CONCOVE TŪHURA

Foundation programmes and the underrepresentation of women and Māori in engineering study at polytechnics in New Zealand

November 2025 | James Mackay

I wish to thank the following for their help in developing this report:

- ConCoVE for their funding and support, particularly Mani Saini and Eve Price;
- All the participants in the study, who gave of their time and made very helpful suggestions;
- Joelle Peters for her help in capturing the data we collected;
- Karsten Zegwaard and Brendan Mischewski, our two peer reviewers, for their meticulous reviews and useful suggestions.

CONTENTS

CONTENTS CONTINUED

1. EXECUTIVE SUMMARY

Worldwide, foundational programmes have been developed to enable students without the necessary prerequisites to enter into and be successful in science and engineering study. Often the development of these programmes has been driven by a necessity to address underrepresentation of minorities in specific disciplines. At polytechnics across Aotearoa New Zealand, there is a noticeable lack of representation of women and Māori students in engineering study, with both groups typically averaging below 10% of the annual cohort. The provision of engineering foundation programmes, while a successful support mechanism for many students, has not had a substantial effect on improving this underrepresentation.

This report describes an investigation of engineering foundation programmes at 14 polytechnics offering either degree or diploma engineering programmes in Aotearoa New Zealand. Using a mixed methods approach, engineering schools were surveyed about their programmes and follow up interviews with academic staff and other stakeholders were used to determine what barriers currently exist for women, Māori and Pasifika students in engineering study. These data were coupled with a student survey carried out over five institutions totalling 107 respondents. Results of this investigation are as follows:

Foundation programme provision

Of the 14 institutions investigated, one did not offer either a degree or a diploma in engineering and of the other 13, nine offered some version of a foundation programme. Across Aotearoa New Zealand, three different models of engineering foundation are currently available. These include:

- Non-certified pre-diploma block course (e.g., summer school)
- One-semester mathematics course
- One-semester pre-diploma certificate with multiple courses

Two institutions previously offered foundation courses, but these have been cut due to financial constraints.

There is some agreement between students, teaching staff, and management as to what the barriers are academically. However, feedback from students highlighted a much wider range of barriers to their learning, and what is encouraging is that there were many more factors that they had identified as influencing their success.

Recommendations made:

1. Using a modular approach, make it possible for the New Zealand Diploma in Engineering (NZDE)to have foundational components integrated into the curriculum.
2. Smaller institutions partner with the Open Polytechnic to share the delivery of foundation programmes where they are needed.
3. Modularise the NZDE so that the assessments move away from a high stakes single examination at the end of courses (particularly mathematics) and instead set up a system where credit is given on the basis of performance in a combination of smaller assessments.
4. Make Governmental funding available for all foundation programme enrolment in engineering foundation programmes, including short one month courses and including living subsidies.

Women in engineering study

While in general female students appeared to not be disadvantaged in terms of academic preparation on entry into engineering study, the impact of a predominantly male oriented environment has affected some female students. There is much concern regarding the success of Māori and Pasifika women students given some of the cultural expectations. Some of the initiatives designed to induct female students into engineering should be made part of the mainstream, particularly if the focus is on Māori and Pasifika women in engineering.

Recommendations made:

1. Raise funds to set up projects aimed at encouraging women into engineering across the country.
2. Set up mechanisms to support female Māori and Pasifika engineering students in particular to help them navigate between family and community responsibilities on one hand and their studies on the other.
3. Ensure that in all engineering schools there are mechanisms for female students to voice their concerns.

Māori and Pasifika students in engineering study

Māori and Pasifika students were a small portion of the population surveyed, and so generalisation should be cautious. The Student’s t-test for small samples was used on the Likert-style responses and these were compared with the whole population. In these, significantly low levels of confidence were reported by the students in three areas; mathematics and physics ability on entry into the programme and confidence in their perception of their ability to improve in their studies. Unlike the engineering academics’ response that focused on mathematics as an issue with student success, learning support provided by the Māori and Pacific offices took a broader view of the barriers to success for Māori and Pasifika students. Their suggestions emphasised some of the non-academic barriers that were also highlighted by the students, namely finance, workload, travel and community and family expectations, to name a few. These barriers were acknowledged by students but also seen as a strength in some cases.

