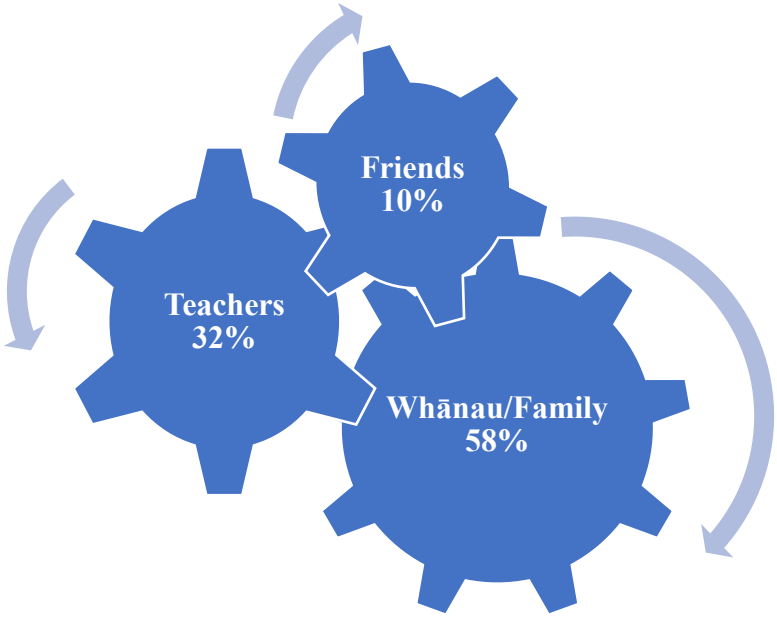
5.3.2.2 Harakeke Relationships

Like Kōwhai, when Harakeke discussed her relationships distinguishing the data between whānau and friends was difficult. Whānau was Harakeke's most crucial relationship,

accounting for 58% of her relationship narrative, followed by teachers at 32% and friends at only 10%. Figure 5.10 depicts the analysis of Harakeke's relationships as a cogwheel.

Figure 5.10

Harakeke Sharers her Relationships (Who I Am With)



Harakeke spent most of her time with her siblings, who attended the same school, which could account for the high whānau frequency. As whānau is the most significant contributor to Harakeke's relationship narrative, it is explored first.

Whānau

Harakeke often discussed her whānau especially her Mum and Nan, who had been instrumental in helping her form her Māori identity, which was explored in section 5.2.1.2. Again, the theme of role modelling was interlaced with Harakeke whānau narrative. She admired the role-modelling of her older siblings, especially those who attended the same school, which motivated her to stay and complete her NCEA through years 12 and 13. Harakeke gave an account of how the role modelling by whānau helped her look at life differently. Recounting a story, Harakeke described how she had been in trouble when she knew a group of students had taken a person's mobile [cell] phone. Although she had not

stolen it, she knew she had not encouraged her friends to return it. Harakeke learned a valuable lesson, and it was her older sibling who was her teacher. She said:

> It taught me don't steal; then my [older sibling] said, 'You could just ask me, and I would have done the mahi [work] and get the treats.' This inspired me: you can have more money to do what you want, but money doesn't make me happy; my family makes me happy.

This was another story which reminded me that the Story Sharers were aware that they could not always afford 'the treats' and that they had to 'work' for them.

Subsequent conversations reinforced the pivotal role that other whānau members played in supporting Harakeke's aspirations and academic achievement. She consistently identified her mother and grandmother as key influences, stating, "I have role models, my Mum and Nan," and further emphasising, "My Mum is my biggest role model at the moment." These relationships provided not only emotional support but also aspirational figures who modelled the values and behaviours Harakeke sought to embody. I was reminded that Harakeke also identified Māori wahine as significant role models, highlighting the importance of cultural and gendered identity in shaping her aspirations and sense of self. Demonstrating a similar narrative to Kōwhai, Harakeke discussed the importance of whānau in contributing to her succeeding at school. For example, during her one-to-one interview, when I asked how she overcame the issues that made learning hard, Harakeke let me know how important her whānau were to her progress; she said, "My family helps unblock all those things."

Harakeke also gave accounts of the important level of support whānau provided in ensuring a feeling of safety and support. During the one-to-one interview, Harakeke described a story of how a situation arose and their home was no longer a safe space, and they had to move. She said, "Over in [place name], we got death threats and ended up moving". This move resulted in her living in her current school zone. Harakeke described her family's challenges and how things had changed for her. She said, "Come a long way, to be honest with what went on with my family". After this conversation, I realised that in our previous discussion group 2 interview, when Harakeke had agreed that school was a safe space, she meant a secure physical space.

Harakeke detailed the importance of her relationships with her whānau and how they helped her overcome the blockers to learning. Whānau was Harakeke's primary support group, and

she could detail how their role modelling and her desire to be a role model motivated her to achieve.
Having heard Harakeke recount stories of experiencing racism in school, I was interested in how she would share stories of her teacher relationships.

Teachers

In section 5.1, Experiencing Discrimination, Harakeke discussed how some of the racism she and her whānau had experienced had been from educators. These experiences of racism had led Harakeke to believe that she was 'dumb' because she was 'Māori.' Harakeke had often found teachers were not trustworthy. When Harakeke believed a teacher to be untrustworthy her behaviour would change to reflect this. Describing a previous science class experience she explained, "So, because the teachers said we were going to do projects and then we didn't end up doing it, so I kinda went off task and off science and started wagging [truanting]."

Harakeke wanted to build a good relationship with her teachers, but circumstances meant it was not always possible. At school, there were times when a teacher was absent, or a long-term reliever (substitute) was in place. Harakeke was clear that a reliever was a challenging teacher to build a relationship with. She said: "They don't help as much as a real teacher does, but even if we try to have that relationship, bond with the teacher, they still don't know how to work with us." Student-teacher relationships were a critical factor for Harakeke academically achieving and she strongly agreed that she would not want to attend a class where there was a poor relationship with a teacher. I was mindful when Harakeke made such comments that in the background of this narrative was a history of discrimination from educators and the school system.

Experiences of discrimination meant it was hard for Harakeke to trust her teachers, and it was trust that led to positive relationships; Harakeke expressed this when she said, "not having trust with them and telling us what to do." When Harakeke believed there was no trust with her teacher a security response ensued which included truanting class, and finding safety with her sibling, or going home. Harakeke articulated how a teacher could gain her trust by treating her with respect and in the same manner as whānau. For example, she said a teacher should, "talk to us like you'd talk to your own." This was a contrast to Kōwhai who wanted teachers to role model the behaviours they expected of their students. A positive student-

teacher relationship, built on trust and mutual respect, would enable Harakeke to be the 'good' student she wanted to be.

The last relationship Harakeke discussed was with her friends. This was the least discussed relationship, which could be due to the following circumstances: her older sibling attending the same school, which was counted within the whānau data analysis, and because Harakeke only spoke of one friend who she referred to as a sister.

Friends

Harakeke used similar language to describe her friend relationships as she did her whānau, yet friends only accounted for 10% of her relationship narrative. However, student-student relationships were another key motivator for Harakeke. She was the Story Sharer who highlighted the importance of student-student relationships when she said, "It's not just about the teacher, it's like friends." Harakeke clarified how collaboration was an important classroom approach as she expanded her statement by stating how she wanted to work with various people in the STEM class to get to know them better. She said, "That's why I'd rather work not just the girls in our class but the boys as well." After this conversation, I tried to ensure there were opportunities to collaborate with a variety of students in the STEM class through their project work.

Relationships were central to Harakeke's academic engagement and success. She consistently emphasised the importance of her whānau, whom she regarded as key role models. In particular, her mother and grandmother were significant sources of guidance and inspiration, while her older sibling's academic achievements served as a powerful motivator for her to persevere in her own studies. Like Kōwhai, Harakeke credited her whānau with helping her overcome barriers to learning, particularly when she encountered challenges within the school environment.

However, Harakeke's ability to form trusting relationships with teachers was compromised by previous experiences of discrimination. This lack of trust was exacerbated by the frequent turnover of teaching staff, which disrupted continuity and made it difficult to establish meaningful student-teacher connections. When trust was eroded, Harakeke would disengage from the classroom choosing to 'wag' class and instead seek support and affirmation from her whānau.

Peer relationships also played a role in Harakeke's educational journey. Through collaborative learning with classmates, she was able to strengthen student-student relationships, although her social circle remained small. Some of her close friends were considered whānau, reflecting the depth of those connections. This may have been shaped by earlier experiences in another town, where her home environment was unsafe and her family was eventually forced to relocate. When Harakeke described school as a "safe place," she was referring to physical safety rather than a culturally safe space where she could fully express her identity as Māori.

5.3.2.3 Relationship Summary

Relationships were central to the identity development and academic engagement of the Story Sharers, with whānau consistently emerging as the most influential. Despite facing different challenges within their family contexts, both Kōwhai and Harakeke identified whānau as their primary source of support. They not only viewed their whānau as role models but also aspired to become role models themselves. This reciprocal dynamic of influence and aspiration was central to their motivation to succeed.

While both Kōwhai and Harakeke expressed a desire for positive student-teacher relationships, they also described a deep-seated mistrust of teachers, senior leadership, and the broader school system. This mistrust, shaped by prior experiences of discrimination, often hindered the development of meaningful connections with educators. Harakeke, for instance, emphasised the importance of being treated fairly and "like their own," while Kōwhai wanted teachers to "role model" the behaviours they expected from students.

In response to these relational challenges, the Story Sharers developed alternative support systems. When school relationships became strained, they often turned to whānau or close friends for emotional safety and guidance. Both Kōwhai and Harakeke expressed a desire to strengthen student-student relationships, particularly when these could evolve into genuine friendships. They identified collaboration and opportunities to work with a range of peers as key strategies for fostering these connections. When both student-teacher and peer relationships improved, the Story Sharers described a reinforcing cycle of positive behaviours, including increased motivation, greater effort, and consistent task completion.

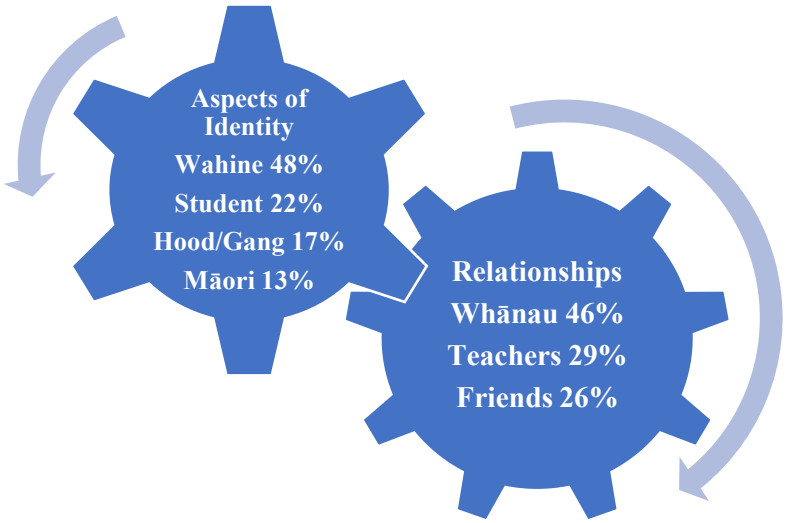
The Story Sharers' relationships, much like their identities, were experienced as interconnected and intersecting and are represented metaphorically through the image of reinforcing cogwheels. Just as identity was not experienced in isolation, neither were relationships. Each interaction had the potential to influence others, creating a dynamic and layered relational landscape. These experiences were deeply personal and shaped by the Story Sharers' unique interpretations, highlighting the phenomenological nature of their relationship journeys.

5.3.3 Lived Experiences Summary

The lived experiences of the Story Sharers were shaped by the constant interplay between their multiple, intersecting identities and their complex, interconnected relationships. These two dimensions, identity and relationships were not experienced in isolation but were deeply entangled, with each influencing and reinforcing the other. To represent this complexity, the metaphor of cogwheels was used. Each cogwheel captures either the dynamic nature of identity or the evolving nature of relationships, and each Story Sharer's narrative has been conceptualised through the integration of these two cogwheels. This visualisation reflects how identity and relationships are co-constructed through lived experience, with each turning point in one domain influencing movement in the other. Figure 5.11 illustrates this conceptual model.

Figure 5.11

The Story Sharers Interconnected Identity and Relationships Cogwheels



As with previous cogwheel diagrams, the movement of one cog initiates the movement of the other. This visual metaphor reflects how, as the Story Sharers explored and developed their identities, they were simultaneously supported and challenged by their relationships. For example, when a Story Sharer discussed an identity factor such as being wahine, it was always situated within the broader context of their intersecting identities and relational experiences. The cogwheels metaphor captures the reciprocal and evolving nature of these interactions, demonstrating that identity development is shaped by relational dynamics, just as relationships are influenced by how identity is expressed and experienced.

A further layer of complexity emerged through the Story Sharers' experiences of discrimination, which significantly impacted both their identities and relationships, as well as their overall sense of wellbeing. These experiences were not compartmentalised; rather, they overlapped and reinforced one another, further entrenching the challenges the Story Sharers faced. The following section explores these intersecting experiences of discrimination and their implications for identity and relational development.

5.4 Intersectionality

This section describes the development of the intersectional cogwheeling framework. The development of the complete intersectional cogwheeling diagram happened over time and

was finalised at the end of the study. This has resulted in this area of the findings not being as data rich as the previous sections.

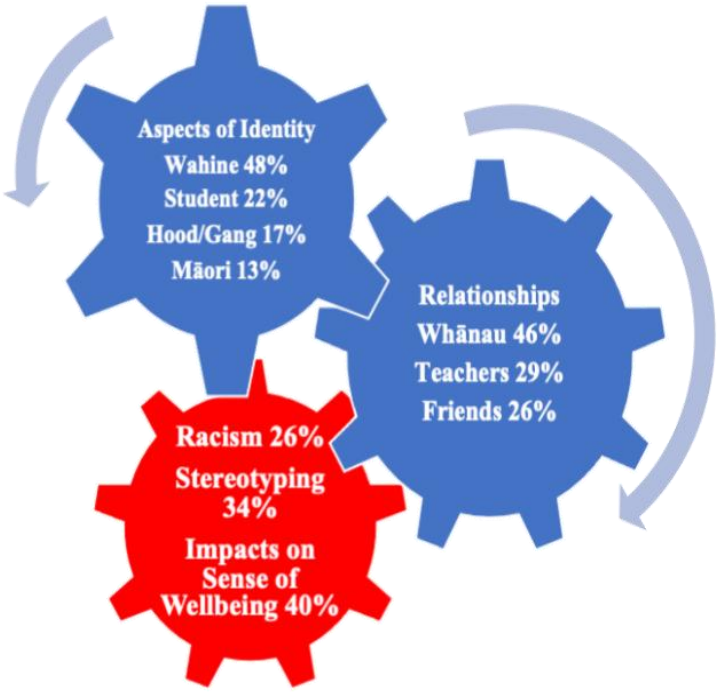
Towards the end of the study, when checking the data analysis for the lived experience's themes, I realised these stories were also interconnected and that using a cogwheel diagram could be a suitable representational approach. Using cogwheels was helpful as it depicted how the interplay between Identity, Relationships and Experiencing Discrimination happens in unison, are interconnected and create a unique intersectional experience. As one cogwheel turns, so do the others. At the final discussion group (number 6), I brought the cogwheel diagrams to the interview, but it was only attended by two of the Story Sharers, Kōwhai and Manuka. Both Story Sharers agreed that it depicted their stories. The final discussion group meeting (number 6) discussions regarding the intersectional Cogwheels of Being are presented next.

5.4.1 Intersectionality and The Cogwheels of Being

The final discussion group meeting at the end of 2019 was an opportunity to present the intersectional cogwheels of being, gain feedback on the interpretation and enable the Story Sharers to reflect upon previous responses. Although I previously introduced cogwheel diagrams to visualise their interpreted data of aspects of identity, relationships and events of discrimination, this was the first time they had been presented with how the cogwheels interact as a unique intersectional whole. Explaining, the interconnected cogwheels that represent 'learning is hard' are shaded in red and depict how discriminatory events are interlinked and do not happen in isolation from the lived experiences of the Story Sharers, which are also interwoven. The interconnected lived experiences cogwheels create the opportunity for an identity behaviour response, but when the discriminatory events occur, they disrupt the synchronicity and 'block' learning uniquely for each Story Sharer. These are the challenges to studying STEM which are intersectional. The interplay between the cogwheels is depicted in figure 5.12.

Figure 5.12

Intersectional Cogwheels of Being for the Story Sharers



Next, I illustrate how Kōwhai reacted to and reflected on her cogwheel diagram. Unfortunately, Harakeke was not present at the last discussion group (number 6), and I was not able to share her cogwheel diagram with her. However, it has been included to show the variation of intersectional narrative and exemplify how each Story Sharer has a unique experience.

Kōwhai and Intersectional Cogwheels of Being

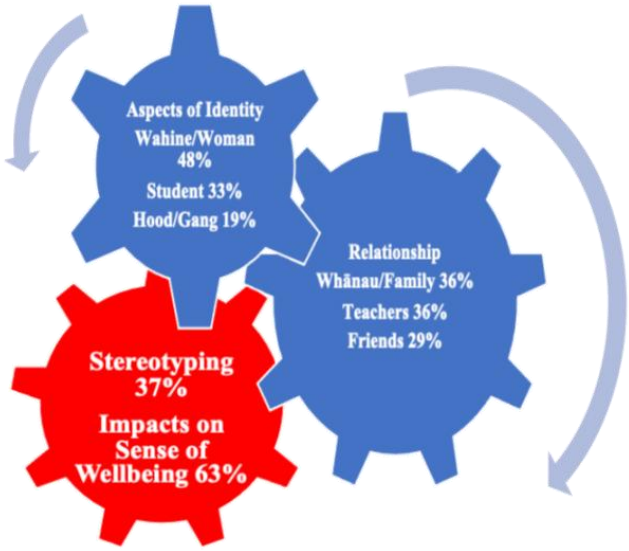
During discussion group interview 6, I introduced the cogwheels diagram to Kōwhai as a conceptual tool to interpret her narrative. I explained that the blue cogwheels represented the interrelated themes of relationships and aspects of identity. These cogwheels illustrated how identity is not static but relationally constructed shaped and reshaped through interactions with others. For example, Kōwhai described behaving as ‘gang’ when with her friends, and as a ‘student’ when with her teachers. These shifts in behaviour reflected the fluid and

context-dependent nature of her identity, influenced by the relational environments she navigated.

I then explained that the red cogwheels symbolised experiences of discrimination, including stereotyping and its impact on her sense of wellbeing. These red cogwheels disrupted the alignment between identity and relationships, creating misalignments that interfered with her ability to maintain positive behavioural patterns. The cogwheels metaphor thus represented the unique intersectional experiences for Kōwhai, as depicted in Figure 5.13.

Figure 5.13

Intersectional Cogwheels of Being for Kōwhai



To further clarify the diagram's relevance, I used an example to demonstrate how the cogwheels depicted her narrative. I described how aspects of her identity could be both supported and challenged by her relationships. When the cogwheels aligned such as when she enacted student behaviours and received affirming responses from her teachers reciprocal positive feedback enhanced her wellbeing and supported her academic success. This alignment also provided a secure foundation from which she could explore and affirm other aspects of her identity, including being Māori.

In contrast, when discrimination occurred, the red cogwheels caused misalignment. Kōwhai's stories revealed that she felt most comfortable with her friends in the hood, many of whom attended the same school. When she experienced discrimination, her wellbeing was compromised, prompting her to seek support from her 'homies'. This shift often involved a behavioural and identity transition from 'student' to 'gang', initiating a cycle of negativity. Within this cycle, Kōwhai internalised gang-related stereotypes, which led to feelings of moral conflict and a belief that she could not be 'nice'. These internalised perceptions further strained her relationships with teachers and whānau, exemplifying how the red cogwheels disrupted identity formation and relational dynamics, ultimately impeding her learning.

I asked Kōwhai whether she felt I had interpreted her narrative accurately. She nodded in agreement and responded, "It is Miss, it's not may, it is." This moment confirmed that the cogwheels metaphor resonated with her and provided a meaningful framework for understanding the complex interplay between identity, relationships, discrimination, and learning.

This interpretive exchange laid the foundation for broader reflections within the group including reflecting on their experiences, acknowledging how they were beginning to challenge the influence of stereotypes on their self-perceptions.

Harakeke and Intersectional Cogwheels of Being

During discussion group 6, where the intersectional cogwheels framework was presented to Manuka and Kōwhai, I also developed a cogwheels diagram to interpret Harakeke's narrative. Although I was unable to check this framework directly with her due to her departure from school in Term 2, 2019, shortly after the dissolution of the Alternative Programme and STEM class Harakeke had previously engaged with and affirmed the cogwheel analyses discussed in earlier interviews (Groups 3, 4, and 5). Figure 5.14 depicts the intersectional cogwheels of being for Harakeke.

Figure 5.14

Intersectional Cogwheels of Being for Harakeke.

Harakeke's cogwheels illustrate the intersection of her identity as a Māori wahine student and the relational influences of whānau, teachers, and peers. Her strong connection to her Māori identity was evident in her fluency in te reo Māori and her cultural engagement. She was recognised as a 'good student' due to her consistent attendance, although this was contrasted by underperformance in her e-asTTle assessments. The red cogwheels representing discriminatory events such as racism and stereotyping interacted with her identity cogwheels in ways that disrupted her sense of self. When subjected to deficit discourses, Harakeke internalised these messages, leading her to suppress expressions of her Māori identity for fear of being perceived as 'dumb'.

Unlike Kōwhai, Harakeke did not navigate a gang identity or maintain close ties with gang-affiliated peers. Instead, her response to discrimination was to disengage from school by 'wagging' classes and retreating to the safety of her whānau. Over the course of the study, however, Harakeke began to reclaim and express her Māori identity more openly. This was evidenced by her increasing participation in Kapa Haka and other cultural activities, signalling a shift toward feeling safe to be Māori within the school context.

Harakeke's narrative highlights the long-term impact of systemic racism and stereotyping within education and the time it takes for Māori students to feel safe enough to bring their full selves into learning spaces. Her cogwheels demonstrate how identity, relationships, and experiences of discrimination intersect to either enable or obstruct learning. When the cogwheels were in synchronicity free from the interference of red cogwheels, Harakeke was able to navigate learning more effectively.

This framework offers a lens through which to understand intersectionality in practice. Harakeke's experience underscores how multiple dimensions of identity (ethnicity, gender, learner status) interact with structural forces (racism, stereotyping) and relational contexts (whānau, teachers, peers). The cogwheels metaphor makes visible the complexity of these intersections and the conditions required for positive identity development and educational engagement.

5.5 Chapter Five Summary

Chapter Five presented findings in response to the second research question: What challenges did the Story Sharers report in studying STEM within an English-medium high school? The data revealed a complex and deeply interconnected picture, where lived experiences, discriminatory events, and impacts on wellbeing were tightly woven together.

The narratives shared by the Story Sharers exposed the profoundly harmful effects of discrimination. These effects extended beyond the classroom, manifesting as barriers to learning, diminished school belonging, disrupted identity development, reduced self-confidence, and strained relationships with whānau, teachers, and peers. Importantly, discriminatory experiences were not confined to the school environment. The Story Sharers also described witnessing racism and stereotyping directed at their whānau in workplaces and community settings. These intergenerational experiences contributed to a broader sense of injustice and reinforced internalised deficit discourses. Tropes such as Māori being 'dumb', wahine needing to 'work harder' and Māori wahine being 'untrustworthy' were not only experienced personally but observed systemically.

While the Story Sharers clearly articulated their experiences of discrimination, they did not always identify the structural conditions that compounded their intersectional realities. For

instance, Harakeke's narrative revealed how school structures failed to recognise and validate Māori ways of knowing. Despite her strong Māori identity and fluency in te reo Māori, she was unable to demonstrate academic knowledge through culturally relevant frameworks, such as connecting mathematics with weaving. The requirement to complete external exams to gain University Entrance and access STEM pathways further compounded these challenges. All the Story Sharers ultimately rejected participation in external exams, a response shaped by internalised deficit discourses and academic underperformance.

Although socioeconomic disadvantage was not explicitly named as a barrier, glimpses of its impact emerged. Both Kōwhai and Harakeke described moments where economic hardship affected their relationships and educational engagement, suggesting that material conditions were part of their broader intersectional experience.

The intersectional cogwheels diagram was developed to represent the dynamic and interwoven nature of these challenges. It illustrates how multiple aspects of identity (e.g., being Māori, being wahine, being a student), relationships (e.g., with whānau, teachers, peers), and experiences of discrimination interact in complex ways. The cogwheels framework makes visible how these elements can reinforce one another either positively, when in alignment, or negatively, when disrupted by discrimination.

When the cogwheels are in synchronicity, they generate reinforcing cycles of wellbeing, identity affirmation, and academic engagement. However, when discrimination (represented by red cogwheels) interferes, misalignment occurs. This misalignment leads to detrimental outcomes: disengagement from learning, strained relationships, diminished wellbeing, and academic underperformance. These outcomes, in turn, reinforce negative stereotypes and create conditions for identity conflict, where the student identity becomes incompatible with other aspects of self.

Although common themes emerged across the Story Sharers' narratives, the cogwheels framework also revealed the individualised nature of intersectional experience. Kōwhai and Harakeke's responses exemplify this diversity. Kōwhai navigated a gang identity alongside her student identity, shifting between relational contexts in the hood and at school. Harakeke, by contrast, withdrew from school and sought refuge in whānau when faced with racism, gradually reclaiming her Māori identity through cultural participation. These distinct

responses underscore the importance of an intersectional lens not only to identify overlapping systems of oppression but to understand how they manifest uniquely in each learner's life.

By applying an intersectional approach, this study demonstrates that educational challenges are not simply additive but emerge from the interplay of multiple, interwoven experiences which include personal, relational, structural and intergenerational dimensions. The cogwheels metaphor provides a powerful visual and conceptual tool for understanding how identity, relationships and discrimination interact to shape the conditions for learning, belonging and success in STEM education.

Chapter 6 Discussion and Conclusions

6.1 Introduction

This chapter is focused on discussing the study findings concerning the research questions, including the overarching research aim of understanding how to encourage more Māori wāhine to study STEM subjects.

A review of previous research, as presented in Chapter Two, offers theoretical support for exploring how Māori wāhine experience STEM education and the challenges they encounter. Literature also suggests the challenges encountered by Māori wāhine could be intersectional. The study findings were presented in two chapters: Chapter 4 examined the how the young Māori wāhine experienced a interdisciplinary project-based STEM education class I taught, and Chapter 5 examined and reported on the intersectional challenges they experienced when trying to succeed in STEM. Findings were developed using narrative analysis and an intersectional lens.

The following discussion centres on the guiding research questions in Section 6.2 and Section 6.3 and is focused on the prominent themes. Subsequently, the conclusions and implications of this research for educators, policymakers and researchers are outlined.

6.2 The Experiences of Māori wāhine Studying STEM

This section concerns findings from Chapter 4 which presented data on how the Māori wāhine Story Sharers' in my study experienced the STEM class, which included their perceptions of the pedagogical approach, the academic outcomes and the importance of relationships with their teachers and other students.

6.2.1 Pedagogical Approach and Academic Outcomes of the STEM Class

The Story Sharers' perceptions indicated three themes related to the pedagogical learning approach of the STEM class: type of work (section 4.3.3), work completion (4.3.2), and structure (4.3.4). Outcomes from this section of the study demonstrate similarity to those established in the literature, further supporting the idea that project-based integrated STEM programmes can improve student attitudes towards learning, boost motivation for STEM, and

improve school outcomes (Hiğde & Aktamış, 2022). The Story Sharers discussed their preference for a project-based, problem-solving pedagogical approach compared to their previous traditional science class instruction. They commented about this learning style, saying it was "way better than before." Like the outcomes in the study by Chang and Cheng (2023), the students recounted their enjoyment of this type of learning, that the project work was 'easy,' how they were motivated by completing project work and that they were 'proud' of the finished products.

Studies in the USA have shown that students who learn in a project-based learning environment perform as well in standardised tests as those taught in traditional teaching settings (Craig & Marshall, 2019). Tracking and analysing the Story Sharers' NCEA credits, attendance and retention data demonstrated improved school performance compared to their year 10 results (section 4.2.3). Having previously underperformed in their year 10 e-asTTle exams, and with attendance rates below expected standards, the Story Sharers had been identified as a group requiring extra support during their year 11 National Certificate of Educational Achievement (NCEA) Level 1. Most Story Sharers progressed to achieving the NCEA Level 1 Literacy and Numeracy requirements expected at their level, completed most of their STEM class NCEA achievement standards, and gained further NCEA Level 1 and 2 credits (see Table 4.2). Two Story Sharers completed two of their STEM NCEA internally assessed achievement standards at the Merit level, denoting the quality of their work. Complementing their academic achievement, the Story Sharers attended the STEM class more often than their other subjects and their previous science class (see Table 4.1). All the Story Sharers completed the school year and wanted to continue their STEM studies into the following years 12 and 13. This outcome aligns with studies that indicate project-based STEM programmes can improve students' attitudes towards learning and support retention in STEM (Hiğde & Aktamış, 2022).

An earlier study, conducted in Aotearoa New Zealand, suggests that an extended learning period can create the opportunity to transform learning compared to approaches within a traditional, shorter mixed-subject timetable (Hipkins, 2008; Hipkins et al., 2008). To provide the opportunity to complete complex authentic projects, the STEM class was timetabled for an extended learning period, which consisted of one 55-minute session as the last lesson on a Tuesday and four consecutive 55-minute sessions on Wednesday (section 3.5.1). The Story Sharers said that they preferred this extended learning structure using words such as 'cool.'

When compared to the traditional 55-minture lessons with five different subjects, an extended learning period created a less hectic day, and alleviated the pressure they had felt when they had not completed work from previous classes (Zepeda & Mayers, 2006). The result was they could focus on tasks and complete their work. However, all the Story Sharers agreed that this extended learning period was acceptable for the STEM class but not for other subjects, especially those taught using traditional instruction. The students took a responsible approach to co-constructing their extended learning time to maximise completion of their projects.

Whilst the Story Sharers preferred the extended learning period, the STEM project-based class remained within the interdisciplinary field. Students coordinated contributions from science, technology/engineering, and mathematics while keeping disciplinary threads visible. Although project work encouraged integrative thinking, meeting the requisites for NCEA achievement standards required explicit articulation of subject-specific knowledge, reinforcing disciplinary boundaries. This is consistent with literature indicating that sustaining fully transdisciplinary STEM in secondary classrooms is difficult (Anderson et al., 2022; Chowdhury et al., 2024; Deehan et al., 2024; Diego-Mantecón et al., 2021; Vasquez, 2015).

Studies document high school teachers who move from traditional teaching to project-based learning are concerned about ensuring students can fulfil assessment requirements (Margot & Kettler, 2019). These findings come primarily from schooling systems in the USA utilising standardised testing. In contrast, the flexible, internally assessed NCEA system enabled the students to gain NCEA credits whilst completing project work. However, in discussion group 1, the Story Sharers could not identify their STEM classes as including traditional science, as evidenced when they all agreed the only improvement to the STEM programme would be "more [traditional science] experiments." This outcome is similar to studies which have documented that students learning integrated content can find difficulty discerning the connections within and across subjects (English, 2016). Whilst the Story Sharers completed authentic STEM projects, an essential provision was ensuring the completion of NCEA achievement standards. The traditional single-subject assessment requirements demonstrate the need to explicitly link projects to subjects within STEM and any assessment requisites.

Whilst studies indicate teachers need resourcing to implement project-based learning (Margot & Kettler, 2019), the Ministry of Education's TKI website (Ministry of Education, 2023b)

included helpful advice on various methods students can use to demonstrate their knowledge of internally-assessed standards. This support meant that internally assessed NCEA achievement standards were more accessible to providing an authentic, interdisciplinary STEM pedagogical experience. However, the requirement that the Story Sharers explicitly articulate the science content within their STEM projects to fit with the NCEA achievement standards adds to literature that questions whether traditional knowledge and assessment requirements can be an inhibitor to interdisciplinary STEM becoming a new paradigm (English, 2016).

6.2.2 STEM Class Improving Relationships

A key finding of the Story Sharers' experience in the STEM class was their reports of improved student–student and student–teacher relationships. The student–student relationships were described with similar words used for denoting friends and whānau (family). A key component to improving student–student relationships was the whānau format of the class. Developing positive student–teacher relationships was centred around recognising the role of teacher support and included comments such as "[the teacher] is interested in us learning."

Student- Student Relationships

Project-based learning can improve students' interpersonal and intrapersonal skills, which is brought about by the collaborative nature of this style of pedagogy (Chang & Chen, 2023; Tsybulsky & Sinai, 2022). Improving these skills can enhance student–student relationships (Alves et al., 2019; Hugerat, 2016). In my STEM class, the use of co-construction and a whānau approach were central to fostering an environment of cooperation, support, and collective responsibility. The Story Sharers described their peer relationships using language associated with friendship and whānau, repeatedly stating that they had "bonded better by being in the STEM class." For many, their most valued achievement was "making friends," and they attributed this to the collaborative, whānau-based structure of the class. These findings add to studies that suggest Māori learners prefer a relational learning environment (Berryman et al., 2023). While previous research has often focused on academically high-achieving Māori students being motivated by working with their peers, my findings suggest this may be an outcome that translates to all Māori students (Adams, 2018).

The collaborative, whānau-based structure and co-construction of learning routines meant that students were not only working together on projects but also shaping the way the class functioned. This fostered a sense of belonging and mutual support and allowed students to develop both intra- and inter-personal skills. The Story Sharers' sense of belonging was evident in their reflections on the class environment, with comments such as "we've bonded better by being in here" being cited as their most important achievements. These outcomes align with research showing that when students are given agency and responsibility within a supportive, culturally grounded environment, they are more likely to develop strong interpersonal relationships and a sense of collective agency (Banks & Barlex, 2020; Kennedy & Odell, 2014).

A further dimension that emerged is that relational thinking, the ability to make meaningful connections among concepts, people, and contexts was a natural by-product of these approaches (Bybee, 2015; Banks & Barlex, 2020). In the STEM class, students engaged in authentic, collaborative tasks that required them to integrate knowledge across disciplines and work together to solve real-world problems. This process not only fostered cognitive growth but also deepened social bonds, as students described how working collectively on projects led to a sense of mutual support and belonging. Meta-analytic evidence further supports these connections: project-based approaches significantly improve academic achievement and higher-order thinking skills, particularly when implemented in small groups and over extended periods (Zhang & Ma, 2023). The findings extend this literature by showing that, for Māori wāhine, these cognitive gains were inseparable from the strengthening of peer relationships and the development of both intra- and inter-personal skills. The Story Sharers repeatedly emphasised that their most valued achievements were "making friends" and "bonding better by being in the STEM class," highlighting how the collaborative, relational environment, grounded in co-construction and whānau approaches was especially effective for Māori learners. This collaborative environment was consistent with culturally grounded pedagogies that emphasise collective responsibility, reciprocity, and support (Highfield & Webber, 2021). Within this context, the integration of relational thinking in project-based STEM appeared to support both academic and social outcomes, as evidenced by the Story Sharers' reflections on strengthened peer relationships and sense of belonging.

Student–Teacher Relationships

The Story Sharers identified the learning approaches within the STEM class as facilitating improved student–teacher relationships. They consistently described teacher support, trust, and understanding as critical to their engagement and achievement, with comments such as "[the teacher] is interested in us learning." When I asked why they liked the project work in the STEM room, Kauri added, "You understand how we work," reflecting how recognition of their collaborative approaches and learning preferences contributed to a sense of being seen and valued. These findings are strongly supported by the literature on relational pedagogy and culturally responsive teaching, which demonstrates that when teachers build trust, model fairness, and understand students' circumstances, learners experience greater engagement, improved behaviour, and higher academic achievement (Berryman et al., 2023; Bishop, 2019; Highfield & Webber, 2021).

These findings not only reinforce established literature on the importance of relational pedagogy and project-based learning for Māori learners (Berryman et al., 2023; Bishop, 2019; Highfield & Webber, 2021), but also extend it by demonstrating how the intersection of relational thinking and relational pedagogy in a project-based STEM context can transform student–teacher relationships for learners who have previously been underserved by traditional approaches. The Story Sharers described how teachers' recognition of their collaborative learning preferences, enacted through co-construction and whānau-based routines, contributed to a deeper sense of being understood. This understanding was not limited to emotional support but was reflected in shared agency and mutual respect in shaping learning routines and project work. Their narratives highlighted the impact of teachers actively engaging with students' preferred ways of learning, fostering enhanced trust, engagement, and a stronger sense of belonging within the learning community. This provides extra evidence that the synergy between relational thinking and relational pedagogy can foster positive, enduring student–teacher relationships that support both academic and personal growth for Māori wāhine.

However, a key nuance in this research is that the relational dynamic was not limited to emotional support but extended through the co-construction of learning routines and project work. This is consistent with research from *Te Kotahitanga* and *Kia Eke Panuku*, which emphasises that high expectations and dialogic, co-constructed learning are essential for

Māori student success (Berryman et al., 2023; Bishop, 2019). The Story Sharers' experiences reinforce that when students feel their teachers "understand how we work," they are more likely to engage, persist, and achieve.

Importantly, the improvement in student–teacher relationships was closely linked to the Story Sharers' sense of wellbeing. For example, Manuka said, "I really like teachers supporting me," and added, "It makes me feel better." Other Story Sharers also described how positive relationships with teachers and feeling supported contributed to their motivation and engagement. These outcomes are echoed in the literature, which shows that project-based learning fosters wellbeing by embedding social and emotional processes such as collaboration, argumentation, and shared problem-solving (Banks & Barlex, 2020; Kennedy & Odell, 2014).

The improvements in relationships, the development of intra- and inter-personal skills, and the enhancement of wellbeing were not isolated outcomes, but closely tied to the pedagogical design of the STEM class. These relational outcomes were deeply interconnected with the wider approach of the class, shaping not only how students experienced learning but also their engagement and persistence. As the next section discusses, these elements did not operate in isolation, but as part of a wider, interconnected system that underpinned the success of the STEM class for Māori wāhine.

6.2.3 The STEM Class Pedagogical Approach is Interconnected.

Project-based learning, when aligned with co-construction and whānau learning approaches, enabled the Story Sharers to build and develop their own knowledge while exercising agency over their working relationships within the classroom. The whānau format, commonly used in Aotearoa New Zealand to strengthen student–teacher relationships, appeared to have an additive effect when combined with project-based learning. In this context, it not only supported teacher–student interactions but also significantly enhanced peer relationships.

The Story Sharers' experiences indicated that extended learning time (structure, 18%), collaborative group work (type of work, 27%), and collective responsibility for task completion (work completion, 25%) all contributed to improved student–student and student–teacher relationships (relationships, 30%). These elements were not experienced in isolation;

rather, they operated as a cohesive pedagogical system. The interconnected nature of these components is exemplified by the percentage data and visually represented in Figure 6.1.

Figure 6.1

Interconnected Cogwheels of the STEM Class Pedagogical Approach

In keeping with the style of this study, cogwheels are used to illustrate how the Story Sharers' preferences for various aspects of the STEM project-based pedagogical approach were interdependent. As each element of the pedagogy was implemented, it reinforced the others, functioning in unison. Depending on the learning context, a different cogwheel may act as the primary driver for example, relationships may be the dominant force, but its effectiveness depends on the presence and integration of the other components. If one cogwheel is absent or underdeveloped, the overall pedagogical impact is diminished.

In summary, this study demonstrates that project-based STEM education, underpinned by co-construction and whānau learning approaches, contributed to improved attendance, retention, and academic performance among the young Māori wāhine who participated. However, the most significant success marker identified by the Story Sharers was the development of student–student relationships, which often evolved into friendships and became central to their engagement and persistence.

The four pedagogical components; structure, type of work, work completion and relationships, functioned as an holistic system. Their interconnectedness reflects not only a relational pedagogy but also a form of relational thinking, where learning is understood through the connections between people, ideas, and contexts. For students unfamiliar with this mode of learning, support frameworks were essential to help them navigate and make sense of the interdisciplinary nature of STEM education. Moreover, the findings suggest that these pedagogical elements are closely linked to broader social and cultural dimensions including identity, wellbeing and systemic barriers, underscoring the importance of designing inclusive and equitable learning environments that are responsive to the diverse needs and lived realities of learners.

6.3 The Challenges to Succeeding in STEM are Intersectional

6.3.1 Introduction

This section discusses the findings presented in Chapter Five and is focused on the Story Sharers' narratives when talking about the challenges to succeeding in STEM. The first theme in this section focused on how the Story Sharers experienced discrimination and its impact on their Sense of Wellbeing (section 5.1). The second is focused on lived experiences (section 5.2) and discusses aspects of the Story Sharers' identity and relationships. The third brings together discrimination, wellbeing and lived experiences to discuss the intersectional nature of the challenges to the Story Sharers' succeeding in the STEM class (section 5.3). A final section discusses how socioeconomic inequality is an unspecified challenge within the Story Sharers' developing intersectional narrative.

6.3.2 Experiencing Discrimination

The Story Sharers discussed two distinct experiences of discrimination: Racism (section 5.1.2) and Stereotyping (section 5.1.3). Studies demonstrate that Māori experience

discrimination every day, and it is mainly Māori wāhine who are increasingly experiencing racial discrimination (Smith et al., 2021). The findings of this study are synonymous with the Story Sharers describing daily encounters with racial discrimination and prejudice. Discriminatory events occurred at school, in their community and online through social media platforms and websites. The Story Sharers said that because they were Māori, they were "judged" and they described events that included being told they had to wait to enter shops, being followed once inside, and having their pockets checked when trying to leave. The pervasive nature of experiencing racism was strikingly relayed by Kōwhai. Having not identified racism as a 'blocker' to her learning in the final interview, she accounted for this omission by stating that she did not identify it because it had become 'normal' to her. Studies suggest that over time Māori have become likelier to call out discriminatory events than in the past (Smith et al., 2021), but none of the Story Sharers described doing this. Alongside the Story Sharers discussing their own experiences of discrimination, they also talked about how they had witnessed whānau who were Māori wāhine experiencing prejudice at their places of work, including being abused by their boss and not being believed. They also spoke of the historical discrimination experienced by Māori whānau who had been punished for speaking te reo Māori and noting the intergenerational trauma this had caused.

Experiencing racism and stereotyping were given as reasons for what made 'learning hard,' or 'blocked' learning, and as a factor in why Māori wāhine would not choose STEM subjects. For example, Kauri said that Māori wāhine were told "They ain't good enough" and that people "Think you can't do it." Like other Māori narratives which document experiencing low expectations from their teachers (Bishop, 2011, 2019), the Story Sharers discussed their experiences of discrimination within the school system. For example, Rata and Manuka gave an account of how a teacher had told them "They're always going to fail." This was in response to them not bringing the correct stationery equipment to school.

Seeking an escape from discrimination, many Māori report finding solace with their whānau and other Māori protected spaces such as the marae (Smith et al., 2021). This finding is corroborated by the Story Sharers, who often sought solace with whānau and friends. They also reported feeling safer in their community and at school due to the demographics.