Recommendations made:

1. Develop school-based programmes to emphasise science, technology, engineering and mathematics (STEM) subjects and engineering in particular. Some of these exist, but having a nationally co-ordinated project such as the Saturday School model employed by PROTEC in South Africa from 1982 to present would be good. A focus on lifting numeracy levels in schools should also be a priority and this could happen with such a national programme.
2. Set up direct relationships between engineering schools and communities from which engineering students are drawn. Include whānau and community members in engineering showcase events so that they can see the successes of their own community members.

General comment

There are several limitations to this study. These limitations necessitate a cautious approach to the data collected. Two general limitations were identified:

- Insufficient student data collected
- Getting a national picture

Recommendations made:

1. Based on the survey just completed, set up an annual survey of students to gauge their feelings about various aspects of engineering study specifically.
2. Complete the interview process using the current data set to "dig deeper" into factors affecting Māori and Pasifika success, as well as issues that affect women in engineering study.

Conclusion

While perception and opportunity are often cited as reasons for low representation of women in engineering study at polytechnics, the representation of Māori is a more complicated issue, influenced by community and family demands. In this report, we make the case for the creation of foundational pathways into engineering study more suited to individual needs than the provision of the current foundation programme., This would help develop a greater relationship between the community and the polytechnic, and expand the good practice found in some institutions to help ameliorate the poor representation of Māori and Pasifika students, as well as women in engineering study.

2. INTRODUCTION

In this report, we attempt to understand the reasons for the underrepresentation of women as well as Māori and Pasifika* students in engineering study at polytechnic level in Aotearoa New Zealand. In so doing, we have investigated only two qualifications, the Bachelor of Engineering Technology (BEngTech) and the New Zealand Diploma in Engineering (NZDE), as well as the foundation programmes leading into these qualifications. The traditional route into a level 7 BEngTech degree at a polytechnic is through the lower (level 6) NZDE. Currently, the number of Māori and Pasifika students enrolling on an annual basis in NZDE programmes nationwide is on average between 5% and 10% of each cohort, similar to the number of women entering engineering study (Māori make up 17.8% of the population of Aotearoa according to the 2023 census). The fact that the degree apprenticeship pilot appeared to boost the representation of women, but not Māori and Pasifika numbers, could lie in foundational knowledge gained (or not) at school prior to entry into tertiary study. This discrepancy has highlighted the need to investigate issues affecting the representation of Māori and Pasifika as well as women in engineering study in Aotearoa. These include the provision of foundational pathways at polytechnics, academic and non-academic support in engineering study, as well as the impact of outside factors on student success.

To investigate the factors affecting access and retention of Māori, Pasifika and women students in engineering study, the study has been divided into two parts. The first is a catalogue of engineering specific foundation programmes that exist in Aotearoa and the identification of areas of excellence in these programmes. The second is the investigation of factors affecting the underrepresentation of Māori, Pasifika and women in engineering study. These two parts seek to answer the following two questions:

1. What foundation programmes / interventions in engineering are there at polytechnics in New Zealand and how these could be adapted to better suit the needs of Māori, Pasifika and women in engineering study?
2. What factors affect the representation of Māori, Pasifika, and women in polytechnic engineering study in Aotearoa, what are the barriers to representation and in what ways have these barriers already been addressed?

Two possible benefits of this study have been identified. The first is that it could be used to inform the design of a foundational intervention that better suits Māori, Pasifika and women students entering engineering study. The second would be to address the needs of Māori, Pasifika and women in the construction industry who want to progress to higher levels of study, thus increasing their workplace mobility.

*It must be noted that while "Pacific Peoples" would be a better term to use than "Pasifika", as it represents the diversity of various Pacific cultures in study in Aotearoa, Pasifika has been used throughout this report, in part because the participants responses have used the term throughout the interviews conducted.

3. LITERATURE REVIEW

This review is divided into three parts, namely issues surrounding the representation of women in engineering study, the issues surrounding the representation of Māori and Pasifika in engineering study and finally, issues around the models of foundation programmes in Science, Technology, Engineering and Mathematics (STEM) worldwide.