At the end of the study a reflection by Kōwhai described the deep consequences of experiencing discrimination when she stated that these events had made her 'not trust white

people' creating an extra layer of difficulty in forming relationships with her predominantly "white" teachers. This reflection coincided with an that indication there was a change in her social context, understanding the negative impacts of stereotypes. She continued to add that she was questioning this viewpoint as she had met 'some nice white people'.

6.3.3 Impacts on Sense of Wellbeing

It has been documented that people who experience discrimination report detrimental impacts on their physical, mental and emotional wellbeing (Roy et al., 2023; Tinner et al., 2023). Similarly, the Story Sharers discussed the impact discrimination had on their Sense of Wellbeing (section 5.1.4) and how this 'blocked' their learning. Whilst the Story Sharers could describe the positive effects the outcomes of the STEM class had on their Sense of Wellbeing, describing aspects and outcomes that made them feel 'proud' or feel 'better', they also discussed how discrimination made them feel sad and angry. For example, Harakeke said racism made her feel "rubbish", whilst Rata said it was hard to concentrate at school when you feel "sad or suicidal". Sometimes, they used strong language to express the depth of their anger and sadness. This finding links with the outcomes denoted within the *Whakatika* survey of Māori respondents aged 16+ who also self-reported feeling angry and sad at experiencing discrimination (Smith et al., 2021). Overall, their lack of a sense of wellbeing pervaded our discussions and became a broader theme. This was especially true for the narrative that indicated that experiencing racism and stereotyping had been internalised and transformed into negative perceptions about themselves, their gender, race/ethnicity and their academic ability. For example, all the Story Sharers said they believed they had been entered into the STEM class because they were 'dumb', and this was additive to an alignment with their perception that Māori were 'dumb' who go to 'dumb' schools.

The detrimental perceptions the Story Sharers held about themselves, and their academic ability contributed to a cycle of disengagement and avoidance, consistent with patterns observed in stereotype-linked academic anxiety (Zhou et al., 2025; Dhawan, 2024). Rather than simply fearing failure, the Story Sharers described a deeper emotional response to being judged not just as individuals, but as Māori wāhine within a system that often positioned them as academically inferior. This aligns with research showing that stereotype cues can erode perceived control and belonging, triggering anxiety that disrupts cognitive functioning and leads to avoidance behaviours, particularly in high-stakes assessment contexts (Dutt et

al., 2025; Watson et al., 2025). In this study, several Story Sharers chose not to sit their year 10 e-asTTle exams (Table 4.2), and later, despite successfully completing internally assessed NCEA achievement standards, all refused the opportunity to complete an interdisciplinary STEM project designed to prepare them for external exams. Their decision to avoid traditional exams, even when aware this could limit access to tertiary pathways, reflects how anxiety linked to stereotyping can manifest as strategic withdrawal from evaluative environments.

This finding adds nuance to the outcomes reported in the Starpath Project. While Starpath schools offered internally assessed courses to improve NCEA achievement, the unintended consequence was that Māori students, overrepresented in these pathways, were often excluded from externally assessed standards required for progression into science and university-level study (Buntting et al., 2016). In this study, the Story Sharers were also enrolled in a fully internally assessed course, but their avoidance of external exams was not simply structural, it was shaped by internalised discrimination and the emotional toll of stereotype-based anxiety. This highlights how the education system's reliance on external exams as gatekeepers to further study and career opportunities can compound barriers for students living at the intersection of ethnic, gendered, and socioeconomic marginalisation. For Māori wāhine, the pressure to perform in environments that do not affirm their identity or relational ways of knowing can trigger disengagement, even when academic capability is present.

These negative emotions and perceptions were creating a barrier to the Story Sharers perceptions about being able to succeed in STEM. The Story Sharers said that discrimination and the effect on their sense of wellbeing 'made learning hard.'

6.3.4 Lived Experiences

As the study progressed, the discussion group interviews increasingly reflected the characteristics of a counterspace, a culturally affirming environment where the Story Sharers could collectively resist microaggressions, challenge deficit-based narratives, and critically engage with dominant cultural discourses. These spaces fostered relational safety and solidarity, enabling the Story Sharers to validate one another's experiences and articulate counter-narratives grounded in their lived realities. (Gray et al., 2025; Ong et al., 2018;

Strayhorn, 2018). Whilst discussing their experiences of discrimination the Story Sharers narrative was interwoven with their lived experiences which included aspects of their identity (section 5.2.1) and relationships (section 5.2.2). Although these elements were not identified by the Story Sharers as blocking their learning, they have been included in the challenges to succeeding in STEM as they highlight the covert nature of discrimination, which can create another layer of hidden barriers and adding to the nature of the Story Sharers intersectional experience. Aspects of identity were described in response to questions based on the study theme and STEM class experience and therefore findings here are constrained to these parameters.

Aspects of Identity

The aspects of the Story Sharers' identity important for challenges to succeeding in the STEM class were being wahine (woman), Māori, student and gang. These descriptors were used interchangeably by each Story Sharer throughout the study. Indicating that the Story Sharers were navigating their identity development and the aspects of identity shared within the scope of this study were multiple (Harris & Leonardo, 2018; Settles & Buchanan, 2014). Although all the Story Sharers were registered as Māori, not all self-identified in this way. One Story Sharer did not use any identifiers as Māori; similarly, one Story Sharer did not use any identifiers as being gang.

When the Story Sharers described aspects of their Māori identity, there was a similar juxtaposition as reported in the *Whakatika* survey, whereby the positive enjoyment of cultural activities such as making poi or weaving were counterbalanced with experiences of racism, including how Māori are 'judged.' It was primarily the racism associated with their Māori identity that led the Story Sharers to believe they were 'dumb.' When the Story Sharers encountered deficit theorising by educators, particularly when associated with their academic underperformance in school tests, this perception of being 'dumb' was reinforced further (Bishop, 2011). The Story Sharers discussed how, when they were offered the opportunity to enrol into the Alternative Programme and STEM class, senior members of staff commented that the reason they were chosen was because they "hadn't planted themselves" into the school. Alongside reinforcing their academic underperformance and/or attendance rates these comments contributed to the negative perceptions the Story Sharers had about themselves.

Historically preconceived ideas regarding the relationship between “being bright” and Māori, especially speaking te reo Māori, continue to be reinforced through prejudicial tropes (McKinley, 2005; Simmonds, 2011; Smith et al., 2021). The perception that Māori are “dumb” had a multifaceted detrimental effect on the Story Sharers. For example, the school’s cultural expectations included the regular performance of Karakia (prayers) at the beginning of the school day and before the sharing of food. During assemblies, elements of tikanga Māori were embedded within the kaupapa, including school-wide kapa haka performances. These practices reflected an institutional commitment to integrating Māori cultural protocols into the daily rhythm of school life. This expectation was especially difficult for Harakeke, who was often stereotyped by school staff due to her te reo Māori fluency to lead cultural practices and she recounted the responsibility she felt to understand and perform Tikanga Māori. This stereotyping is similar to reports suggesting Māori are often required to participate or lead kaupapa Māori or Tikanga Māori practices in organisations and events regardless of their inherent knowledge (McAllister et al., 2022). However, Harakeke chose not to speak te reo Māori in class, fearing that doing so would make her visibly identifiable as Māori and subject to the stereotype of being ‘dumb.’ This perception risked reinforcing deficit narratives and created conditions for identity conflict, undermining the ‘good’ student identity she was striving to embody. The assumption that students who are Māori must be able to perform Tikanga added another layer of bias, especially for those uncomfortable presenting their Māori identity in this way (Hoskins & Jones, 2022). Although culturally appropriate pedagogy, such as utilising relationality through co-construction and whānau learning approaches, had positive outcomes for the Story Sharers, experiencing discrimination resulted in other aspects of cultural responsiveness creating a double jeopardy effect. Culturally responsive initiates assume that Māori learners want their cultural identity to be recognised, which can lead to ‘othering’ and stereotyping (Lourie, 2016). Students who feel ‘othered’ can have a poor sense of school belonging, resulting in a detrimental effect on their wellbeing and harm to their academic achievement (Jang, 2023). This was true for Harakeke who celebrated her Māori culture in the safety of her home, but at school, her desire to reduce stereotyping by becoming invisible and ‘blending in’ meant she did not want to be recognised for this aspect of her identity. Whilst the school wanted to be inclusive of Māori culture, the education system did not make Harakeke feel supported or safe to be Māori as there was no ability to recognise her Indigenous knowledge, adding another layer of prejudicial tropes of Māori not being “bright” (McKinley, 2005; Simmonds, 2011). This

finding further supports claims that the indigenisation of schools and curricula could alleviate this outcome (Hoskins & Jones, 2022).

Data suggests that historical colonising policies have hindered Indigenous women from reaching gender equality (Rorintulus et al., 2024). Within the workplace in Aotearoa New Zealand, Māori wāhine continue to be socioeconomically disadvantaged and have a perception of greater gender discrimination and report poorer work (job satisfaction) and wellbeing (job stress and anxiety) outcomes (Haar, 2023; Reilly, 2019). The Story Sharers were no exception and only discussed the negative aspects of being wāhine, acknowledging experiencing an additional layer of scrutiny. This scrutiny included being 'judged' for how they dressed, witnessing other whānau who were Māori wāhine being labelled as untrustworthy and a perception they would have to work harder to be viewed as equal to men. These discussions resulted in the Story Sharers saying one of the reasons they had an interest in STEM careers, particularly construction, was due to the opportunity to escape feminine stereotypes and become a "man girl." Literature suggests that young girls in school years 7 and 8 (ages 12 and 13) must do identity work to belong in science (Godec, 2018), and the Story Sharers reflected similar responses, denoting how they had to do identity work to fulfil their desire to work in STEM. However, the Story Sharers desired gender invisibility as it could provide a form of disidentification and provide an opportunity to distance themselves from feminine stereotypes; belonging in STEM was a conduit in which to achieve this outcome (Yip & Lee, 2016).

When the Story Sharers described themselves 'gang' it was due to their associations of elements of gang culture in their community or mixing with friends who would call themselves 'gang.' This identity descriptor was heavily overlayed with the impact of representational intersectionality. Representational intersectionality is one of the three intertwined pillars that creates the interlocking systems of power, privilege and discrimination (Collins & Bilge, 2016). For example, studies document that in Aotearoa New Zealand, media narratives of gangs and Māori communities are represented as overtly stereotypical, depicting violence and criminality (Barnes & McCreanor, 2023). Māori have responded to these stories by expressing how they invoke feelings of shame and anger (Barnes & McCreanor, 2023). Whilst the Story Sharers would discuss how their 'gang' friends were the cornerstone of their support networks, aiding them to navigate through difficult situations and sheltering them from discrimination, they only discussed the negative

aspects associated with gang identity when referencing themselves. For example, they all agreed when Kōwhai said, “You can’t be nice when your gang.”

The Story Sharers discussed the difficulties in navigating their student identity. While acknowledging understanding the behaviours required to be a ‘good’ student, such as attending class, wearing the correct uniform, bringing the correct stationery, passing exams, attending school and class on time, each Story Sharer could describe not fulfilling one or many of these categories and being ‘growled’ at by school staff. Exemplifying the impact of deficit theorizing by educators Rātā and Manuka discussed a story of a staff member telling them they “ain’t gonna amount to anything” because they had not brought a pencil to class (Bishop, 2011, 2019). Often, these stories were recited as the events that started the decline in their relationship with a staff member and a desire to not attend their classes and/or school. Studies suggest that to improve a student’s academic performance and wellbeing a school must foster a sense of belonging (Ahn & Davis, 2020; Jang, 2023; Paradies, 2006). These exchanges negatively affected the Story Sharers’ sense of belonging to the school, primarily when they denoted a sense of unfairness in their treatment for these misdemeanours. Alongside academically underperforming, these events reinforced the negative perceptions of themselves and created the conditions for identity conflict (Nielson et al., 2024; Settles & Buchanan, 2014).

As with other intersectional studies regarding identity, the Story Sharers’ identities were not fixed but multiple, with each identity element prioritised at various times (Harris & Leonardo, 2018). Being Wāhine, Māori, gang and student were each aspect of the Story Sharers’ intersectional identities that contributed to the challenges to succeed in the STEM class. The aspects of their identity shared at the time of this study indicate that their identity development was not a positive experience, as they were not self-confident and lacked a positive Sense of Wellbeing, including perceiving themselves as ‘dumb’ and ‘not nice’ (Shmulsky et al., 2021; Verhoeven et al., 2019). Aspects of the Story Sharers’ discussions suggest they may have been experiencing identity conflict. While adolescents are often aware of how they are positioned within social categories, such as ethnicity, gender, and learner status, they may lack the conceptual language or sociocultural understanding to articulate how these identities intersect and are shaped by broader social structures. Without a framework to interpret systemic influences such as racism, colonial legacies, and institutional norms, their experiences of marginalisation may be internalised rather than critically

examined, contributing to confusion, self-doubt, and identity tension. (Azmitia, Garcia Peraza, Thomas, et al., 2023).

Similarly, the Story Sharers recognised that aspects of their identity resulted in additional challenges and conveyed this with an additive approach, such as being Māori 'and' wāhine but were yet to convey how these identities combined to be uniquely intersectional. Also, from an intersectional perspective they could not identify the barriers to their success created within the schooling system which had a contributing effect on the perceptions of their ability. For example, the schooling system could not recognise knowledge achievement through alternatives to 'Western' traditional subjects. The result was that their academic underperformance maintained the internalisation of 'being dumb' when they had unrecognised skills and knowledge. For example, Harakeke could account for the maths required to create patterns within her weaving, but numeracy was only recognised through traditional subjects.

Relationships

Adolescent identity development is a phenomenological process requiring the processing of lived experiences as either a support or stressor (Moffitt et al., 2020). As well as environmental considerations, self-identity formation includes the interactions and contexts within relationships such as with family and friends (Branje et al., 2021). The Story Sharers also discussed their intertwined relationships of whānau, teachers and friends within the context and interactions of their identity development as Māori, wāhine, student and gang.

The Story Sharers emphasised the strong bond they had with their whānau and, as in other studies, described how whānau motivated them to succeed (Adams, 2018). For example, Kōwhai said it was her Mum who "made her get out of bed in the morning" and Harakeke said that whānau "unblocked" the barriers to learning. The Story Sharers who strongly self-identified as Māori reported that intergenerational whānau support equipped them with skills and knowledge to embrace their Māori identity. Whānau role models were a strong motivator for the Story Sharers, and they expressed a desire to be a role model themselves. However, the Story Sharers expressed similar concerns as the study by Rolleston et al (2022), that technology had become a whānau disruptor which made it difficult for them to achieve their role modelling goal. For example, discussing how role modelling was the passing of

"knowledge" from "older to younger" Kōwhai shared her childhood experiences of playing outside and interacting through play and games with whānau, but she was unsure how to role model when whānau wanted to play computer games. Kōwhai discussed how the traditions of the eldest role modelling behaviours through play to the youngest had been disrupted and "killed by the wi-fi." The theme of role modelling for whānau also overlapped with other relationships, as Kōwhai was keen to be a role model for her friends, especially regarding being a 'good' student.

Like the self-report data in the *Whakatika* survey (Smith et al., 2021), friends were vital in providing a safe space and support when the Story Sharers experienced discrimination. Friends were often given whānau descriptions such as cousin or sister. However, the Story Sharers also described how their friends could encourage them to break the school rules. These events often harmed their relationships with their teachers, the school and their whānau. Kōwhai explained, "School was bad when all your homies are around." However, the Story Sharers considered their main accomplishment in the STEM class was making friends, and this was especially important as a descriptor for their classmates. Alongside literature which documents the positive academic outcomes that relational teaching can achieve, studies also suggest adolescents who have high-quality relationships with one best friend and can interconnect the identification of classmates as friends have characteristics of a well-adjusted identity development narrative (Albarello et al., 2018; Bishop, 2019; de Moor et al., 2019). This raises the possibility that the STEM class project-based pedagogical approach utilising relationality in the form of co-constructing and the whānau format was a potential contributor to supporting the Story Sharers' identity development by providing the opportunity to create friendships through improved student-student relationships.

It has been acknowledged by the Office of the Auditor General in Aotearoa New Zealand, that there is a complex history for Māori within the education system (Auditor General, 2023). Sustained academic underachievement has led to deficit theorising regarding Māori academic outcomes rather than questions regarding historical education policies and system approaches (Auditor General, 2023; Bishop, 2011; Bishop et al., 2009). To improve the student-teacher relationships and eradicate deficit theorising, education policies to culturally reform the education system included the introduction of the *Te Kotahitanga* and *Kia Eke Panuku* culturally responsive programmes (Berryman & Eley, 2017; Bishop, 2019; Bishop et

al., 2009; Kia Eke Panuku, 2023). A key tenet of these culturally responsive programmes is relationality as good student-teacher relationships have been documented as essential to Māori students' academic success (Webber & Macfarlane, 2020). Likewise, the Story Sharers could describe how relationships with their teachers could be both a motivator and a blocker to their learning. Poor student-teacher relationships led to detrimental student behaviours whilst good relationships could lead to self-reinforcing positive cycles which made them feel 'better.' All the Story Sharers agreed that being treated fairly was important to student-teacher relationships, having all recited stories of perceiving unfair treatment in relation to matters such as being reprimanded in front of the class for being late which made them 'stand out.' Being made to feel as if they 'stood out' was an insightful reflection by the Story Sharers regarding the difficulties they had experienced in forming good relationships with their teachers. These comments were made towards the end of the study when there was acknowledgement that their experiences of discrimination had resulted in them trying to hide, disidentify, or make invisible aspects of their identities. For this reason, 'standing out' in front of the class simultaneously with being reprimanded created a double jeopardy, impacting their ability to form relationships with their teachers and contributing to detrimental student behaviours such as 'wagging' class. Other aspects to improve student-teacher relationships included being trustworthy such as providing promised learning opportunities and role modelling expected behaviours.

In summary, all the relationships the Story Sharers described were intertwined, providing them with inspiration, motivation, challenges and safe spaces from micro- and macroaggressions. It would be crucial to consider how a project-based interdisciplinary STEM initiative could be extended to include enhancing relationships with whānau, such as showcasing projects (Larmer et al., 2017).

Socioeconomic Disadvantage

One area of intersectional discrimination describes belonging to a socioeconomically disadvantaged group (Stewart, 2023). Although the Story Sharers attended a low decile (section 1.2) school, were on the school's financial hardship register, and often as their teacher I had insight into situations caused by socioeconomic disadvantage, they did not identify socioeconomic factors as something that 'made learning hard.' However, there were glimpses of the difficulties the Story Sharers experienced due to socioeconomic disadvantage.

For example, Kōwhai shared a story recounting a conversation with her caregiver regarding her priorities when she had to choose between 'money and her Mum.' Harakeke described upsetting her family when she had been involved in the theft of a cell phone. Her sibling had to remind her she would have to 'work hard' for such treats. There was only one other account in which the Story Sharers mentioned socioeconomics within discussion group 5. When asked if they could change anything to improve their school experience, Manuka replied, "Make school free." This reply concerned the cost of uniforms, books, computers and other school necessities. The Story Sharers were often without these school items, which were given as a reason as to why they had been reprimanded by a teacher. As these examples describe, sometimes socioeconomic factors created tension within their relationships which were pivotal within their identity development and providing a sense of belonging. However, socioeconomics was not identified as a challenge by the Story Sharers, and there was inadequate content to create a theme from the narrative, meaning it was omitted from the cogwheel diagrams (Section 3.7.4). Reasons for this omission could be due to similarities in the study by Azmitia et al (2023), who discuss how some adolescents cannot account for their intersectional identities within structural inequalities. It could also be argued socioeconomics was not identified in a similar way that Kōwhai did not identify racism, in that it was considered 'normal' by the Story Sharers.

6.3.5 Living an Intersectional Life

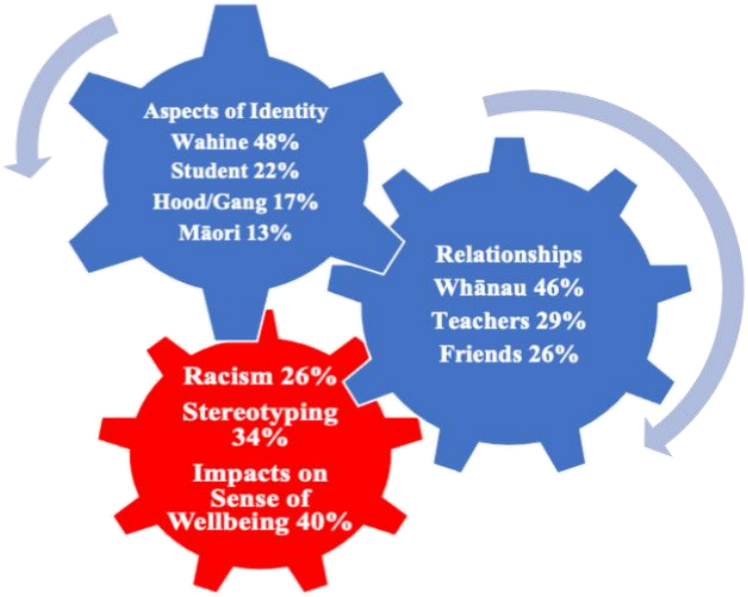
This final section pulls together the Story Sharers' intersectional narratives about the interplay between their identities, relationships and how these interacted with and were disrupted by discriminatory events. This critical aspect of the findings data developed over the course of the discussions.