3.1 MODELS OF FOUNDATION PROGRAMMES FOR ENGINEERING STUDY

In the past few decades, there have been a wide range of efforts worldwide to provide foundational support to learners entering studies in STEM. These initiatives seem to address multiple challenges that tertiary institutions have faced with high failure rates for courses in the first year of study. In this part, we review literature specifically around STEM-related foundation programmes. mainly in the UK, the USA, South Africa and Australasia. In these areas, engineering and science foundation programmes have been set up for a variety of reasons, often depending on the unique circumstances surrounding STEM education in that country. The review looks at two issues: foundation programme design, and the impact these foundation programmes have had. In the concluding section we reflect on the implications these experiences have for engineering.

Engineering foundation programmes are found in most universities and polytechnics offering engineering and have been put in place primarily to ameliorate low retention rates of students attempting to engage with engineering study. The high reliance of engineering coursework on mathematics and physics has meant that students often fall at the first hurdle, resulting in a low retention of students from their first year of study to their second. This has led to an emphasis on mathematics and physics in most foundation programme initiatives with communication and study skills included, but not central to the curriculum design. In many places, this low retention rate has had a disproportional impact on some groups of students leading to the underrepresentation of minorities in engineering and in STEM qualifications. For this reason, some of the examples in this review have been chosen to reflect initiatives designed to improve the representation of minorities in engineering.

The underrepresentation of women in engineering study (see part 1 above) is not due to a lack of academic foundation in mathematics and physics. Girls in most OECD countries outperform boys in these subjects at high school, but for several reasons, do not choose to go into engineering or physics-based STEM fields. This is inherently a different problem and not the same as the reasons for the low representation of Māori and Pasifika in engineering study. Foundation programmes in this discussion are more likely to serve Māori and Pasifika students than women.

Foundation programme design

Foundation programmes in engineering are available at many tertiary institutions. Typically, the design is a year-long pre-degree course to get students up to speed in critical areas needed for engineering study and does not address a broader aspect of what it takes to become an engineer (Cardiff University Website, 2024). One initiative that appears to differ from this model is that offered by the University of Western Australia (Trevelyan et al., 2010), which recognises the fact that engineering has changed and that there is now a greater reliance on the ability to apply technical fundamentals in unfamiliar situations, alongside a broad education that gives young engineers the ability to communicate effectively, and work with both data and people in a creative way. For this reason, they have redesigned their engineering curriculum as an integrated one and central to this is the possibility to accept multiple pathways into the degree. A foundation block that is designed to develop students' capabilities in several areas, seeks to broaden the curriculum and add additional strength in areas such as communication, ethics and diversity, apart from focussing on their engineering science major. The benefit of this approach in the New Zealand context is that such a foundation design could cater to the different strengths of different students and allow entry into an engineering degree despite poor initial performance in key subject areas such as mathematics and physics.

In New Zealand, foundation programmes face challenges that emanate from the external metrics adopted by government, particularly in terms of funding (Spooner & Clear, 2016). This has led to a smaller uptake in foundation programme places as they are not funded as part of any degree / diploma. At university level, this has led to programme closures and the ending of collaborative initiatives between university and polytechnic programmes to provide a comprehensive set of pathways focused on the needs of the region rather than the needs of any one tertiary education institution. A good example of this is the ending of the collaborative design of a foundational pathway for the Wellington region (Carnegie et al., 2012).

Factors that need consideration in curriculum design are the reasons given by students as to why they have opted to do a foundation programme in engineering. Wint (2023) has surveyed students across the United Kingdom and found eight distinct factors. These include gender, the influence of family, geographical location, both school-based and extra-curricular learning experiences, proximal environmental experiences (unexpected events that propel the student to enrol in a foundation programme) and being good at or enjoying engineering-related activities.

Marshall & Berland, (2012) outline a project implemented to design a research-based high school engineering course. In the design, they identified core engineering concepts and skills to create teaching materials for the course. This process appears to have had a positive effect on the engineering educators and could conceivably influence practice beyond the course that was designed. Bringing engineering into the realm of high school is an option worth considering in New Zealand.

Lastly, critical to designing foundation programmes is the understanding of the educational philosophies that have underpinned existing programme design. Kloot et al., (2008) highlight the importance of this and point to the evolution of different models. These range from the those designed to "fill the gaps" having a deficit model approach, to an approach of changing the institution in order to acknowledge the changing demographic. In the article, Kloot et al., (2008) outline how the model of foundation programmes changed in South Africa from the original basic skills model (focus on "plugging the gaps") to a more integrated skills model (integrating language and communication into the content subjects) and then onto a holistic model (includes skills, language and counselling) of foundation. A further development was to integrate what was considered foundation work into the mainstream engineering curriculum, while maintaining the holistic model of foundation.

Review of the impact of foundation programmes

In South Africa, where foundation programmes in STEM have existed since the 1980's, there is a wealth of literature available on the impact that such programmes have had (Kloot et al., 2008). Originally intended as redress for the unequal system of education under apartheid, these programmes have specifically targeted poorer African students who have been grossly underrepresented in engineering. A recent study of the impact of one of these programmes shows that a foundation intervention has improved both access into engineering for underrepresented students as well as retention of those students (Snyman et al., 2021) in the degree programme.

Spooner & Clear, (2016) reflecting on the success of a one-year pre-degree programme based in New Zealand, found that students performed particularly well on average (89% retention) and that this has helped in improving diversity amongst students studying STEM subjects.

One intervention in South Africa that has been very successful is a pre-university Saturday and Vacation School programme that has had a large impact on the training of engineers in South Africa. This programme provides academic support as well as career guidance and exposure to engineering for underprivileged African students and manages to place 70% of their learners in engineering or engineering related positions in industry. This in-school programme works with university and polytechnic foundation programmes around the country to place students and continues to support them (although to a lesser extent) while completing their studies. This programme acknowledges that a simple one-year foundation programme is insufficient to address the issue of underrepresentation of African students in engineering study. Similar in-school programmes targeting Māori and Pasifika exist in New Zealand. The impact of these is discussed in part 2 of this review.

Concluding remarks

In conclusion, while there appear to be many models of foundation programme worldwide, with many pedagogical philosophies, a model of foundation needs to be developed that caters specifically for the needs of underrepresented students in New Zealand. This could be different from the standard one-year, and one-size-fits-all model currently available and could be a more holistic model of foundation that extends lower, possibly into schools and communities, and also higher, providing support in the degree / diploma itself. Māori and Pasifika students bring their culture into what is predominantly a Western classroom and so it may be that the classroom needs to change and not the student. Similarly, while a different issue, it may be that the culture within engineering needs to be addressed to be more inclusive of women.

3.2 WOMEN IN ENGINEERING STUDY

Worldwide, far more men than women take up careers in science, technology, engineering and mathematics (STEM). Over the past three decades at least, multiple studies have shown this lack of parity between men and women in many different countries, indicating that this phenomenon is not unique to any one culture. There are for example, studies undertaken in the United States (Babiar, 2011), New Zealand (Goodyer & Soysa, 2017), Kenya (Sefuna, 2006), Kuwait (Al-Sanad and Koushki, 2001) and a study by Kodate et al., (2010) that compares gender equality in science in Japan and the UK. All have highlighted a gender gap when it comes to STEM, evidence not only that this is common worldwide, but also that despite efforts to change the situation, the effect is persistent.

Employment in STEM is on average better paid than the areas in which women predominate (such as clerical work and the "caring professions" of nursing and occupational therapy). This has possibly led to a gendering of some areas of STEM as male and others as female, something that over the past few decades has been difficult to ameliorate, as it is often seen as a natural part of social organisation (Young, 1990). The assumption that some areas of science and technology are male and others female, permeates cultural beliefs worldwide, subtly influences the way children view themselves, the choices they make and has had a substantial impact on the self-efficacy of women entering areas such as engineering and computer science. Lewis (1996) points out that such preferences may be a manifestation of the differential treatment afforded male and female children (including females' primary early socialisation from a parent of the same sex while males are usually socialised by parents of the opposite sex).