Discrimination occurs when a person is mistreated compared to others due to a personal characteristic such as race, gender, or age (Collins & Bilge, 2016). Crenshaw (1989) used intersectionality to explain how people experience discrimination and oppression at intersections. For this study the Story Sharers inhabited multiple identity factors that could be understood within an intersectional framework, for example being Māori, Indigenous, wāhine (woman), young (age) and socioeconomically disadvantaged. To explain the unique relationality of the intersectional identity experiences I drew upon Collins (2019) notion of using an additive framework (section 2.4.6). The Story Sharers discussed and agreed upon

my interpretation of this relationality between their multiple identities, multiple group membership and experiences of discrimination as it was represented in the cogwheels diagram Figure 6.2 (reproduced from Figure 5.12). The cogwheels depict how the Story Sharers' intersectional lived experiences interconnect with discriminatory events, which cause disruption and 'block' the Story Sharers from succeeding in the STEM class.

Figure 6.2

The Story Sharers Intersectional Cogwheels of Being.



The cogwheels demonstrate how the Story Sharers experienced the STEM class through multiple identities and multiple group membership. Experiencing discrimination can cause interference or conflict between the identities and similar to other studies, this disconnect can cause academic underperformance, lower self-esteem and a lack of Sense of Wellbeing (Nielson et al., 2024; Settles & Buchanan, 2014). When the Story Sharers described the negative tropes and behaviours associated with their multiple identities of Māori 'and' wahine 'and' gang, the negative associations with their multiple identities led to identity conflict with being 'student' (Collins, 2019; Nielson et al., 2024; Settles & Buchanan, 2014). Whilst associating behaviours with being a 'good' student, their multiple intersected identity of Māori wahine (gang) were not harmonised with being a Māori wahine (gang) student. All the Story Sharers discussed disidentifying, hiding or masking aspects of their identity to become invisible to the potential harm inflicted by micro and macro aggressions, identifying aspects

of ethnic/racial, cultural and gender invisibility to denote a way to ‘blend in’ (Godec, 2018; Yip & Lee, 2016). Utilising an additive approach in harm reduction strategies, for example, reducing the ‘scrutiny’ of being wahine by navigating gender invisibility through opportunities in STEM careers and alleviating ‘judgement’ of being Māori by not taking part in cultural activities.

For Māori wāhine, identity development is inherently relational and shaped through whakapapa, whānau, and reciprocal relationships rather than individualistic constructs (Greaves et al., 2021; Hamley et al., 2023). Relational thinking, which emphasises the interconnectedness of ideas, people, and contexts, offers a powerful lens for understanding how identity is co-constructed within social systems (Collins, 2019; Lee & Lee, 2025). In the STEM class, relational pedagogy created space for the Story Sharers to engage in identity work that was culturally grounded and emotionally safe. This environment functioned as a type of counterspace, where students could resist deficit narratives and explore who they were not just as learners, but as Māori wāhine navigating complex social realities. By embedding relational thinking into pedagogy, educators can support the development of coherent, mana-affirming identities, especially for students living at the intersection of multiple marginalised positions (Smith et al., 2022; Highfield & Webber, 2021).

The intersectional relationality of the cogwheels reflects a form of additive co-habitation, where each Story Sharer’s identity and experience reinforce one another in distinct and dynamic ways. Drawing on Collins’ (2019) additive framework, this relationality combines individual and socio-structural positionalities to illustrate how the challenges to succeeding in STEM are not isolated but deeply interconnected. Each Story Sharer’s identity development consisted of a phenomenological processing of their environmental experiences and relationships, which are also grounded within sociocultural power systems that are interdependent (Bentley et al., 2023; Collins, 2019; Ken & Helmuth, 2021; Velez & Spencer, 2018). These interconnections were frequently disrupted by discriminatory events, echoing the ripple effects of colonising policies that disconnected Māori from their language, culture, and economic stability (Hetaraka, 2022; Nielson et al., 2024; Settles & Buchanan, 2014).

These disruptions exemplify how the three intersecting pillars of intersectionality - political, structural, and representational, continue to perpetuate inequality for Māori wāhine (Collins, 2019; Crenshaw, 1989). The education system, with its reliance on traditional assessment

structures and deficit-based narratives, often fails to recognise the relational and cultural dimensions of Māori identity. This systemic misrecognition contributes to ongoing marginalisation, where students are not only judged by dominant norms but also denied access to affirming learning environments. While the Story Sharers described their multiple identities and discriminatory events in additive terms, their experiences of marginalisation were not simply cumulative. The challenges to succeed in STEM for each Story Sharer were interconnected and unique, shaped by the relational contexts in which they lived and learned. Their cogwheels of identity were not fixed but fluid, constantly rotating in response to relationships, environments, and systemic forces. This underscores the value of intersectionality not only as a tool for analysing oppression, but as a lens for understanding the unique and interconnected identity journeys of Māori wāhine, and the need to challenge the systems that sustain educational inequality.

6.4 Conclusion

This study establishes that Māori wāhine engagement with STEM education in English-medium secondary schooling is shaped less by curricular content than by the cumulative effects of discrimination on identity, wellbeing, and participation. Theoretically, it clarifies that these effects are intersectional and relational: being Māori, being wāhine, and (for some) being gang-affiliated interact within school, community, and policy settings to produce patterned barriers and uneven recognition. Practically, it shows that these barriers are not immutable. An interdisciplinary, project-based STEM programme, designed around co-construction, whānau-like routines, and extended learning time, can create conditions in which belonging, participation, achievement, and retention improve. In this sense, relational pedagogy operationalises relational thinking aligned with Māori epistemologies, offering a counterspace to dominant deficit narratives without sacrificing academic rigour.

More generally, the findings indicate that progress on participation and achievement will remain fragile if assessment pathways are narrowed to high-stakes examinations. When evaluative contexts amplify stereotype pressure, capable students make protective choices that close future options. System-level transformation is therefore required: sustained resourcing for relational, coherent programmes; assessment breadth that recognises learning as it accumulates (internals alongside externals); and structural attention to timetable, continuity, and moderation so belonging is carried by the system, not a single teacher or class. For STEM educators, the implication is clear: design for relationship first, coherence next,

and only then optimise for performance; when conditions honour identity and connection to people and place, academic outcomes follow.

While this study is situated within the context of Māori wāhine, its findings offer broader relevance for those working with Indigenous and marginalised communities globally. Relational, culturally grounded pedagogies can foster belonging, wellbeing, and educational success when systems recognise multiple valid forms of evidence and build durable structures of belonging that enable participation and success in STEM. Future work should examine how these principles scale across schools, how assessment policies can safeguard breadth without diluting standards, and how partnerships with whānau and communities can be embedded so that gains endure beyond any single programme.

6.5 Limitations of the Study

The Māori wāhine interviewed in this study were from one co-educational low-decile urban school, and the interviews were conducted by me in my dual role as both researcher and their teacher. This positioning may have enriched the depth of insight due to established trust and relational dynamics, but it also introduced potential bias, as participants may have shaped their responses based on our existing relationship. Reflexivity and member-checking were employed to mitigate this, though future studies may benefit from external facilitation to further reduce researcher influence. Additionally, as a non-Māori researcher, my analysis may have missed cultural nuances or misinterpreted themes. The study students participated in the STEM class and interviews conducted in 2018–2019 with analysis occurring at the same time. However, literature within the area of intersectionality has moved forward and potential questions and interpretations were not made due to a lack of this current knowledge. Also, as with a reflexive intersectional phenomenological study, I have changed and constructed a different worldview and could potentially prioritise interpreting the nuance in the findings and discussions differently.

6.6 Implications

The findings of this study have implications for educators, school leaders, policymakers, and researchers seeking to improve equity and engagement in secondary education, particularly for Māori wāhine and other historically underserved learners.

6.6.1 Practice

Teachers and school leaders should consider project-based learning as a viable and effective approach to delivering integrated STEM education. When inclusive of design-thinking, this approach enables collaborative project development and supports interdisciplinary learning that reflects real-world complexity. When embedded within relational pedagogy through co-construction, whānau-based structures, and extended learning periods, project-based learning can foster deeper engagement and strengthen student–student and student–teacher relationships. In these environments, teachers play a critical role in shaping relational dynamics by role-modelling respectful behaviours, building trust, and responding to students' circumstances with fairness and care.

Within the classroom, relational practice can be further strengthened by co-constructing learning experiences that affirm students' identities and aspirations. Relational thinking encourages students to make connections across disciplines, contexts, and communities and can be embedded within project-based learning to support both cognitive and social development. To enable these practices, school leaders may wish to explore timetabling structures that support extended learning periods. These structures not only create the conditions for authentic project-based learning but also reduce the cognitive and emotional load of a fragmented school day, fostering sustained engagement and a more positive classroom climate.

It is critical that schools recognise that designing learning environments to support Māori learners not only benefits those students, but also contributes to broader improvements in school culture, engagement, and equity. The relational pedagogies that underpin such environments, when embedded across teaching practice and school structures, can reshape classroom dynamics and foster inclusive engagement. School leaders could consider how the impact of these approaches might be evaluated beyond academic achievement, using indicators such as student–teacher trust, peer relationships, and sense of belonging, which reflect the broader relational conditions that support learning.

Professional development providers could support these shifts by offering training in project-based learning, culturally sustaining pedagogy, and intersectional approaches to student engagement. This may include equipping educators with tools to identify and respond to the relational and identity-based barriers that can affect student participation and persistence.

When disseminating academic achievement and providing alternative learning opportunities, educators could remain mindful not to reinforce deficit narratives or prejudicial tropes. Instead, they might centre student voice and success as defined by the learners themselves, recognising that relational outcomes such as belonging, trust, and identity affirmation, are integral to educational success.

6.6.2 Policy Makers

To support equitable participation in STEM and improve outcomes for underrepresented learners, policymakers could consider embedding integrated STEM education into *The New Zealand Curriculum* and providing clear guidance for implementation. This may include resourcing schools to develop interdisciplinary programmes that align with NCEA requirements and local community contexts.

The current NCEA system enabled the flexibility required to implement the project-based STEM class in this study. By allowing students to gain credits across multiple learning areas through authentic, integrated projects, the system supported a more personalised and culturally responsive learning journey. However, further refinement could enhance this potential. Policymakers could consider how the qualifications framework might more explicitly support identity-affirming pathways, reduce systemic barriers to subject access, and recognise diverse forms of success. This includes ensuring that assessment structures do not inadvertently constrain innovation or reinforce traditional subject silos. In doing so, greater use could be made of digital platforms that support project tracking, evidence collection, and cross-curricular assessment, enabling more flexible, learner-centred approaches to qualification design and delivery.

To achieve the intended equity outcomes of project-based STEM initiatives, policymakers could also take a broader approach to the recognition and evaluation of knowledge. This may involve moving beyond single-subject examinations and acknowledging the wider learning that occurs through integrated, real-world projects. Additional credit could be attached to project development and design, project completion, and the demonstration of 21st-century competencies such as collaboration, communication, and project management. Furthermore, the inclusion of mātauranga Māori within STEM learning should be explicitly supported and

given equal status to traditional Western knowledge systems within assessment and curriculum frameworks.

Policymakers could also enable schools to strengthen the relational dimensions of teaching and learning by investing in the conditions that support them. This may involve resourcing professional learning in relational pedagogy, providing tools to help schools understand students' experiences of belonging, and supporting initiatives that foster sustained partnerships with whānau and communities. Rather than focusing solely on outcomes, such support could help schools create the kinds of learning environments where all students feel seen, valued, and connected. When historical policies have contributed to educational harm, one of the most effective ways to rebuild trust with communities is by ensuring that current learners experience positive, affirming school environments. Doing so can lay the foundation for sustained long-term transformation.

In addition, policy design could benefit from intersectional analysis to ensure that initiatives do not inadvertently reinforce systemic barriers. Successive New Zealand governments have introduced policies aimed at addressing educational disparities, yet these have often had limited success in improving outcomes for Māori. The persistent achievement gap reflects a complex interplay of historical, structural, and sociocultural factors. To better address equity within the education system, policymakers could draw on intersectional research that accounts for the interdependent nature of learners' experiences within these systems. Evaluation frameworks might be expanded to include holistic indicators such as student engagement, cultural identity affirmation, and relational connectedness, dimensions that are critical for Māori student success but often overlooked in traditional metrics.

6.6.3 Researchers

This study contributes to the growing body of research on intersectionality, relational pedagogy, and culturally sustaining STEM education. Future research could continue to explore how these frameworks are applied across diverse educational contexts and how they influence long-term learner outcomes.

There is a need for longitudinal studies that track the impact of relational, project-based STEM education on student retention, tertiary transitions and wellbeing.

Further research could also examine how schools meaningfully measure and respond to relational success indicators, and how relational thinking and relational pedagogy interact to support identity development and academic engagement.

By centring student voice and relational experiences, researchers can help shift the discourse from achievement gaps to opportunity gaps, and from deficit to strength-based narratives. This requires methodologies that are reflexive, culturally grounded, and attentive to the lived realities of learners navigating multiple forms of marginalisation.

6.7 Final Remarks

I started this study with some fundamental questions about how to attract Māori wāhine into post-compulsory science subjects. The question evolved into how Māori wāhine experience STEM education in an English-medium, mainstream, co-educational high school and what the challenges to succeeding in STEM. These questions grew out of reflections on my own teaching practice. Whilst I believed that I was an inclusive and culturally responsive teacher, I was also aware that many Māori students were not engaging or performing academically within my science classroom. Conducting this study as both a teacher and researcher has provided insight into the complexity of Māori learner existence. The study has demonstrated that a project-based STEM initiative can encourage Māori wāhine to succeed in STEM subjects, but it has alerted me that the challenges they face to succeeding in STEM are multiple and intersectional. Māori wāhine experience discrimination in multiple forms that are additive in nature and have a profound and pervasive effect. Alongside providing positive learning environments, relationality can enable Māori wāhine to develop support groups and relationships based on mutual understanding and trust. Creating a sense of belonging within educational settings is a vital component as there can be vulnerability in learners' continuation if a trusting relationship rests with a single educator, an outcome demonstrated by two of the Story Sharers who left the school after the disestablishment of the STEM class. The other five Story Sharers continued their education into years 12 and 13 and completed NCEA Levels 1, 2 and 3, with some gaining higher academic outcomes above the school average. All the Story Sharers and I remain in contact and continue to encourage and support one another.

I hope this study encourages other educators to try pedagogies, seek student feedback, and explore the value of an intersectional lens.

References

Adams, H. (2018). *Student success: What matters most for high achieving Māori and non-Māori students at secondary school?* [Doctoral Dissertation, The University of Auckland]. https://researchspace.auckland.ac.nz/items/63f95f5d-8f7e-4ee0-a3f8-9ee39e5afdf8

Ahmed, S. K. (2024). The pillars of trustworthiness in qualitative research. *Journal of Medicine, Surgery, and Public Health, 2*, 100051. https://doi.org/10.1016/j.glmedi.2024.100051

Ahn, M. Y., & Davis, H. H. (2020). Four domains of students' sense of belonging to university. *Studies in higher education (Dorchester-on-Thames), 45*(3), 622-634. https://doi.org/10.1080/03075079.2018.1564902

Al Salami, M., Makela, C., & Miranda, M. (2017). Assessing changes in teachers' attitudes toward interdisciplinary STEM teaching. *Int J Technol Des Educ, 27*(1), 63-88. https://doi.org/10.1007/s10798-015-9341-0

Albarello, F., Crocetti, E., & Rubini, M. (2018). I and Us: A longitudinal study on the interplay of personal and social identity in adolescence. *A Multidisciplinary Research Publication, 47*(4), 689-702. https://doi.org/10.1007/s10964-017-0791-4

Alexakos, K. (2015). *Being a teacher researcher: A primer on doing authentic inquiry research on teaching and learning*. Rotterdam : SensePublishers : Imprint: SensePublishers.

Alexander, P., Jablansky, S., Singer Trakhman, L., & Dumas, D. (2016, 01/05). Relational reasoning: What we know and why it matters. *Policy Insights from the Behavioral and Brain Sciences, 3*. https://doi.org/10.1177/2372732215622029

Allen, K.-A., Vella-Brodrick, D., & Waters, L. (2016, 2016/07/01). Fostering school belonging in secondary schools using a socio-ecological framework. *Educational and Developmental Psychologist, 33*(1), 97-121. https://doi.org/10.1017/edp.2016.5

Allen, R. E. S., & Wiles, J. L. (2016, 2016/04/02). A rose by any other name: Participants choosing research pseudonyms. *Qualitative Research in Psychology, 13*(2), 149-165. https://doi.org/10.1080/14780887.2015.1133746

Allison, P., Gray, S., Sproule, J., Nash, C., Martindale, R., & Wang, J. (2015). Exploring contributions of project-based learning to health and wellbeing in secondary education. *Improving Schools, 18*(3), 207-220. https://doi.org/10.1177/1365480215599298

Almeida, S. (2015). Four: Race-based epistemologies: The role of race and dominance in knowledge production. *Wagadu, 13*, 79.

Alves, A., Moreira, F., Carvalho, M., Oliveira, S., Malheiro, M., Brito, I., Leao, C., & Teixeira, S. (2019, 01/01). Integrating Science, Technology, Engineering and Mathematics contents through PBL in an Industrial Engineering and Management first-year program. *Production, 29*. https://doi.org/10.1590/0103-6513.20180111

Anderson, J., Tytler, R., & Williams, G. (2022, 14 Nov. 2022). Supporting curriculum innovation in integrated STEM for secondary teachers in Australia. *Research in Integrated STEM Education, 1*(1), 30-59. https://doi.org/https://doi.org/10.1163/27726673-00101001

Angelini, F., Gini, G., Marino, C., & Van Den Eijnden, R. (2024). Social media features, perceived group norms, and adolescents' active social media use matter for perceived friendship quality. *Frontiers in psychology, 15*, 1222907. https://doi.org/10.3389/fpsyg.2024.1222907

Atewologun, D. (2018). Intersectionality theory and practice. *Oxford Research Encyclopedia of Business and Management*.

Auckland Council. (2015). *Auckland Economic Plan*. http://www.aucklandcouncil.govt.nz/EN/planspoliciesprojects/plansstrategies/theaucklandplan/economicdevelopmentstrategy/Pages/home.aspx

Auditor General. (2023). *Four initiatives supporting improved outcomes for Māori* https://oag.parliament.nz/2023/outcomes-for-maori/part5.htm

Avraamidou, L. (2019). Stories we live, identities we build: How are elementary teachers' science identities shaped by their lived experiences? *Cultural Studies of Science Education, 14*(1), 33-59. https://doi.org/10.1007/s11422-017-9855-8

Avraamidou, L. (2020). Science identity as a landscape of becoming: Rethinking recognition and emotions through an intersectionality lens. *Cultural Studies of Science Education, 15*(2), 323-345. https://doi.org/10.1007/s11422-019-09954-7

Ayiro, L. P. (2012). *A functional approach to educational research methods and statistics: Qualitative, quantitative, and mixed methods approaches*. The Edwin Mellen Press.

Azmitia, M., Garcia Peraza, P., Thomas, V., Ajayi, A., & Syed, M. (2023). The promises and challenges of using an intersectional framework to study identity development during adolescence and early adulthood. In (pp. 391-405). https://doi.org/10.1037/0000298-024

Azmitia, M., Garcia Peraza, P. D., & Casanova, S. (2023). Social identities and Intersectionality: A conversation about the what and the how of development. *Annual review of developmental psychology, 5*(1), 169-191. https://doi.org/10.1146/annurev-devpsych-120321-022756

Azmitia, M., & Thomas, V. (2015, 05/15). Intersectionality and the development of self and Identity. *Emerging Trends in the Social and Behavioural Sciences* https://doi.org/10.1002/9781118900772.etrds0193

Banks, F., & Barlex, D. (2020). *Teaching STEM in the secondary school: Helping Teachers meet the challenge* (2 ed.). Taylor & Francis Group. https://doi.org/10.4324/9780429317736

Barnes, A. M., & McCreanor, T. (2023). "Feeding people's beliefs": Mass media representations of Māori and criminality. In *The Routledge international handbook on decolonizing justice* (1 ed., Vol. 1, pp. 22-32). Routledge. https://doi.org/10.4324/9781003176619-4

Becker, S. J., & Börnert-Ringleb, M. (2025). Stress and anxiety in schools: A multilevel analysis of individual and class-level effects of achievement and competitiveness. *Frontiers in education (Lausanne), 9*. https://doi.org/10.3389/feduc.2024.1519161

Bell, P. (2019). Infrastructuring teacher learning about equitable science instruction. *Journal of science teacher education, 30*(7), 681-690. https://doi.org/10.1080/1046560X.2019.1668218

Bentley, C., Muyoya, C., Vannini, S., Oman, S., & Jimenez, A. (2023). Intersectional approaches to data: The importance of an articulation mindset for intersectional data science. *Big Data & Society, 10*(2), 20539517231203667. https://doi.org/10.1177/20539517231203667

Berryman, M. (2014). Relational and culturally responsive, Indigenous approach to belonging and inclusion. In *Tales from School* (pp. 199-211). Brill.

Berryman, M., Egan, M., & Haydon-Howard, J. (2023, 05/30). A Pedagogical continuum: Driving culturally responsive school reform for Māori secondary students. *Journal of Education and Development, 7*, 30. https://doi.org/10.20849/jed.v7i2.1339

Berryman, M., & Eley, E. (2017). Succeeding as Māori: Māori students' views on our stepping up to the Ka Hikitia challenge. *New Zealand Journal of Educational Studies, 52*(1), 93-107. https://doi.org/10.1007/s40841-017-0076-1

Berryman, M., Lawrence, D., & Lamont, R. (2018). Cultural relationships for responsive pedagogy: A bicultural mana ōrite perspective. *Set: research information for teachers (Wellington)*(1), 3-10. https://doi.org/10.18296/set.0096

Berryman, M., & Wearmouth, J. (2018, 06/18). Development of an observation tool designed to increase cultural relationships and responsive Pedagogy to raise the achievement of Māori students in secondary classrooms in Aotearoa New Zealand. *Journal of Education and Development, 2*, 32. https://doi.org/10.20849/jed.v2i2.428

Besic, E. (2020). Intersectionality: A pathway towards inclusive education? *Prospects (Paris), 49*(3-4), 111-122. https://doi.org/10.1007/s11125-020-09461-6

Bingham, A. J. (2023). From data management to actionable findings: A five-phase process of qualitative data analysis. *International journal of qualitative methods, 22*. https://doi.org/10.1177/16094069231183620

Bishop, R. (2011). *Freeing Ourselves*. Rotterdam: SensePublishers.

Bishop, R. (2019). *Teaching to the north-east: Relationship-based learning in practice*. NZCER Press.

Bishop, R., & Berryman, M. (2010). Te Kōtahitanga: Culturally responsive professional development for teachers. *Teacher Development, 14*(2), 173-187. https://doi.org/10.1080/13664530.2010.494497

Bishop, R., Berryman, M., Cavanagh, T., & Teddy, L. (2009). Te Kōtahitanga: Addressing educational disparities facing Māori students in New Zealand. *Teaching and Teacher Education: An International Journal of Research and Studies, 25*(5), 734-742. https://doi.org/10.1016/j.tate.2009.01.009

Bishop, R., Ladwig, J., & Berryman, M. (2014). The centrality of relationships for pedagogy: The Whanaungatanga thesis. *American Educational Research Journal, 51*(1), 184-214. https://doi.org/10.3102/0002831213510019

Bolstad, R. (2011a). Principles for a future-oriented education system.

Bolstad, R. (2011b). *Taking a "Future Focus" in education-What does it mean? An NZCER working paper from the Future-Focussed Issues (FFI) in education project*.

Bower, J. M., van Kraayenoord, C., & Carroll, A. (2015). Building social connectedness in schools: Australian teachers' perspectives. *International journal of educational research, 70*, 101-109. https://doi.org/10.1016/j.ijer.2015.02.004

Bowleg, L. (2008). When Black + Lesbian + Woman ≠ Black Lesbian Woman: The methodological challenges of qualitative and quantitative intersectionality research. *Sex roles, 59*(5-6), 312-325. https://doi.org/10.1007/s11199-008-9400-z

Bradbury-Jones, C., Sambrook, S., & Irvine, F. (2009, Mar). The phenomenological focus group: An oxymoron? *J Adv Nurs, 65*(3), 663-671. https://doi.org/10.1111/j.1365-2648.2008.04922.x

Branje, S., De Moor, E. L., Spitzer, J., & Becht, A. I. (2021). Dynamics of identity development in adolescence: A decade in review. *Journal of Research on Adolescence, 31*(4), 908-927.

Braun, V., & Clarke, V. (2013). *Successful qualitative research: A practical guide for beginners*. SAGE.

Breiner, J. (2016). Do we have a STEM crisis in America? *School Science and Mathematics, 116*(3), 113-115. https://doi.org/10.1111/ssm.12167

Brewer, K. M., Harwood, M. L. N., McCann, C. M., Crengle, S. M., & Worrall, L. E. (2014). The use of interpretive description within Kaupapa Māori research. *Qualitative Health Research, 24*(9), 1287-1297. https://doi.org/10.1177/1049732314546002

Broughton, D., & McBreen, K. (2015). Mātauranga Māori, tino rangatiratanga and the future of New Zealand science. *Journal of the Royal Society of New Zealand, 45*(2), 83-88.

Brown, B. A. (2004). Discursive identity: Assimilation into the culture of science and its implications for minority students. *Journal of Research in Science Teaching, 41*(8), 810-834. https://doi.org/10.1002/tea.20228

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Bybee, R. W. (2010). What Is STEM education? *Science, 329*(5995), 996-996. https://doi.org/10.1126/science.1194998

Bybee, R. W. (2015). *The BSCS 5E instructional model: Creating teachable moments*. NSTA Press.

Carastathis, A. (2016). *Intersectionality: Origins, contestations, horizons*. UNP - Nebraska. https://doi.org/10.2307/j.ctt1fzhfz8

Chang, C.-C., & Chen, Y.-K. (2023). A transdisciplinary STEM course integrated through project-based learning on robotics: Perspective from teacher and student feedback. *Asia Pacific journal of education, ahead-of-print*(ahead-of-print), 1-16. https://doi.org/10.1080/02188791.2023.2209698

Chen, W., Huang, Z., Peng, B., & Hu, H. (2025). Unpacking the relationship between adolescents' perceived school climate and negative emotions: The chain mediating roles of school belonging and social avoidance and distress. *BMC Psychology, 13*(1), 58-20. https://doi.org/10.1186/s40359-025-02364-1

Cherewick, M., Lama, R., Rai, R. P., Dukpa, C., Mukhia, D., Giri, P., & Matergia, M. (2024). Social support and self-efficacy during early adolescence: Dual impact of protective and promotive links to mental health and wellbeing. *PLOS global public health, 4*(12), e0003904. https://doi.org/10.1371/journal.pgph.0003904

Cho, H., & Wang, X. C. (2020). Fluid identity play: A case study of a bilingual child's ethnic identity construction across multiple contexts. *Journal of Early Childhood Research 18*(2), 200-213. https://doi.org/10.1177/1476718X19898746

Chowdhury, T. B. M., Holbrook, J., & Rannikmäe, M. (2024, 2024/08/12). A model conceptualising trans-disciplinarity within school science education based on a systematic literature review. *International Journal of Science Education, 46*(12), 1169-1191. https://doi.org/10.1080/09500693.2023.2281007

Clark, H. D. D. (2022). *Budget 2022 invests in Tech sector growth* https://www.beehive.govt.nz/release/budget-2022-invests-tech-sector-growth#:~:text=%E2%80%9CIn%202020%2C%20the%20digital%20technologies,economy%2C%E2%80%9D%20David%20Clark%20said.

Clark, T. C., Le Grice, J., Moselen, E., Fleming, T., Crengle, S., Tiatia‐Seath, J., & Lewycka, S. (2018). Health and wellbeing of Māori secondary school students in New Zealand: Trends between 2001, 2007 and 2012. *Australian and New Zealand journal of public health, 42*(6), 553-561. https://doi.org/10.1111/1753-6405.12839

Clements, K., Cooper, G., Corballis, M., Elliffe, D., Nola, R., Rata, E., & Werry, J. (2021, Saturday July 24). In the defence of science. *New Zealand Listener*.

Cochran, G. L., Boveda, M., Prescod-Weinstein, C., Mohr-Schroeder, M. J., English, L. D., Johnson, C. C., & Moore, T. J. (2020). Intersectionality in STEM education research. In *Handbook of Research on STEM Education* (1 ed., pp. 257-266). Routledge. https://doi.org/10.4324/9780429021381-24

Cohen, L. (2013). *Research methods in education* (7th ed.. ed.). Hoboken : Taylor and Francis.

Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (Eighth edition ed.). Routledge.

Collins, & Bilge. (2016). *Intersectionality*. Polity Press.

Collins, P. (2015). Intersectionality's definitional dilemmas. *Annual review of sociology, 41*(1), 1-20. https://doi.org/10.1146/annurev-soc-073014-112142

Collins, P. H. (2019). *Intersectionality as critical social theory*. Duke University Press. https://doi.org/10.1515/9781478007098

Connors-Kellgren, A., Parker, C., Blustein, D., & Barnett, M. (2016). Innovations and challenges in project-based STEM education: Lessons from ITEST. *Journal of Science Education and Technology, 25*(6), 825-832. https://doi.org/10.1007/s10956-016-9658-9

Cooper, G. (2012). Kaupapa Māori research: Epistemic wilderness as freedom? *New Zealand Journal of Educational Studies, 47*(2), 64-73.

Cormack, D., Stanley, J., & Harris, R. (2018). Multiple forms of discrimination and relationships with health and wellbeing: Findings from national cross-sectional surveys in Aotearoa/New Zealand. *International journal for equity in health, 17*(1), 26-15. https://doi.org/10.1186/s12939-018-0735-y

Craig, T. T., & Marshall, J. (2019). Effect of project ‐ based learning on high school students' state ‐ mandated, standardized math and science exam performance. *Journal of Research in Science Teaching, 56*(10), 1461-1488. https://doi.org/10.1002/tea.21582

Cram, F. (2006). Talking ourselves up. *AlterNative: An International Journal of Indigenous Peoples, 2*(1), 28-43. https://doi.org/10.1177/117718010600200102

Crenshaw, K. (1989). Demarlginalizing the intersection of Race and Sex: A Black Feminist critique of antidiscrimination doctrine, Feminist Theory and antiracist politics. *Chicago Legal Forum, 1989*(8). https://chicagounbound.uchicago.edu/uclf/vol1989/iss1/8

Crenshaw, K. (1991). Mapping the margins: Intersectionality, identity politics, and violence against Women of Color. *Stanford law review, 43*(6), 1241-1299. https://doi.org/10.2307/1229039

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry & research design: Choosing among five approaches* (Fourth edition. International Student Edition. ed.). SAGE Publications.

Crocetti, E., Albarello, F., Meeus, W., & Rubini, M. (2023). Identities: A developmental social-psychological perspective. *European review of social psychology, 34*(1), 161-201. https://doi.org/10.1080/10463283.2022.2104987

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. St Leonards, NSW : Allen & Unwin.

Crowe, S., & Kairn, T. (2016). Women in medical physics: A preliminary analysis of workforce and research participation in Australia and New Zealand. *Australas Physical and Engineering Sciences in Medicine, 39*(2), 525-532. https://doi.org/10.1007/s13246-016-0428-z

Curran M. (2016). So why the STEM push. *EducationHQ New Zealand*. http://nz.educationhq.com/news/33914/so-why-the-stem-push/

Davies, H., & O'Neill, J. (2022). Adolescents' experiences of identity development in schooling. *Set: research information for teachers (Wellington)*(3), 28-33. https://doi.org/10.18296/set.1516

de Moor, E. L., Van der Graaff, J., Van Dijk, M. P. A., Meeus, W., & Branje, S. (2019). Stressful life events and identity development in early and mid-adolescence. *Journal of Adolescence 76*(1), 75-87. https://doi.org/10.1016/j.adolescence.2019.08.006

de Moor, E. L., Van der Graaff, J., van Doeselaar, L., Klimstra, T. A., & Branje, S. (2021). With a little help from my friends? Perceived friendship quality and narrative identity in adolescence. *Journal of Research on Adolescence, 31*(2), 384-401. https://doi.org/10.1111/jora.12605

Deehan, J., Danaia, L., Redshaw, S., Dealtry, L., Gersbach, K., & Bi, R. (2024, 2024/11/01). STEM in the classroom: A scoping review of emerging research on the integration of STEM education within Australian schools. *The Australian Educational Researcher, 51*(5), 1-24. https://doi.org/10.1007/s13384-024-00691-7

Dennissen, M. H. J., Benschop, Y. W. M., & Brink, M. C. L. v. d. (2020). Rethinking diversity management: An intersectional analysis of diversity networks. *Organization studies, 41*(2), 219-240. https://doi.org/10.1177/0170840618800103

Denzin, N. K., & Lincoln, Y. S. (2013). *The landscape of Qualitative research* (Fourth Edition.. ed.). Thousand Oaks, California : SAGE Publications.

Dhawan, K. (2024, 06/24). Exam anxiety in adolescents and the fficacy of its Interventions – A systematic review. *International Journal of Psychological Studies, 16*, 1-1. https://doi.org/10.5539/ijps.v16n3p1

Diana, N., Yohannes, & Sukma, Y. (2021). The effectiveness of implementing Project-Based Learning (PjBL) model in STEM education: A literature review. *Journal of Physics: Conference Series, 1882*(1), 12146. https://doi.org/10.1088/1742-6596/1882/1/012146

Diego-Mantecón, J. M., Prodromou, T., Lavicza, Z., Blanco, T., & Ortiz-Laso, Z. (2021, 09/03). An attempt to evaluate STEAM project-based instruction from a school mathematics perspective. *ZDM - International Journal on Mathematics Education, 53*. https://doi.org/10.1007/s11858-021-01303-9

Dierking, L., & Falk, J. (2016). 2020 Vision: Envisioning a new generation of STEM learning research. *Cultural Studies of Science Education, 11*(1), 1-10. https://doi.org/10.1007/s11422-015-9713-5

Dodgson, J. E. (2019). Reflexivity in qualitative research. *Journal of human lactation, 35*(2), 220-222. https://doi.org/10.1177/0890334419830990

Dost, G., & Mazzoli Smith, L. (2023, 2023/07/03). Understanding higher education students' sense of belonging: A qualitative meta-ethnographic analysis. *Journal of Further and Higher Education, 47*(6), 822-849. https://doi.org/10.1080/0309877X.2023.2191176

Doucet, A., & Mauthner, N. S. (2006). Feminist Methodologies and Epistemology. *Handbook of 21st century sociology, 2*, 36-43.

Dutt, A., Lee, Y., Soh, L., Chua, K. L., Chen, S. Y., Yeo, L. S., Tan, C. S., Chen, M., Nah, Y. H., & Suh, H. (2025). Evaluating the efficacy of a universal classroom-based test anxiety intervention program for secondary school students. *School mental health, 17*(2), 540-552. https://doi.org/10.1007/s12310-025-09750-5

Edith, T. (1997). The vulnerable observer: Anthropology that breaks your heart. *American anthropologist, 99*, 862-862. https://doi.org/10.1525/aa.1997.99.4.862

Education Gazette. (2021). Providing furture-world pathways into STEM careers. *Education Gazette*, *100*(4). https://gazette.education.govt.nz/articles/providing-future-world-pathways-into-stem-careers/

Edwards, E. B., & King, N. S. (2023). "Girls Hold All the Power in the World": Cultivating sisterhood and a counterspace to support STEM learning with Black girls. *Education sciences, 13*(7), 698. https://www.mdpi.com/2227-7102/13/7/698

Elliott, G., Kao, S., & Grant, A.-M. (2004). Mattering: Empirical validation of a social-psychological concept. *Self and identity, 3*(4), 339-354. https://doi.org/10.1080/13576500444000119

Ellis, D., Williams, J., Didier, V. d. V., Mann, V., Yang, C., Dagan, O., Gorinskiy, S., Lin, K.-Y., Sie, Y.-J., & Wells, J. (2021). *Looking at STEM education in different countries* (Second Edition. ed.). Routledge.

English, L. (2016). STEM education K-12: Perspectives on integration. *International Journal of STEM Education, 3*(3), 1. https://doi.org/10.1186/s40594-016-0036-1

Ermakoff, I. (2017). Shadow plays: Theory's perennial challenges. *Sociological theory, 35*(2), 128-137. https://doi.org/10.1177/0735275117709774

Falk, J. H., Dierking, L. D., Staus, N. L., Wyld, J. N., Bailey, D. L., & Penuel, W. R. (2016). The Synergies research-practice partnership project: A 2020 vision case study. *Cultural Studies of Science Education, 11*(1), 195-212. https://doi.org/10.1007/s11422-015-9716-2

Fiteriani, I., Diani, R., Hamidah, A., & Anwar, C. (2021). Project-based learning through STEM approach: Is it effective to improve students' creative problem-solving ability and metacognitive skills in physics learning? *IOP Conference Series: Earth and Environmental Science, 1796*(1), 12058. https://doi.org/10.1088/1742-6596/1796/1/012058

Fontana, A. (2010). *The interview from formal to postmodern*. Walnut Creek : Left Coast Press.

Forster, M. E., Palmer, F., Barnett, S., Wolfgramm, R., Spiller, C., & Voyageur, C. (2016). Karanga mai ra: Stories of Māori women as leaders. *Leadership, 12*(3), 324-345. https://doi.org/10.1177/1742715015608681

Galy-Badenas, F., Gray, F. E., & Cassidy, F. (2023). An intersectional approach to media coverage of politics in New Zealand: The case of Metiria Turei and Paula Bennett. *Media international Australia incorporating Culture & policy, 187*(1), 88-103. https://doi.org/10.1177/1329878X211007176

Gandhi-Lee, E., Skaza, H., Marti, E. J., Schrader, P. G., & Orgill, M. K. (2017). Faculty perceptions of student recruitment and retention in STEM fields. *European Journal of STEM Education, 2*, 2.

Godec, S. (2018). Sciencey girls: Discourses supporting working-class girls to identify with science. *Education sciences, 8*(1), 19. https://doi.org/10.3390/educsci8010019

Gonzalez, E. (2018, 2019/04/01). Ethnoracial attitudes and identity-salient experiences among Indigenous Mexican adolescents and emerging adults. *Emerging Adulthood, 7*(2), 128-137. https://doi.org/10.1177/2167696818805336

Granshaw, B. (2016). STEM education for the twenty-first century: A New Zealand perspective. *Australasian Journal of Technology, 3*. https://doi.org/ https://doi.org/10.15663/ajte.v3i1.43

Gray, D. E. (2013). *Doing research in the real world* (3rd ed.. ed.). London : SAGE.

Gray, M. J., Yacobian, J. N., & Shortlidge, E. E. (2025, 2025/01/29). Elements of social capital and counterspace processes contribute to undergraduate STEM student development of a sense of belonging. *Science Education*(n/a). https://doi.org/https://doi.org/10.1002/sce.21947

Greaves, L. M., Le Grice, J., Schwencke, A., Crengle, S., Lewycka, S., Hamley, L., & Clark, T. C. (2021). Measuring whanaungatanga and identity for well-being in Rangatahi Māori. *MAI journal, 10*(2), 93-105. https://doi.org/10.20507/MAIJournal.2021.10.2.3

Grzanka, P. R., & Miles, J. R. (2016). The problem with the phrase "Intersecting Identities": LGBT affirmative therapy, intersectionality, and neoliberalism. *Sexuality research & social policy, 13*(4), 371-389. https://doi.org/10.1007/s13178-016-0240-2

Gubrium, J. F., & Holstein, J. A. (2002). *Handbook of interview research: Context and method*. Thousand Oaks, Calif. : Sage Publications.

Haar, J. (2023). Perceived discrimination of Māori and Pacific employees in Aotearoa/New Zealand: Work and well-being consequences and testing the symbolic interaction perspective. *Evidence-based HRM: A Global Forum for Empirical Scholarship, 11*(4), 781-800. https://doi.org/10.1108/EBHRM-03-2022-0064

Hagerty, B. M., Lynch-Sauer, J., Patusky, K. L., Bouwsema, M., & Collier, P. (1992). Sense of belonging: A vital mental health concept. *Archives of psychiatric nursing, 6*(3), 172-177.

Hall, N., Hornby, G., & Macfarlane, S. (2015). Enabling school engagement for Māori families in New Zealand. *Journal of Child and Family Studies, 24*(10), 3038-3046. https://doi.org/10.1007/s10826-014-0107-1

Hall, S. (1980). *Race, articulation and societies structured in dominance*. Duke University Press.

Hamley, L., Le Grice, J., Greaves, L., Groot, S., Lindsay Latimer, C., Renfrew, L., Parkinson, H., Gillon, A., & Clark, T. C. (2023). Te Tapatoru: A model of whanaungatanga to support Rangatahi wellbeing. *Kōtuitui, 18*(2), 171-194. https://doi.org/10.1080/1177083X.2022.2109492

Harris, A., & Leonardo, Z. (2018). Intersectionality, Race-Gender subordination, and education. *Review of Research in Education, 42*(1), 1-27. https://doi.org/10.3102/0091732X18759071

Harris, J. C., & Patton, L. D. (2019). Un/Doing intersectionality through higher education research. *The Journal of Higher Education 90*(3), 347-372. https://doi.org/10.1080/00221546.2018.1536936

Harris, R., Stanley, J., & Cormack, D. (2018). Racism and health in New Zealand: Prevalence over time and associations between recent experience of racism and health and wellbeing measures using national survey data. *PLoS One, 13*(5), e0196476. https://doi.org/10.1371/journal.pone.0196476

Hasanah, U. (2020). Key definitions of STEM education: Literature review *Interdisciplinary journal of environmental and science education, 16*(3). https://doi.org/10.29333/ijese/8336

Haynes, C., Joseph, N. M., Patton, L. D., Stewart, S., & Allen, E. L. (2020). Toward an understanding of Intersectionality Methodology: A 30-year lterature synthesis of Black Women's experiences in Higher Education. *Review of educational research, 90*(6), 751-787. https://doi.org/10.3102/0034654320946822

Heidegger, M. (2008). *Ontology. The hermeneutics of facticity*. Bloomington, IN : Indiana University Press.

Hetaraka, M. (2022). Myth-Making: On-going impacts of historical education policy on beliefs about Māori in education. *New Zealand Journal of Educational Studies, 57*(2), 321-333. https://doi.org/10.1007/s40841-022-00257-0

Hiğde, E., & Aktamış, H. (2022, 2022/03/01/). The effects of STEM activities on students' STEM career interests, motivation, science process skills, science achievement and views. *Thinking Skills and Creativity, 43*, 101000. https://doi.org/https://doi.org/10.1016/j.tsc.2022.101000

Highfield, C., & Webber, M. (2021). Mana Ūkaipō: Māori student connection, belonging and engagement at school. *New Zealand Journal of Educational Studies, 56*(2), 145-164.