Much literature exists, based on US and European research, regarding differential performance and participation of boys and girls in science and technology. While no evidence exists for innate difference in ability (Silverman and Pritchard, 1996; Francis 2000; AAUW 1996), boys receive more familial encouragement in STEM fields (Mammes, 2004) and play games that develop spatial abilities. School STEM tasks appear to be designed to be more interesting to boys than girls (Silverman and Pritchard 1996; Weber and Custer, 2005). Boys outperform girls in technology, have higher interest levels in it (Schiefele, Krapp and Winteler, 1992), and show interest in different aspects of technology than girls (Silverman and Pritchard 1996; Mammes, 2004; Atkinson, 2006; Weber and Custer, 2005; Jones and Kirk, 1990). While female performance in mathematics and physics in the UK remains high, participation in STEM areas decreases in higher grades of school. This, combined with parental perception of the inappropriacy of technological careers for girls, (Woolnough, 1990 quoted in Davies and Elmer 2001; McCarthy and Moss, 1990) is a factor that historically could account for the low participation of women in STEM careers (Mammes, 2004; Francis 2000; Brainard and Carlin, 2001). Similar statistics are found in Canada, where most university graduates are women, yet they are underrepresented in the areas of science, technology and engineering (Hango, 2013). This study showed that women are always less likely to select a career in STEM, regardless of their ability in mathematics.

In New Zealand, as has been the case in the United Kingdom, girls regularly outperform boys in mathematics and physics at high school (NZQA, 2024), but this does not translate into girls selecting to study towards STEM careers past high school, where there is still an underrepresentation of women (Goodyer & Soysa, 2017). Movement into engineering study does not depend on prior foundational background, but rather on issues of self-efficacy and choice.

Existing barriers to participation for women in engineering and interventions that have attempted to ameliorate these barriers

The underrepresentation of women in STEM has drawn multiple interventions over time to change the statistics for the better. Many of these have worked, but still there is a persistent shortage of women working in these fields. This next section discusses the common barriers to participation that have been found in the literature and while they are interconnected and should be dealt with holistically, it is useful to identify them separately. Barriers to participation for women include a lack of a sense of a STEM identity (Petersen et al., 2024), lack of self-efficacy and anxiety towards physics and mathematics (Brewster and Miller, 2024) and a lack of knowledge regarding STEM careers (Hur et al., 2017).

Developing a STEM identity

The development of a STEM identity is important for everyone wanting to work in these fields. In engineering for example, students are inducted into engineering as a profession in a combination of ways, through association with professional engineers, through a common educational experience with their fellow students and also through direct curriculum interventions where students are taught to think, act and write like engineers. This is important for any profession, however in STEM careers this identity is sometimes hard to acquire. Petersen et al., (2024), found that faculty (engineering) were aware of the importance of developing an engineering identity and actively encouraged this development through research projects, service and mentorship. They also passively encouraged the development of identity in the classroom, however, when asked, they did not have a clear idea or could define what an engineering identity was. The importance of a STEM identity has also been studied by Johnson et al., (2019) who examined the relationship that identity formation had with the provision of appropriate role models and found this to be a key factor in increasing participation rates, particularly when both gender and ethnicity were represented.

In a study of high school girls, Veldman et al., (2021) examined how girls in the process of making STEM-related choices at high school made decisions based on the anticipated belonging in a particular field rather than their achievement or aptitude for that field. A sense of belonging was highly correlated with interest and girls felt attracted to certain STEM fields and pushed away from others. This perception of future identity is important when designing interventions to attract or retain women in STEM fields of study. Foundational competence appeared to not feature as an issue, which fits with the data from the latest NCEA results, mentioned earlier, that shows girls consistently outperforming boys in the key foundational subjects of mathematics and physics (NZQA, 2024).

Developing self-efficacy and reducing anxiety

Coupled with identity, self-efficacy can be thought of as self-confidence in a particular field or area of endeavour. It is the 'belief in one's ability to carry out specific actions that produce desired outcomes' (Aronson et al., 2005:485). One can have generally high self-esteem but lack belief in one's abilities in a certain area. Self-efficacy predicts persistence and effort at a task. People with high self-efficacy experience lower anxiety and are more likely to view tasks not as difficult but as challenges that can be overcome (Bandura, 1994). Ways of developing self-efficacy include mastery of difficult tasks (indicating importance of practical work) and seeing social models achieve the behaviour (accounting for higher confidence in ability to achieve technological tasks in male compared to female students) (Bandura, 1994). In order to improve the development of self-efficacy amongst women in STEM, this survey explores the development of appropriate interventions that are targeted at girls in school, as well as women in the workplace and in engineering study.