Hikuroa, D. (2017). Mātauranga Māori-the ūkaipō of knowledge in New Zealand. *Journal of the Royal Society of New Zealand, 47*(1), 5-10. https://doi.org/10.1080/03036758.2016.1252407

Hipkins, R. (2008). Longer learning periods for the secondary school day: What does research say? *Set: research information for teachers (Wellington)*(1), 40-43. https://doi.org/10.18296/set.0510

Hipkins, R., Shanks, L., & Denny, M. (2008). Early experiences of longer learning periods at Alfriston College. *Set: research information for teachers (Wellington)*(1), 44-49. https://doi.org/10.18296/set.0509

Hipkins, R., Tolbert, S., Cowie, B., & Waiti, P. (2022). Enduring competencies for designing science learning pathways. *New Zealand Council for Educational Research*. https://doi.org/https://doi.org/10.18296/rep.0025

Hobbs, L., Clark, J. C., & Plant, B. (2018). Successful Students – STEM Program: Teacher learning through a multifaceted vision for STEM education. In R. Jorgensen & K. Larkin (Eds.), *STEM Education in the Junior Secondary: The State of Play* (pp. 133-168). Springer Singapore. https://doi.org/10.1007/978-981-10-5448-8_8

Hooks, B. (2015). *Black looks: Race and representation* (2nd ed. ed.). Routledge. https://doi.org/10.4324/9781315743226

Hoskins, T. K., & Jones, A. (2022, 2022/08/29). Indigenous inclusion and Indigenising the University. *New Zealand Journal of Educational Studies*. https://doi.org/10.1007/s40841-022-00264-1

Hotere-Barnes, A., Bright, N., & Hutchings, J. (2014). Reo and mātauranga Māori revitalisation: Learning visions for the future. *Set: research information for teachers (Wellington)*(1), 7-15. https://doi.org/10.18296/set.0331

Hugerat, M. (2016). How teaching science using project-based learning strategies affects the classroom learning environment. *Learning Environments Research, 19*(3), 383-395. https://doi.org/10.1007/s10984-016-9212-y

Hunter, J., & Hunter, R. (2024). Weaving together the threads of Indigenous knowledge and mathematics. *Educational studies in mathematics, 116*(3), 501-518. https://doi.org/10.1007/s10649-023-10256-7

[Record #257 is using a reference type undefined in this output style.]

Jagiello, T., Belcher, J., Neelakandan, A., Boyd, K., & Wuthrich, V. M. (2024). Academic stress interventions in High Schools: A systematic literature review. *Child psychiatry and human development*. https://doi.org/10.1007/s10578-024-01667-5

James, S. M., & Singer, S. R. (2016). From the NSF: The National Science Foundation's investments in broadening participation in Science, Technology, Engineering, and Mathematics education through research and capacity building. *CBE life sciences education, 15*(3), fe7. https://doi.org/10.1187/cbe.16-01-0059

Jang, S. T. (2023). Sense of school belonging among Asian American and Pacific Islander students in U.S. high schools: A critical quantitative intersectionality analysis. *Teachers College record (1970), 125*(3), 289-318. https://doi.org/10.1177/01614681231173019

Jensen, S., Madjar, I., & McKinley, E. (2010). Students and NCEA course choices and allocations. *Set: Research Information for Teachers*(2), 45-51.

Jensen, S., McKinley, E., & Madjar, I. (2010). NCEA subject choices in mid-low-decile schools: What schools and parents need to know about the university pathway. *Set: Research Information for Teachers*(2), 37-43.

John, M.-S., Sibuma, B., Wunnava, S., Anggoro, F., & Dubosarsky, M. (2018, 09/06). An iterative participatory approach to developing an Early Childhood problem-based STEM curriculum. *European Journal of STEM Education, 3*. https://doi.org/10.20897/ejsteme/3867

Johnson. (2012). Campus racial climate perceptions and overall sense of belonging among racially diverse women in STEM majors. *Journal of college student development, 53*(2), 336-346. https://doi.org/10.1353/csd.2012.0028

Johnson, Moore, & Peters-Burton. (2021). *STEM Road Map 2.0: A framework for integrated STEM education in the innovation age* (Second ed.). Routledge. https://doi.org/10.4324/9781003034902

Johnson, R. M., Strayhorn, T. L., & Parler, B. (2020). "I just want to be a regular kid:" A qualitative study of sense of belonging among high school youth in foster care. *Children and youth services review, 111*, 104832. https://doi.org/10.1016/j.childyouth.2020.104832

Jones, A. (2012). Dangerous liaisons: Pākehā, kaupapa Māori, and educational research. *New Zealand Journal of Educational Studies, 47*(2), 100-112.

Jordano, M. L., & Touron, D. R. (2017, May). Stereotype threat as a trigger of mind-wandering in older adults. *Psychol Aging, 32*(3), 307-313. https://doi.org/10.1037/pag0000167

Juan, M. J., Syed, M., & Azmitia, M. (2016, 10/01). Intersectionality of Race/Ethnicity and gender among women of color and White women. *Identity, 16*, 225-238. https://doi.org/10.1080/15283488.2016.1229606

Ka'ai-Mahuta, R. (2011, 12/01). The impact of colonisation on te reo Māori: A critical review of the state education system. *Te Kaharoa, 4*(1). https://doi.org/10.24135/tekaharoa.v4i1.117

Kelly, C., Kasperavicius, D., Duncan, D., Etherington, C., Giangregorio, L., Presseau, J., Sibley, K. M., & Straus, S. (2021, 2021/08/21). 'Doing' or 'using' intersectionality? Opportunities and challenges in incorporating intersectionality into knowledge translation theory and practice. *International journal for equity in health, 20*(1), 187. https://doi.org/10.1186/s12939-021-01509-z

Ken, I. (2010). Digesting Race, Class, and Gender. In I. Ken (Ed.), *Digesting Race, Class, and Gender: Sugar as a Metaphor* (pp. 105-124). Palgrave Macmillan US. https://doi.org/10.1057/9780230115385_5

Ken, I., & Helmuth, A. S. (2021). Not additive, not defined: Mutual constitution in feminist intersectional studies. *Feminist theory, 22*(4), 575-604. https://doi.org/10.1177/1464700120987393

Kennedy, T. J., & Odell, M. R. (2014). Engaging students in STEM education. *Science Education International, 25*(3), 246-258.

Kennedy, T. J., & Odell, M. R. L. (2023). STEM education as a Meta-discipline. In B. Akpan, B. Cavas, & T. Kennedy (Eds.), *Contemporary Issues in Science and Technology Education* (pp. 37-51). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-24259-5_4

Kennedy, T. J., & Sundberg, C. (2020). *21st century skills* (1 ed.). Springer Nature. https://doi.org/10.1007/978-3-030-43620-9

Kia Eke Panuku. (2023). *Kia Eke Panuku, building on success 2013-2016*. https://kep.org.nz/

Kidman, J., Abrams, E., & McRae, H. (2011). Imaginary subjects: School science, Indigenous students, and knowledge–power relations. *British Journal of Sociology of Education, 32*(2), 203-220. https://doi.org/10.1080/01425692.2011.547306

Kim, S. (2003). Research paradigms in organizational learning and performance: Competing modes of inquiry. *Information Technology, Learning, and Performance Journal, 21*(1), 9-18.

Kincheloe, J. L. (2005). *Critical constructivism primer*. New York : Peter Lang.

Kolluri, S. (2023). Patchwork capital and postsecondary success: Latinx students from high school to college. *Race, ethnicity and education, 26*(6), 793-813. https://doi.org/10.1080/13613324.2020.1798389

Krzyzosiak, J., & Stewart, G. T. (2019). Can culturally responsive policies improve Māori achievement? *Curriculum matters, 15*(15), 42-58. https://doi.org/10.18296/cm.0036

Larmer, J., Ross, D., & Mergendollar, J. (2017). *PBL starter kit.* (Second ed.). Buck Institute for Education.

Le, P. T., Doughty, L., Thompson, A. N., Hartley, L. M., & Dolan, E. L. (2019). Investigating undergraduate Biology students' science identity production. *CBE life sciences education, 18*(4), ar50-ar50. https://doi.org/10.1187/cbe.18-10-0204

Leask, A. (2023). Elon Musk and Richard Dawkins' criticism of mātauranga Māori in schools faces backlash from Kiwi researcher. *New Zealand Herald*. https://www.nzherald.co.nz/nz/elon-musk-richard-dawkins-criticism-of-matauranga-maori-in-schools-faces-backlash-from-kiwi-researcher/QQWSKLTDF5DCTETX5F3P3RBC5Y/

Lee, C. J. G. (2012). Reconsidering Constructivism in Qualitative research. *Educational Philosophy and Theory, 44*(4), 403-412. https://doi.org/10.1111/j.1469-5812.2010.00720.x

Lee, M. Y., & Lee, J. S. (2025). Project-based learning as a catalyst for integrated STEM education. *Education sciences, 15*(7), 871. https://doi.org/10.3390/educsci15070871

Li, Q., & Palaroan, R. (2024). Multidimensional academic anxiety: Examining domain-specific differences and motivational impacts. In J.-H. Ye, L. Nong, L. Wang, & W. Nong (Eds.), *Motivation in Learning*. IntechOpen. https://doi.org/10.5772/intechopen.1008203

Littlejohn, S. W., & Foss, K. A. (2009). *Encyclopedia of communication theory* (Vol. 1). Sage.

Lourie, M. (2016). Bicultural education policy in New Zealand. *Journal of Education Policy*, 1-14. https://doi.org/10.1080/02680939.2016.1159339

Lyu, Y. (2024, 11/09). Shifting research paradigms in educational research: From Positivism to Interpretivism. *Science, Technology and Social Development Proceedings Series, 2*, 11-14. https://doi.org/10.70088/bmq18v35

MacKinnon, C. A. (2013). Intersectionality as method: A note. *Signs: Journal of Women in Culture and Society, 38*(4), 1019-1030. https://doi.org/10.1086/669570

Margot, K. C., & Kettler, T. (2019). Teachers' perception of STEM integration and education: A systematic literature review. *International Journal of STEM Education, 6*(1), 1-16. https://doi.org/10.1186/s40594-018-0151-2

Masquelier, C. (2022). Pluriversal intersectionality, critique and utopia. *The Sociological review (Keele), 70*(3), 616-631. https://doi.org/10.1177/00380261221079115

May, T. (2002). *An introduction to the philosophy of social research*. Hoboken : Taylor and Francis.

Mayoh, J., & Onwuegbuzie, A. J. (2015). Toward a conceptualization of mixed methods phenomenological research. *Journal of Mixed Methods Research, 9*(1), 91-107. https://doi.org/10.1177/1558689813505358

Mazzei, J., & O'Brien, E. E. (2009). You got it, so when do you flaunt it? Building rapport, Intersectionality, and the strategic deployment of gender in the field. *Journal of contemporary ethnography, 38*(3), 358-383. https://doi.org/10.1177/0891241608330456

McAllister, T. (2022). 50 Reasons why there are no Māori in your science department. *Journal of Global Indigeneity, 6*, 1-10.

McAllister, T. G. (2019). Why isn't my professor Māori? A snapshot of the academic workforce in New Zealand universities. *MAI journal (Online), 8*(2), 235-249. https://doi.org/10.20507/MAIJournal.2019.8.2.10

McAllister, T. G., Naepi, S., Wilson, E., Hikuroa, D., & Walker, L. A. (2022). Under-represented and overlooked: Māori and Pasifika scientists in Aotearoa New Zealand's universities and crown-research institutes. *Journal of the Royal Society of New Zealand, 52*(1), 38-53. https://doi.org/10.1080/03036758.2020.1796103

McDonald, C. V. (2016, 01/01). STEM education: A review of the contribution of the disciplines of Science, Technology, Engineering and Mathematics. *Science Education International, 27*, 530-569.

McGovern, J. (2017). *Capturing the lived experience: Getting started with interpretive phenomenology research*. SAGE Publications Ltd.

McGrath, K. (2015). Sustainable growth of New Zealand's economy from New Zealand's science sector. *Journal of the Royal Society of New Zealand, 45*(2), 114-117. https://doi.org/10.1080/03036758.2015.1011174

McKinley, E. (2002). Brown bodies in white coats: Maori women scientists and identity. *Journal of Occupational Science, 9*(3), 109-116.

McKinley, E. (2003). *Brown bodies, white coats: Postcolonialism, Māori women, and science* The University of Waikato]. https://researchcommons.waikato.ac.nz/entities/publication/ca7ffc7c-5070-49a9-bd4b-5adabe523ff1

McKinley, E. (2005). Brown bodies, white coats: Postcolonialism, Māori Women and science. *Discourse: Studies in the Cultural Politics of Education, 26*(4), 481-496. https://doi.org/10.1080/01596300500319761

McKinley, E., Gan, M., Buntting, C., & Jones, A. (2015). New Zealand: Towards inclusive STEM education for all students. In B. Freeman, S. Marginson, & R. Tytler (Eds.), *The Age of STEM* (pp. 223-236). Routledge. https://doi.org/10.4324/9781315767512-21

McLean, V. (2023). *Index of excellence in STEM education compares U.S. students to global competition*. https://www.cee.org/newsevents/press-releases/index-excellence-stem-education-compares-us-students-global-competition-0

Melinda, W. (2018). *Starpath project: What have we learned?* https://www.auckland.ac.nz/en/news/2018/05/24/starpath-project-what-have-we-learned.html

Mercier, O. (2018). Mātauranga and science. *New Zealand science review, 74*, 83-90.

Mergendoller, J., Maxwell, N., & Bellisimo, Y. (2006, 11/17). The effectiveness of problem-based instruction: A comparative study of instructional methods and student characteristics. *Interdisciplinary Journal of Problem-Based Learning, 1*. https://doi.org/10.7771/1541-5015.1026

Metcalf, H., Russell, D., & Hill, C. (2018). Broadening the science of broadening participation in STEM through critical mixed methodologies and intersectionality frameworks. *American Behavioral Scientist, 62*(5), 580-599. https://doi.org/10.1177/0002764218768872

Millar, V. (2020). Trends, issues and possibilities for an interdisciplinary STEM curriculum. *Science & education, 29*(4), 929-948. https://doi.org/10.1007/s11191-020-00144-4

Ministry for Women. (2017). *Empirical evidence of the gender pay gap in New Zealand*. http://women.govt.nz/sites/public_files/Empirical%20evidence%20of%20GPG%20in%20NZ%20-%20Mar2017_0.pdf

Ministry of Business Innovation & Employment. (2024). *Gender Pay Gap*. https://www.employment.govt.nz/fair-work-practices/pay-and-gender-equity/gender-pay-gap

[Record #42 is using a reference type undefined in this output style.]

Ministry of Education. (2009). Ka Hikitia, Managing for success 2008-2012. *Te Tāhuhu o te Mātauranga*. https://web-assets.education.govt.nz/s3fs-public/2024-06/KaHikitia2009PartOne.pdf?VersionId=MrBnBXNPOMWDRHXYhG3jfJeEH1ZY7rOs

Ministry of Education. (2011). *Cultural competencies for teachers of Māori learners*. https://teachingcouncil.nz/assets/Files/Code-and-Standards/Tataiako-cultural-competencies-for-teachers-of-Maori-learners.pdf

Ministry of Education. (2013). *Ka Hikitia, Accelerating Success 2013-2017*. https://kep.org.nz/assets/resources/site/Module-7a-Ka-Hikitia-Accelerating-Success.pdf

Ministry of Education. (2017a). *Digital technologies and the New Zealand Curriculum* (Te Tāhuhu o te Mātauranga, Issue. https://assets.education.govt.nz/public/Documents/dthm/DT-Support-Booklet-PRINT-PDF-20-07web.pdf

Ministry of Education. (2017b). *Ka Hikitia 2013-2017*. https://www.education.govt.nz/our-work/strategies-policies-and-programmes/maori-education-and-language/ka-hikitia-accelerating-success-2013-2017

Ministry of Education. (2017c). *Māori Education*. https://www.education.govt.nz/assets/Documents/Ministry/Publications/Briefings-to-Incoming-Ministers/4-1093092-Maori-Education-BIM-Annex-ABC.PDF

Ministry of Education. (2017d). *Te Kotahitanga*. http://tekotahitanga.tki.org.nz/

Ministry of Education. (2018). *STEM/STEAM*. https://elearning.tki.org.nz/Teaching/Future-focused-learning/STEM-STEAM#js-tabcontainer-1-tab-2

Ministry of Education. (2023a). *Change 2- Equal status for mātauranga Māori in NCEA*. https://ncea.education.govt.nz/change-2-equal-status-matauranga-maori-ncea

Ministry of Education. (2023b). *Project based learning*. TKI. https://elearning.tki.org.nz/Teaching/Future-focused-learning/Project-based-learning

Ministry of Education. (2024). *Rangatahi Māori who were aged 15 years in 2009 - their educational achievement, participation in education and employment up to 2022*. https://www.educationcounts.govt.nz/publications/80898/rangatahi-maori-who-were-aged-15-years-in-2009-their-educational-achievement,-participation-in-education-and-employment-up-to-2022

Mistry, R. S., Nenadal, L., Hazelbaker, T., Griffin, K. M., & White, E. S. (2017). Promoting elementary school-age children's understanding of wealth, poverty, and civic engagement. *PS, political science & politics, 50*(4), 1068-1073. https://doi.org/10.1017/S1049096517001329

Moffitt, U., Juang, L. P., & Syed, M. (2020, 2020-January-31). Intersectionality and youth identity development research in Europe [Review]. *Frontiers in psychology, 11*. https://doi.org/10.3389/fpsyg.2020.00078

Moffitt, U., Katsiaficas, D., Ghavami, N., Minor, I., Padilla, D., & Rogers, L. O. (2023, 2023/10/02). Intersectionality and identity: A systematic review and qualitative analysis of U.S. research in Psychological Science. *Identity, 23*(4), 288-313. https://doi.org/10.1080/15283488.2023.2223647

Mohr-Schroeder, M. J., Cavalcanti, M., & Blyman, K. (2015). Stem education: Understanding the changing landscape. In (pp. 3-14). SensePublishers. https://doi.org/10.1007/978-94-6300-019-2_1

Morgenroth, T., Ryan, M., Rink, F., & Begeny, C. (2020, 08/01). The (in)compatibility of identities: Understanding gender differences in work–life conflict through the fit with leaders. *British Journal of Social Psychology, 60*. https://doi.org/10.1111/bjso.12411

Nash, J. C. (2008). Re-thinking intersectionality. *Feminist Review*(89), 1-15. http://www.jstor.org/stable/40663957

New Zealand Government. (2022). *PISA 2022: Ākonga Māori summary*. https://www.educationcounts.govt.nz/publications/schooling/pisa-2022-Akonga-maori-summary

New Zealand Government. (2024). *The Waitangi Tribunal*. https://www.waitangitribunal.govt.nz/en

Ngā Taonga. (2024). *Te Māori 40th anniversary collection*. https://www.ngataonga.org.nz/news/nga-taonga-news/te-maori-40th-anniversary-collection/

Nielson, M. G., Martin, C. L., England, D. E., Hanish, L. D., Santos, C. E., Delay, D., Updegraff, K. A., & Rogers, A. A. (2024, May). Patterns of gender development across intersections of age, gender, and ethnicity-race. *Arch Sex Behav, 53*(5), 1793-1812. https://doi.org/10.1007/s10508-024-02824-6

NSF. (2024). *Elementary and Secondary STEM education* (Science and Engineering Indicators 2024, Issue. N. S. F. (USA). https://ncses.nsf.gov/pubs/nsb202331/assets/nsb202331.pdf

NZARE. (2010). *Ethical Guidelines*. http://www.nzare.org.nz/portals/306/images/Files/NZARE%20EthicalGuidelines2010.pdf

NZQA. (2025). *NCEA levels and certificates*. https://www2.nzqa.govt.nz/ncea/about-ncea/ncea-levels-and-certificates/

Ofek-Geva, E. (2025, 2025/03/01/). Pathways to science: Factors shaping early adolescent science identity development. *Journal of Applied Developmental Psychology, 97*, 101756. https://doi.org/https://doi.org/10.1016/j.appdev.2025.101756

Ong, M., Smith, J. M., & Ko, L. T. (2018). Counterspaces for Women of Color in STEM higher education: Marginal and central spaces for persistence and success. *Journal of Research in Science Teaching, 55*(2), 206-245. https://doi.org/10.1002/tea.21417

Onwuegbuzie, A., & Leech, N. (2005). On becoming a pragmatic researcher: The importance of combining quantitative and qualitative research methodologies. *International Journal of Social Research Methodology, 8*(5), 375-387. https://doi.org/10.1080/13645570500402447

Osterman, K. F. (2000, 2000/09/01). Students' need for belonging in the school community. *Review of educational research, 70*(3), 323-367. https://doi.org/10.3102/00346543070003323

Pack, S., Tuffin, K., & Lyons, A. (2016). Accounting for racism against Maori in Aotearoa/New Zealand: A discourse analytic study of the views of Maori adults.

Journal of Community & Applied Social Psychology, 26(2), 95-109. https://doi.org/10.1002/casp.2235

Pandeli, J., Sutherland, N., & Gaggiotti, H. (2022). *Organizational Ethnography: An experiential and practical guide* (1st ed., Vol. 1). Routledge. https://doi.org/10.4324/9781003021582

Paradies, Y. (2006). A systematic review of empirical research on self-reported racism and health. *International journal of epidemiology, 35*(4), 888-901. https://doi.org/10.1093/ije/dyl056

Peiris-John, R., Ball, J., Clark, T., & Fleming, T. (2024). *Youth mental health needs and opportunities: Leveraging 25 years of research from the Youth2000 survey series.* https://static1.squarespace.com/static/5bdbb75ccef37259122e59aa/t/67070339e1026c23bbd4fbe1/1728512837095/Youth19+Mental+Health+summaries_FINAL_Tuesday+Oct+8.pdf

Pérez-Torres, V. (2024). Social media: A digital social mirror for identity development during adolescence. *Current psychology (New Brunswick, N.J.), 43*(26), 22170-22180. https://doi.org/10.1007/s12144-024-05980-z

Phillippi, J., & Lauderdale, J. (2018). A guide to field notes for qualitative research: Context and conversation. *Qualitative Health Research, 28*(3), 381-388. https://doi.org/10.1177/1049732317697102

Pihama, L., Reynolds, P., Smith, C., Reid, J., Smith, L. T., & Nana, R. T. (2014). Positioning historical trauma theory within Aotearoa New Zealand. *AlterNative: An International Journal of Indigenous Peoples, 10*(3), 248-262. https://doi.org/10.1177/117718011401000304

Pipi, K., Cram, F., Hawke, R., Hawke, S., Huriwai, T., Mataki, T., Milne, M., Morgan, K., Tuhaka, H., & Tuuta, C. (2004). A research ethic for studying Maori and Iwi provider success. *Social Policy Journal of New Zealand, 23*, 141-154.

Pugach, M. C., Gomez-Najarro, J., & Matewos, A. M. (2019). A review of identity in research on social justice in teacher education: What role for intersectionality? *Journal of teacher education, 70*(3), 206-218. https://doi.org/10.1177/0022487118760567

Pūhoro. (2025). *Pūhoro STEMM Te Pūhorotanga o te ao Pūrau*. https://www.puhoro.org.nz/

Punch, S. (2012). Hidden struggles of fieldwork: Exploring the role and use of field diaries. *Emotion, space and society, 5*(2), 86-93. https://doi.org/10.1016/j.emospa.2010.09.005

Ramiah, R., Godinho, L., & Wilson, C. (2022). Tertiary STEM for all: Enabling student success through teaching for equity, diversity and inclusion in STEM. *International Journal of Innovation in Science and Mathematics Education, 30*(3), 32-45. https://doi.org/10.30722/IJISME.30.03.003

Ramsook, L. (2018). A methodological approach to hermeneutic phenomenology. *International journal of humanities and social sciences, 10*(1), 14-24.

Rani, S. (2025, 02/17). Studying the impact of anxiety, stress, and emotion on academic performance: A systematic review. *Journal of Social, Humanity, and Education, 5*, 131-141. https://doi.org/10.35912/jshe.v5i2.2437

Reason, P., & Bradbury, H. (2001). *Handbook of Action Research: Participative inquiry and practice*. Sage.

Reedy, E., Hauiti, C., Chadwick, T., & Gardiner, I. (2006). *Mana wahine Māori women & power* Auckland, N.Z, Front of the Box Productions.

Reilly, A. (2019). Maori women, discrimination and paid work: The need for an intersectional approach. *Law Review 50*(2), 321-339. https://doi.org/10.26686/vuwlr.v50i2.5748

Reisen, C. A., Brooks, K. D., Zea, M. C., Poppen, P. J., & Bianchi, F. T. (2013, Apr). Can additive measures add to an intersectional understanding? Experiences of gay and ethnic discrimination among HIV-positive Latino gay men. *Cultural Diversity & Ethnic Minority Psychology 19*(2), 208-217. https://doi.org/10.1037/a0031906

Rentzi, A. (2024). Social justice in education: Creating an inclusive culture at schools htrough critical multi-cultural theory. *European Journal of Eductaion and Pedagogy, 5*, 94-97. https://doi.org/https://doi.org/10.24018/ejedu.2024.5.1.802

Reznik, G., Massarani, L., & Calabrese Barton, A. (2023). Informal science learning experiences for gender equity, inclusion and belonging in STEM through a feminist intersectional lens. *Cultural Studies of Science Education, 18*(3), 959-984.

Rhinow, A., Noweski, C., & Meinel, C. (2012, 10/31). Transforming constructivist learning into action: Design Thinking in education.

Robnett, R. D., Daniels, E. A., & Leaper, C. (2018). Growing up gendered: Feminist perspectives on development. In C. B. Travis, J. W. White, A. Rutherford, W. S. Williams, S. L. Cook, & K. F. Wyche (Eds.), *APA handbook of the psychology of women: History, theory, and battlegrounds* (pp. 437-454).

Rodham, K., Fox, F., & Doran, N. (2015). Exploring analytical trustworthiness and the process of reaching consensus in interpretative phenomenological analysis: Lost in transcription. *International Journal of Social Research Methodology, 18*(1), 59-71. https://doi.org/10.1080/13645579.2013.852368

Rogers, L. O., Meltzoff, A. N., & Lee, R. M. (2017). Is gender more important and meaningful than Race? An analysis of racial and gender identity among Black, White, and Mixed-Race children. *Cultural diversity & ethnic minority psychology, 23*(3), 323-334. https://doi.org/10.1037/cdp0000125

Rolleston, A., McDonald, M., & Miskelly, P. (2022). Our story: A Māori perspective of flourishing whānau. *Kōtuitui, 17*(3), 277-297. https://doi.org/10.1080/1177083X.2021.1981955

Rorintulus, O. A., Saktiningrum, N., Wuntu, C. N., Hafizh, M. A., & Mamentu, A. C. (2024). Raising awareness of gender discrimination against Indigenous Australian women of the stolen generation through Doris Kartinyeri's Kick The Tin. *Journal of language teaching and research, 15*(4), 1323-1330. https://doi.org/10.17507/JLTR.1504.30

Roy, R., & Greaves, L. (2021). *Youth2000 survey series negotiating multiple identities: Intersecting identities among Māori, Pacific, Rainbow and Disabled young people*.

Roy, R., Greaves, L., Fenaughty, J., Fleming, T., & Clark, T. C. (2023). Mental health and wellbeing for young people from intersectional identity groups: Inequity for Maori, Pacific, Rainbow young people, and those with a disabling condition. *New Zealand Journal of Psychology 52*(1), 25.

Rozek, C. S., Svoboda, R. C., Harackiewicz, J. M., Hulleman, C. S., & Hyde, J. S. (2017). Utility-value intervention with parents increases students' STEM preparation and career pursuit. *Proceedings of the National Academy of Sciences - PNAS, 114*(5), 909-914. https://doi.org/10.1073/pnas.1607386114

Rubie-Davies, C. M., & Hattie, J. A. (2025). The powerful impact of teacher expectations: A narrative review. *Journal of the Royal Society of New Zealand, 55*(2), 343-371. https://doi.org/10.1080/03036758.2024.2393296

Rubie-Davies, C. M., & Peterson, E. R. (2016). Relations between teachers & achievement, over- and underestimation, and students beliefs for Māori and Pākehā students. *Contemporary Educational Psychology*. https://doi.org/10.1016/j.cedpsych.2016.01.001

Salikha, U. A., Sholihin, H., & Winarno, N. (2020, 2021). The influence of STEM project-based learning on students' motivation in heat transfer learning. *Journal of Physics: Conference Series, 1806*, 12222. https://doi.org/10.1088/1742-6596/1806/1/012222

Salmon, R. A., & and Priestley, R. K. (2015, 2015/04/03). A future for public engagement with science in New Zealand. *Journal of the Royal Society of New Zealand, 45*(2), 101-107. https://doi.org/10.1080/03036758.2015.1023320

Salzano, R., Hall, H., Webster, G., & Brazier, D. (2023). Community validation as a method to establish trustworthiness in qualitative LIS research. *Proceedings of the Association for Information Science and Technology, 60*(1), 1110-1112. https://doi.org/10.1002/pra2.961

Sanders, M. E. (2008). STEM, STEM Education, STEMmania. *Technology and Engineering Teacher, 68*(4), 20.

Saunders, K. (2024). Supporting teacher-parent partnerships using the PATI model. *Research Information for Teachers, 1*. https://doi.org/https://doi.org/10.18296/set.1546

Scott, D. (2014). Ontology, epistemology, strategy and method in educational research. A critical realist approach. *Magis, 7*(14), 29-38.

Sen, A. K. (2006). *Identity and violence: The illusion of destiny* (1st ed. ed.). W. W. Norton & Co.

Settles, I. H., & Buchanan, N. T. (2014). Multiple groups, multiple identities, and intersectionality. *The Oxford handbook of multicultural identity, 1*, 160-180.

Sexton, S. S. (2024). Culturally responsive teaching through primary science in Aotearoa New Zealand. *London review of education, 22*(1). https://doi.org/10.14324/LRE.22.1.04

Shirazi, R. (2019). Somewhere we can breathe: Diasporic counterspaces of education as sites of epistemological possibility. *Comparative education review, 63*(4), 480-501. https://doi.org/10.1086/705427

Shmulsky, S., Gobbo, K., Donahue, A., & Klucken, F. (2021). Do neurodivergent college students forge a disability identity? A snapshot and implications. *Journal of Postsecondary Education and Disability, 34*(1), 53-63.

Simmonds, N. (2011). Mana wahine: Decolonising politics. *Women's studies journal, 25*(2), 11.

Slaughter-Acey, J., Simone, M., Hazzard, V. M., Arlinghaus, K. R., & Neumark-Sztainer, D. (2023). More than identity: An intersectional approach to understanding mental-emotional well-being of emerging adults by centering lived experiences of marginalization. *American journal of epidemiology, 192*(10), 1624-1636. https://doi.org/10.1093/aje/kwad152

Smith, Maynard, N., Berry, A., Stephenson, T., Spiteri, T., Corrigan, D., Mansfield, J., Ellerton, P., & Smith, T. (2022). Principles of Problem-Based Learning (PBL) in STEM education: Using expert wisdom and research to frame educational practice. *Education sciences, 12*(10), 728. https://doi.org/10.3390/educsci12100728

Smith, C. W. R., Tinirau, R., Mana, H. R. T., Tawaroa, M., Barnes, H. M., Cormack, D., & Fitzgerald, E. (2021). *Whakatika: A survey of Māori experiences of racism*. Te Atawhai o Te Ao Charitable Trust. https://ndhadeliver.natlib.govt.nz/delivery/DeliveryManagerServlet?dps_pid=IE65760573

Smith, J. A., Flowers, P., & Larkin, M. (2022). *Interpretative phenomenological analysis: Theory, method and research* (2nd edition. ed.). SAGE.

Smith, L. T. (1999). *Decolonizing methodologies: Research and iIdigenous peoples*. London : Zed Books ; Dunedin : University of Otago Press.

Smith, L. T. (2013). *Decolonizing methodologies: Research and Indigenous peoples*. Zed Books Ltd.

Smithson, J. (2000). Using and analysing focus groups: Limitations and possibilities. *International Journal of Social Research Methodology, 3*(2), 103-119.

Solorzano, D., Ceja, M., & Yosso, T. (2000). Critical Race Theory, racial microaggressions, and campus racial climate: The experiences of African American college students. *The Journal of Negro education, 69*(1/2), 60-73.

Sparks, D. (2017). Navigating STEM-worlds. *Journal for Multicultural Education, 11*(3), 162-175. https://doi.org/10.1108/JME-12-2015-0049

Statistics New Zealand. (2013). *Census QuickStats about Māori*. www.stats.govt.nz.

Statistics New Zealand. (2025). *General Social Survey (GSS)*. https://www.stats.govt.nz/search?Search=general%20social%20survey%20

Stewart. (2023, 04/18). The 51st reason why there are so few Māori in science. *ACCESS: Contemporary Issues in Education, 43*. https://doi.org/10.46786/ac23.4369

Stewart, G. (2011a). The extra strand of the Maori science curriculum. *Educational Philosophy and Theory, 43*(10), 1175-1182. https://doi.org/10.1111/j.1469-5812.2010.00669.x

Stewart, G. (2011b). Science in the Māori-Medium curriculum: Assessment of policy outcomes in Putaiao education. *Educational Philosophy and Theory, 43*(7), 724-741. https://doi.org/10.1111/j.1469-5812.2009.00557.x

Stewart, G. (2012). Achievements, orthodoxiesand science in Kaupapa Maori schooling. *New Zealand Journal of Educational Studies, 47*(2), 51-63.

Stewart, G. T. (2022). Mātauranga Māori: A philosophy from Aotearoa. *Journal of the Royal Society of New Zealand, 52*(1), 18-24. https://doi.org/10.1080/03036758.2020.1779757

Stewart, G. T. (2023). Academic-Māori-Woman: The impossible may take a little longer. *Educational Philosophy and Theory, 55*(9), 990-993. https://doi.org/10.1080/00131857.2021.1892484

Stewart, G. T. (2024). Defending science from what? *Educational Philosophy and Theory, 56*(ahead-of-print), 509-512. https://doi.org/10.1080/00131857.2021.1966415

Stolz, S. A. (2023). The practice of phenomenology in educational research. *Educational Philosophy and Theory, 55*(7), 822-834. https://doi.org/10.1080/00131857.2022.2138745

Strayhorn, T. (2018). *College students' sense of belonging: A key to educational success for all students*. https://doi.org/10.4324/9781315297293

Strobel, J., & Van Barneveld, A. (2009, 03/24). When is PBL More Effective? A meta-synthesis of meta-analyses comparing PBL to conventional classrooms. *Interdisciplinary Journal of Problem-Based Learning, 3*. https://doi.org/10.7771/1541-5015.1046

Stroud, B. (2011). Epistemology, the history of epistemology, historical epistemology. *An International Journal of Scientific Philosophy, 75*(3), 495-503. https://doi.org/10.1007/s10670-011-9337-4

Sunarno, W. (2019). The effect of project based learning on learning environment and learning outcomes in vocational high school students. Journal of Physics: Conference Series,

Syed, M. (2010). Disciplinarity and methodology in intersectionality theory and research. *American Psychologist, 65*(1), 61-62. https://doi.org/10.1037/a0017495

Symington, D., & Tytler, R. (2011). Schools and teachers supporting student open investigations. *Teaching Science, 57*(1), 8-12.

Taiaroa, R., & Smith, W. (2017). Māori students' experiences of their Māori identity in a bachelor of physical education. *MAI journal, 6*(1), 17-30.

Teaching Council. (2017). *Standards for the teaching profession*. https://teachingcouncil.nz/assets/Files/Code-and-Standards/Standards-for-the-Teaching-Profession-English-two-pages.pdf

Tefera, A. A., Powers, J. M., & Fischman, G. E. (2018). Intersectionality in education: A conceptual aspiration and research imperative. *Review of Research in Education, 42*(1), vii-xvii. https://doi.org/10.3102/0091732X18768504

Tesch, R. (1990). *Qualitative research: Analysis types and software tools*. Psychology Press.

The University of Auckland. (2025). *STEM online NZ*. https://www.stemonline.auckland.ac.nz/the-standards/

Theodore, R., Tustin, K., Kiro, C., Gollop, M., Taumoepeau, M., Taylor, N., Chee, K.-S., Hunter, J., & Poulton, R. (2015). Māori university graduates: Indigenous participation in higher education. *Higher Education Research & Development*, 1-15. https://doi.org/10.1080/07294360.2015.1107883

Theriault, D., & Daniel, J. (2014). *Principles for the application of intersectionality to qualitative inquiry*.

Thibaut, L., Ceuppens, S., De Loof, H., De Meester, J., Goovaerts, L., Struyf, A., Boeve-de Pauw, J., Dehaene, W., Deprez, J., De Cock, M., Hellinckx, L., Knipprath, H., Langie, G., Struyven, K., Van de Velde, D., Van Petegem, P., & Depaepe, F. (2018, 05/01). Integrated STEM education: A systematic review of instructional practices in secondary education. *European Journal of STEM Education, 3*. https://doi.org/10.20897/ejsteme/85525

Thomas, D. (2003, 09/01). A general inductive approach for Qualitative data analysis. *The American Journal of Evaluation, 27*.

Tinner, L., Holman, D., Ejegi-Memeh, S., & Laverty, A. A. (2023, Jul 15). Use of intersectionality theory in interventional health research in high-income countries: A scoping review. *International Journal of Environmental Research and Public Health, 20*(14). https://doi.org/10.3390/ijerph20146370

Tocker, K. (2015, 2015/04/01). The origins of Kura Kaupapa Māori. *New Zealand Journal of Educational Studies, 50*(1), 23-38. https://doi.org/10.1007/s40841-015-0006-z

Tolbert, S., Hipkins, R., Cowie, B., & Waiti, P. (2024). Epistemic agency, Indigenous knowledge, and the school science curriculum: reflections from Aotearoa New Zealand. *International Journal of Science Education*, 1-17. https://doi.org/10.1080/09500693.2024.2356229

Tolich, M. (2016). *Qualitative ethics in practice*. Walnut Creek, California : Left Coast Press, Inc.

Toyibah, D., & Riyani, I. (2022). Doing gender and race intersectionality: The experiences of female Māori and non-white academics in New Zealand. *International journal of Asia-Pacific studies, 18*(1), 31-47. https://doi.org/10.21315/IJAPS2022.18.1.2

Tsybulsky, D., & Sinai, E. (2022). IoT in project-based biology learning: Students' experiences and skill development. *Journal of Science Education and Technology, 31*(4), 542-553. https://doi.org/10.1007/s10956-022-09972-1

Turner, H., Rubie-Davies, C., & Webber, M. (2015). Teacher expectations, ethnicity and the achievement gap. *New Zealand Journal of Educational Studies, 50*(1), 55-69. https://doi.org/10.1007/s40841-015-0004-1

UNICEF. (2022). *Equity and inclusion in education. Ensuring no child or adolescent is left behind*. https://www.unicef.org/lac/en/equity-and-inclusion-education

van der Riet, M., & Grant, M. (2009, 03/01). Shifting research dynamics: Addressing power and maximising participation through participatory research techniques in participatory research. *South African Journal of Psychology, 39*, 1-18. https://doi.org/10.1177/008124630903900101

van Halderen, L. (2023, 06/30). Reflections and lessons of a non-Māori student working in a Kaupapa Māori research space. *MAI Journal. A New Zealand Journal of Indigenous Scholarship, 12*, 93-109. https://doi.org/10.20507/MAIJournal.2023.12.1.9

Van Manen, M. (1990). *Researching lived experience: Human science for an action sensitive pedagogy*. State University of New York Press.

Van Manen, M. (2023). *Phenomenology of practice: Meaning-giving methods in phenomenological research and writing*. Routledge.

Vasquez, J. (2015). Beyond the acronym. *Educational Leadership, 72*(4), 10.

Velez, G., & Spencer, M. B. (2018). Phenomenology and intersectionality: Using PVEST as a frame for adolescent identity formation amid intersecting ecological systems of inequality. *New directions for child and adolescent development, 2018*(161), 75-90. https://doi.org/10.1002/cad.20247

Verhoeven, M., Poorthuis, A. M. G., & Volman, M. (2019). The role of school in adolescents' identity development. A literature review. *Educational psychology review, 31*(1), 35-63. https://doi.org/10.1007/s10648-018-9457-3

Vincent-Ruz, P., & Schunn, C. D. (2018). The nature of science identity and its role as the driver of student choices. *International Journal of STEM Education, 5*(1), 48-12. https://doi.org/10.1186/s40594-018-0140-5

Waitoki, W. (2022). In defence of mātauranga Māori: A response to the 'seven academics'. *The New Zealand Medical Journal (Online), 135*(1552), 139-142.

Walter, M. (2013). *Social research methods* (3rd edition. ed.). Oxford University Press.

Wanders, F. H. K., Dijkstra, A. B., Maslowski, R., & van der Veen, I. (2020). The effect of teacher-student and student-student relationships on the societal involvement of students. *Research papers in education, 35*(3), 266-286. https://doi.org/10.1080/02671522.2019.1568529

Wang, H.-H., Moore, T. J., Roehrig, G. H., & Park, M. S. (2011). STEM integration: Teacher perceptions and practice. *Journal of pre-college engineering education research, 1*(2). https://doi.org/10.5703/1288284314636

Ward, K. (2015, 09/01). Evolving from a positivist to constructionist epistemology while using grounded theory: Reflections of a novice researcher. *Journal of Research in Nursing, 20*, 449-462. https://doi.org/10.1177/1744987115597731

Watkins, J., & Mazur, E. (2013). Retaining students in Science, Technology, Engineering, and Mathematics (STEM) majors. *Journal of college science teaching, 42*(5), 36-41. https://doi.org/10.2505/4/jcst13_042_05_36

Watson, P., Pearson, D., & Le Pelley, M. E. (2025). Isolating delayed attentional disengagement from biased orienting to signals of threat in anxiety–not there yet. *Cognition and emotion*, 1. https://doi.org/10.1080/02699931.2025.2459847

Wearmouth, J. (2017). Employing culturally responsive pedagogy to foster literacy learning in schools. *Cogent education, 4*(1), 1295824. https://doi.org/10.1080/2331186X.2017.1295824

Webber, M. (2024). Teaching the mana model - a Māori framework for reconceptualising success and thriving. *Research Information for Teachers, 1*. https://doi.org/https://doi.org/10.18296/set.1545

Webber, M., & Macfarlane, A. (2020). Mana Tangata: The five optimal cultural conditions for Māori student success. *Journal of American Indian education, 59*(1), 26-49. https://doi.org/10.5749/jamerindieduc.59.1.0026

Webber, M., McKinley, E., & Rubie-Davies, C. M. (2016). Making it personal: Academic counseling with Māori students and their families. *Contemporary Educational Psychology, 47*, 51-60. https://doi.org/10.1016/j.cedpsych.2016.03.001

Weeks, L. Y. (2021). A field in formation: Intersectionality is/as social justice. *Criticism, 63*(4), 441-444. https://doi.org/10.13110/criticism.63.4.0441

Weis, L., Eisenhart, M., Cipollone, K., Stich, A. E., Nikischer, A. B., Hanson, J., Ohle Leibrandt, S., Allen, C. D., & Dominguez, R. (2015). In the guise of STEM education reform: Opportunity structures and outcomes in inclusive STEM-focused high schools. *American Educational Research Journal, 52*(6), 1024-1059. https://doi.org/10.3102/0002831215604045

Wilhelm, J., Wilhelm, R., & Cole, M. (2019). *Creating project-based STEM Environments The REAL Way* (1st ed. 2019.. ed.). Springer International Publishing

Wilson, K. (2020). Exploring the challenges and enablers of implementing a STEM project-based learning programme in a diverse junior secondary context. *International Journal of Science and Mathematics Education, 19*(5), 881-897. https://doi.org/10.1007/s10763-020-10103-8

World Economic Forum. (2015). *New vision for Education. Unlocking the potential of technology*. https://www.bcgperspectives.com/Images/New_Vision_for_Education_WEF_2015.pdf

Yang, K.-L., Fang, S.-C., & Fan, S.-C. (2025, 2025/02/01). Development and validation of an instrument for assessing secondary students' transdisciplinary STEM practices. *International Journal of STEM Education, 12*(1), 5. https://doi.org/10.1186/s40594-025-00529-3

Yarkwah, C., Kpotosu, C. K., & Gbormittah, D. (2024). Effect of test anxiety on students' academic performance in mathematics at the senior high school level. *Discover education, 3*(1), 1-16. https://doi.org/10.1007/s44217-024-00343-z

Yip, T., & Lee, R. M. (2016). To be or not to be: How ethnic/racial stereotypes influence ethnic/racial disidentification and psychological mood. *Cultural diversity & ethnic minority psychology, 22*(1), 38-46. https://doi.org/10.1037/cdp0000046

Zepeda, S., & Mayers, S. (2006, 03/01). An analysis of research on block scheduling. *Review of educational research, 76*(1), 137-170. https://doi.org/10.3102/00346543076001137

Zhang, A. Y., & Gao, G. (2024, 02/01). Intersectionality in educational psychology and curriculum studies: A critical review. *Extensive Reviews, 4*, 1-14. https://doi.org/10.21467/exr.4.1.5387

Zhang, L., & Ma, Y. (2023). A study of the impact of project-based learning on student learning effects: A meta-analysis study. *Frontiers in psychology, 14*, 1202728. https://doi.org/10.3389/fpsyg.2023.1202728

Zhou, T., Zhou, X., & Wang, B. (2025). Latent profiles of learning engagement and anxiety in high school students: The mediating role of academic self-efficacy. *BMC Psychology, 13*(1), 784-719. https://doi.org/10.1186/s40359-025-03114-z

Zhou, X., Huang, J., Qin, S., Tao, K., & Ning, Y. (2023). Family intimacy and adolescent peer relationships: Investigating the mediating role of psychological capital and the moderating role of self-identity. *Frontiers in psychology, 14*, 1165830. https://doi.org/10.3389/fpsyg.2023.1165830

Appendices

Appendix 1. Discussion group questions for the Story Sharers

Interview 1

1. How are you enjoying being in the STEM class? What is it about being in the STEM class that makes you give that answer?
2. Just thinking about your STEM class, what do you think about it? Why? How does it compare to your previous science classes in Year 9/10?
3. Has your previous science class influenced your career goals? (Probe) What about STEM?
4. Does learning science/STEM help you with your learning in other subjects? Which? How?
5. What do you think about the STEM class? Why?
6. Regarding relationships with your teacher/class. If you had chosen a subject you were passionate about or a class you knew you needed to take a course you were passionate about but didn't have good relationships, what would you do?
7. What do you aim to gain/achieve from the STEM class? Why?
8. What support will you need to succeed?

Interview 2

1. Check the interpretations of the last discussion questions. Is there anything you would like to change or add?
2. What would you say are the reasons Māori wahine are not taking science subjects in year 12 and 13?
3. Why do you think women don't go into STEM jobs (like engineering)?
4. Why do you think that Māori wāhine would not choose a STEM job?
5. How could the school, like the STEM class, encourage Māori wāhine to choose STEM?

Interview 3

1. Check the interpretation of the Flowchart from last meeting. Anything to change? What would you add?
2. With reference to the flowchart - What could help you with the blockers?
3. In a world of no barriers, what would you like to achieve and do?
4. What would it take to get you there?
5. Anything we have done this year in STEM class to change your view?

Interview 4 (End of School Year)

1. Check the interpretations from the previous meeting. Are there any changes or improvements?
2. What do you feel you have achieved this year? What are the positives?
3. In a world of no barriers, what would you like to achieve and do? (check with previous answers have the goals changed)
4. What would it take to get you there?
5. Anything we have done this year to change your view?
6. What type of STEM career would you consider going into?
7. What would it take to get you there?

Interview 5 (Start of 2019 school year)

1. Check the interpretations from the previous meeting. Are there any changes or improvements?
2. Has anything changed for you over the holidays?
3. How have things changed for you now in Year 12?
4. What are your Goals?
5. What improvements could be made to the STEM class?
6. How can the STEM class help you to achieve your goals?

Interview 6 (End of 2019)

(Last meeting – STEM class had been disestablished since April 2019)

1. Explain the interconnected cogwheels – give examples and seek feedback. What would you change to improve this model?
2. How have you been able to concentrate on yourself and your needs? What changes have you made? What changes has the school made to help you?
3. What has helped most to change your mindset? How did the STEM class help with your goals and accomplishments?

Appendix 2. Ethics Approval

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

Division of Education Research
Ethics
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www.waikato.ac.nz

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

TE WĀNANGA
TOI TANGATA
DIVISION OF EDUCATION

14/2/2018

Cheryl Mitchell

Division of Education Research Ethics Committee Application Approved
FEDU009/18

I am pleased to advise you that your ethics application for the project entitled "How can a sustainability themed STEM (Science Technology Engineering Mathematics) programe encourage Māori women into the field?" was approved by Te Wānanga Toi Tangata Division of Education Research Ethics Committee on February 14th, 2018.

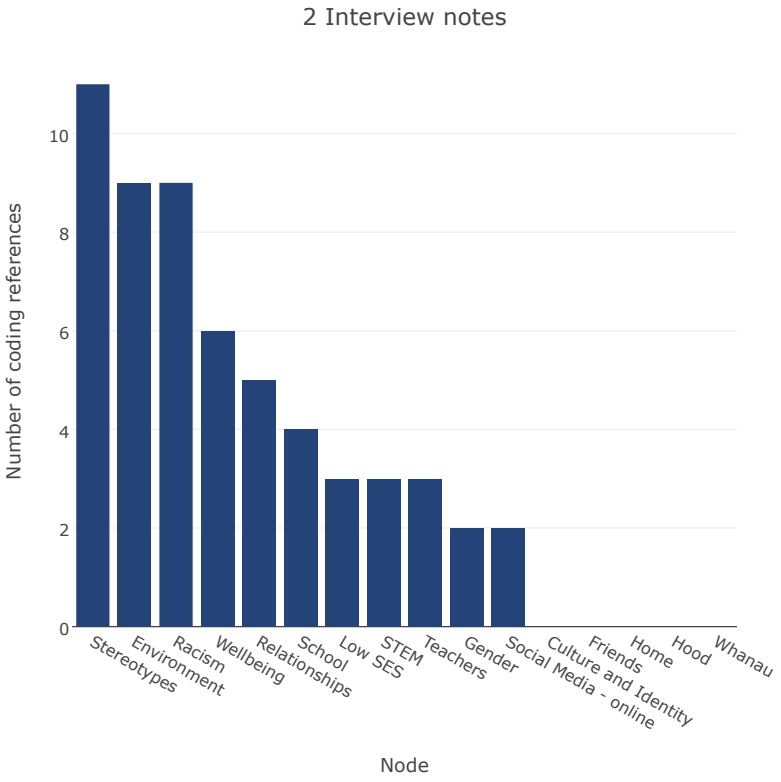
Please be aware that the Te Wānanga Toi Tangata Division of Education Research Ethics Committee must be advised (by memo) of any changes to the details recorded in your approved ethics application. This process is outlined in the application portal, under the heading 'Amendments for an approved application'.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

Kind regards
Ethics Committee

Te Wānanga Toi Tangata Division of Education Research Ethics Committee

Appendix 3. Examples of Data Analysis Outputs Using NVivo and Calculations with Excel

Bar chart of coding from one interview downloaded from NVivo



Calculating the percentages for one of the Story Sharers narratives after downloading coding data for themes from NVivo

Interview (All)	**1**	**2**	**3**	**4**	**5**	**Total**	**Percentage**
Stereotypes	1	11			5	17	17/46x100=37%
Racism		9	2			11	11/46x100=24%
Wellbeing		6	3	4	5	18	18/46x100=39%
Overall total						46	

Appendix 4. NCEA Unit Standards and Achievement Standards Used

Title	**Demonstrate knowledge of workplace health and safety requirements**		
Level	**1**	**Credits**	**3**

Purpose	People credited with this unit standard are able to identify and describe legislative rights and responsibilities for workplace health and safety; describe the systems approach to workplace health and safety; explain how risks and hazards are defined in the HSWA.

Classification	Occupational Health and Safety > Occupational Health and Safety Practice

Available grade	Achieved

Guidance Information

1 *PCBU* refers to a 'Person Conducting a Business or Undertaking'. The Health and Safety at Work Act: Quick reference guide can be sourced http://www.worksafe.govt.nz/worksafe/information-guidance/all-guidance-items/hswa-quick-reference-guide.

2 This unit standard is intended for use by employees as well as students and those on pre-employment training, and may be assessed in either a provider or workplace environment.

3 Legislation relevant to this unit standard includes – Health and Safety at Work Act 2015 (HSWA).

4 Any new, amended or replacement Acts, regulations, Rules, standards, codes of practice affecting this unit standard will take precedence for assessment purposes.

Outcomes and performance criteria

Outcome 1

Identify and describe legislative rights and responsibilities for workplace health and safety.

Performance criteria

1.1 Responsibilities of PCBUs (Persons Conducting a Business or Undertaking) under the HSWA are identified and described.

Range responsibilities include but are not limited to – taking all practicable steps to ensure the safety of workers, providing personal protective clothing and equipment, managing risks, providing supervision and training.

1.2 Responsibilities and rights of workers under the HSWA are identified and described.

Range responsibilities and rights include but are not limited to – protecting the health and safety of self and others, using protective clothing and equipment, the right to refuse unsafe work, to be adequately supervised and/or trained.

Outcome 2

Describe the systems approach to workplace health and safety.

Performance criteria

2.1 The principal systems are described in terms of their requirements.

Range principal systems include but are not limited to – emergency procedures, training, worker participation and engagement, risk identification and hazard reporting, risk management.

2.2 The hierarchy of controls is described in terms of eliminating and minimising risk.

Range evidence is required of two examples each of eliminating, and minimising risk.

Outcome 3

Explain how risks and hazards are defined in the HSWA.

Performance criteria

3.1 Risks and hazards are explained in terms of the requirements in the HSWA.

Range evidence is required of four examples of risks and hazards.

Planned review date	31 December 2022

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1	21 June 1993	31 December 2019
Review	2	4 October 1995	31 December 2019
Revision	3	30 September 1998	31 December 2019
Revision	4	9 August 1999	31 December 2019
Revision	5	14 March 2002	31 December 2019
Revision	6	16 May 2005	31 December 2019
Review	7	21 September 2007	31 December 2019
Rollover and Revision	8	22 May 2014	31 December 2021
Review	9	20 July 2017	N/A
Revision	10	22 August 2019	N/A

Consent and Moderation Requirements (CMR) reference	0121

This CMR can be accessed at http://www.nzqa.govt.nz/framework/search/index.do.

Comments on this unit standard

Please contact The Skills Organisation reviewcomments@skills.org.nz if you wish to suggest changes to the content of this unit standard.

Achievement Standard

Subject Reference	Agricultural and Horticultural Science 1.9				
Title	Demonstrate knowledge of basic plant propagation techniques				
Level	1	**Credits**	4	**Assessment**	Internal
Subfield	Science				
Domain	Agricultural and Horticultural Science				
Status	Registered		**Status date**		17 December 2010
Planned review date	31 December 2019		**Date version published**		20 November 2014

This achievement standard involves knowledge and understanding of basic plant propagation techniques.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Demonstrate knowledge of basic plant propagation techniques.	• Demonstrate in-depth knowledge of basic plant propagation techniques.	• Demonstrate comprehensive knowledge of basic plant propagation techniques.

Explanatory Notes

1 This achievement standard is derived from *The New Zealand Curriculum*, Learning Media, Ministry of Education, 2007, and based on the outcomes in the *Teaching and Learning Guide for Agricultural and Horticultural Science*, Ministry of Education, 2010 at http://seniorsecondary.tki.org.nz/.

2 *Demonstrate knowledge* involves describing the steps taken when performing basic plant propagation techniques to provide conditions important for successful propagation.

Demonstrate in-depth knowledge involves explanation of how basic plant propagation techniques provide conditions important for successful propagation.

Demonstrate comprehensive knowledge involves applying knowledge of basic plant propagation techniques or steps within techniques to provide conditions important for successful propagation. This will involve comparing and contrasting or justifying the use of these techniques or steps within techniques.

3 *Basic propagation techniques* must include sexual propagation (sowing seeds in containers and outdoors) and asexual propagation (cuttings [named type of stem or leaf]; division; and ground layering).

4 Conditions important for successful propagation refer to both environmental and biological conditions.

5 Environmental conditions include water, oxygen, warmth, bottom heat, high humidity, time of year and light.

6 Biological conditions include viable seed, plant type, plant material and plant health.

7 Conditions of Assessment related to this achievement standard can be found at http://ncea.tki.org.nz/Resources-for-Internally-Assessed-Achievement-Standards.

Quality Assurance

1 Providers and Industry Training Organisations must have been granted consent to assess by NZQA before they can register credits from assessment against achievement standards.

2 Organisations with consent to assess and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Consent and Moderation Requirements (CMR) reference 0233

Achievement Standard

Subject Reference	Science 1.7				
Title	Investigate the implications of the properties of metals for their use in society				
Level	1	**Credits**	4	**Assessment**	Internal
Subfield	Science				
Domain	Science - Core				
Status	Registered	**Status date**	30 November 2010		
Planned review date	31 December 2019	**Date version published**	20 November 2014		

This achievement standard involves carrying out practical activities to investigate the implications of the properties of metals for the way that they are used in society.

Mutual exclusion exists between this standard and AS90933.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Investigate the implications of the properties of metals for their use in society.	• Investigate, in depth, the implications of the properties of metals for their use in society.	• Investigate, comprehensively, the implications of the properties of metals for their use in society.

Explanatory Notes

1 This achievement standard is derived from *The New Zealand Curriculum,* Learning Media, Ministry of Education, 2007, Level 6. It is aligned with the Nature of Science and the Material World strands, and is related to the material in the *Teaching and Learning Guide for Science*, Ministry of Education, 2010 at http://seniorsecondary.tki.org.nz.

This standard is also derived from Te Marautanga o Aotearoa. For details of Te Marautanga o Aotearoa achievement objectives to which this standard relates, see the Papa Whakaako.

2 This investigation involves collecting information about the implications of the properties of metals for their use in society. The information could come from a variety of sources such as direct observations, collection of experimental data, resource sheets, photos, videos, websites and reference texts.

The procedures outlined in *Safety and Science: A Guidance Manual for New Zealand Schools*, Learning Media, Ministry of Education, 2000, must be followed during any practical component of the investigation.

3 *Investigate* involves gathering primary data, making and recording experimental observations of the physical and chemical properties of metals, and also typically includes describing, gathering, processing, interpreting, identifying, classifying and giving an account of the properties of metals and the implications for their use in society. This requires the use of chemistry vocabulary, symbols and conventions (including names and formulae), and writing word equations.

4 *Investigate in depth* involves making links between the physical and chemical properties of metals and the implications for their use in society. This requires explanations that use chemistry vocabulary, symbols and conventions (including names and formulae), and completing symbol equations.

5 *Investigate comprehensively* typically involves explaining, elaborating, justifying, relating, evaluating, comparing and contrasting, or analysing the links between the chemical and physical properties of metals and the implications of their use in society. This includes the activity series of metals and requires explanations that consistently use chemistry vocabulary, symbols and conventions (including names and formulae), including writing balanced symbol equations.

6 *Implications* include the consequences of particular properties for the ways that metals are extracted from their ores, treated to prevent corrosion, or used for specific purposes.

7 *Properties* include:

- Physical properties may include - melting point, colour, lustre, hardness, ductility and malleability, electrical and thermal conductivity, density.
- Chemical properties may include - reaction with oxygen, water and acids (HCl, H_2SO_4).

8 Conditions of Assessment related to this achievement standard can be found at http://ncea.tki.org.nz/Resources-for-Internally-Assessed-Achievement-Standards.

Quality Assurance

3 Providers and Industry Training Organisations must have been granted consent to assess by NZQA before they can register credits from assessment against achievement standards.

4 Organisations with consent to assess and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Consent and Moderation Requirements (CMR) reference	0233

Achievement Standard

Subject Reference	Science 1.15				
Title	Demonstrate understanding of the effects of astronomical cycles on planet Earth				
Level	1	**Credits**	4	**Assessment**	Internal
Subfield	Science				
Domain	Science - Core				
Status	Registered	**Status date**	30 November 2010		
Planned review date	31 December 2019	**Date version published**	20 November 2014		

This achievement standard involves demonstrating understanding of the effects of astronomical cycles on planet Earth.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Demonstrate understanding of the effects of astronomical cycles on planet Earth.	• Demonstrate in-depth understanding of the effects of astronomical cycles on planet Earth.	• Demonstrate comprehensive understanding of the effects of astronomical cycles on planet Earth.

Explanatory Notes

1 This achievement standard is derived from *The New Zealand Curriculum,* Learning Media, Ministry of Education, 2007, Level 6. It is aligned with the Astronomical Systems achievement objective in the Planet Earth and Beyond strand, and the Nature of Science strand, and is related to the material in the *Teaching and Learning Guide for Science*, Ministry of Education, 2010 at http://seniorsecondary.tki.org.nz.

This standard is also derived from Te Marautanga o Aotearoa. For details of Te Marautanga o Aotearoa achievement objectives to which this standard relates, see the Papa Whakaako.

2 *Demonstrate understanding* involves describing astronomical cycles and the effects on planet Earth using information, visual representations, and data.

3 *Demonstrate in-depth understanding* involves explaining astronomical cycles and the effects on planet Earth using information, visual representations, and data.

4 *Demonstrate comprehensive understanding* involves explaining thoroughly links between astronomical cycles and the effects on planet Earth using information, visual

representations, and data. It may involve elaborating, applying, justifying, relating, evaluating, comparing and contrasting, or analysing.

5 *Astronomical cycles* are:
- Spin of the Earth
- Orbit of Earth around Sun
- Orbit of Moon around Earth
- Effect of the Earth's tilt and the heating effect of the Sun.

6 *Effects on planet Earth* may be selected from:
- Day and night
- Seasons
- Changes of temperature during the day and night
- Seasonal changes at the North and South poles, latitude of New Zealand, Tropics of Cancer and Capricorn, and the Equator
- Formation and direction of winds in the Southern hemisphere - direction of surface ocean current flows in the Pacific Ocean
- Phases of the Moon
- Formation of tides
- Neap and Spring tides.

7 Conditions of Assessment related to this achievement standard can be found at http://ncea.tki.org.nz/Resources-for-Internally-Assessed-Achievement-Standards.

Replacement Information
This achievement standard replaced AS90192.

Quality Assurance

5 Providers and Industry Training Organisations must have been granted consent to assess by NZQA before they can register credits from assessment against achievement standards.

6 Organisations with consent to assess and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Consent and Moderation Requirements (CMR) reference 0233

Achievement Standard

Subject Reference	Psychology 1.1				
Title	Demonstrate understanding of psychological approaches				
Level	1	**Credits**	6	**Assessment**	Internal
Subfield	Social Science Studies				
Domain	Psychology				
Status	Registered		**Status date**	17 November 2016	
Planned review date	31 December 2019		**Date version published**	17 November 2016	

This achievement standard involves demonstrating understanding of psychological approaches.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Demonstrate understanding of psychological approaches.	• Demonstrate in-depth understanding of psychological approaches.	• Demonstrate comprehensive understanding of psychological approaches.

Explanatory Notes

1 This achievement standard is derived from *The New Zealand Curriculum*, Learning Media, Ministry of Education, 2007, Social Sciences learning area, and the Level 6 achievement objectives and is related to the material in the *Teaching and Learning Guide for Psychology*, Ministry of Education, 2010 at http://seniorsecondary.tki.org.nz.

2 *Demonstrate understanding* involves describing the distinctive features of at least three psychological approaches. The description of the features includes:
- the main ideas of the psychological approach
- psychological theories that are aligned to that approach.

Demonstrate in-depth understanding involves explaining the distinctive features of the psychological approaches. The description of the features includes:
- explanations of psychological theories or studies; and
- references to psychological theories or studies.

Demonstrate comprehensive understanding involves giving a thorough explanation of the distinctive features of the psychological approaches and describing how the features may be applied to a real-life context.

3 *Psychological approaches* refer to paradigms about people and the way that they function. In psychology there are a number of different approaches. There may be several different theories within an approach, but they share common assumptions that

tie them to that approach. Different approaches may offer different explanations for behaviours. Examples of psychological approaches include:

- behavioural
- biological
- cognitive
- sociocultural
- humanistic
- psychodynamic.

4 Conditions of Assessment related to this achievement standard can be found at http://ncea.tki.org.nz/Resources-for-Internally-Assessed-Achievement-Standards.

Replacement Information
This achievement standard replaced unit standard 27255.

Quality Assurance

1 Providers and Industry Training Organisations must be accredited by NZQA before they can register credits from assessment against achievement standards.

2 Organisations with consent to assess and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Consent and Moderation Requirements (CMR) reference	0233