Brewster and Miller, (2024) identified mathematics anxiety as an important factor affecting general levels of self-efficacy amongst women intending to re-enter employment in a STEM field. This is often when women have been outside their subject for a number of years. Anxiety about competence in one area can permeate and lead to the development of anxieties about other areas of science and technology. Therefore, it is important to address causes of low self-efficacy early on. Brewster and Miller (2024) have addressed this issue using expressive writing sessions, but while maths anxiety is a consequence of years of lived experience, it does need to be addressed head on and at the foundational phase of learning.

In an interesting counter to this, studies in Canada (Chopra, 2022) found that in high schools that produce more engineering applicants, females outperformed males in standardised tests. This is something that hints at the relationship between the development of STEM self-efficacy and engineering choice.

Anxieties about other areas of STEM study also arise, notably anxiety regarding doing “male associated” activities, such as in the workshop or on sites that exude an overwhelming “maleness” such as construction. This is closely linked to identity and possibly responsible for women choosing to go into fields where they feel that they belong more.

Increasing knowledge about STEM and STEM-related careers

Closely linked to the issue of women in engineering is the issue of participation of women in information technology related careers. Hur et al., (2017) examined ways to promote computer science amongst girls and found that while girls were interested in computer science, their limited knowledge and experience restricted their aspirations in that direction. They demonstrated that participation in a camp boosted girls’ confidence in their ability to programme and be successful in the field. Sometimes all that is needed is the exposure in a safe, focused environment to promote interest in STEM.

Another interesting intervention developed by Liu et al., (2014) integrated project-based learning with the use of female engineers as role models and was successful in improving the overall STEM self-efficacy of high school students. This links the use of appropriate context-driven teaching materials to expose learners to knowledge about STEM careers to the development of learners’ self-efficacy.

Using context driven teaching materials

According to Lewis, (1996), a context-driven approach to curriculum design is distinguished from a content-driven approach in that it takes social, environmental and physical contexts as starting points and uses these to move towards the theories, models and laws that are the starting point of a content-driven curriculum. This is a useful approach to attracting women into STEM, as expanded on by Hur et al., (2017) and Liu et al., (2014) above.

The intersection of gender and ethnicity

Women coming from minorities that are underrepresented in STEM fields appear to have borne double the impact. Johnson et al., (2019) in studying African American women in STEM who learned about another African American in the same field, would identify more closely with that person and so the identification of an African American role model was crucial to them choosing a career in STEM. In addition, they found that while they were underrepresented as women, the role model's gender was immaterial, and it was the ethnicity that was important.

While there is little in the way of literature on this specifically, Kachchaf et al., (2015), Lakin et al., (2019) and Hinsdale (2015) have all written on the topic, addressing the confluence of race and gender when it comes to representation in STEM careers. Illumoka et al., (2017) reflect on the use of mentoring partnerships to help minority women gain access to STEM careers. What they found was that students who participated in their industry-based mentoring system were more likely to show an interest in STEM subjects and pursue STEM careers.

Gendered cultures in engineering workplaces

Knowledge that engineering workplaces are inherently "male" environments could be a major factor in females' decisions when considering an engineering career. Male et.al., (2018) explored student's experiences in engineering workplaces and found that this was a major contributor to women leaving the profession. Anecdotally, the author's experience has been that this culture is duplicated in engineering learning spaces. While there may be no "quick fix" to changing workplace culture, Male et. al., (2018) suggest that students should be better prepared for the gendered characteristic of engineering workplaces.

Concluding remarks

This study proceeds from the assumption that underrepresentation of female students in STEM careers do not arise from ability differences, but rather from issues of identity, lack of self-efficacy and social attitudes that view certain fields as less appropriate for women. These attitudes are embedded in the subtly different ways that male and female children are treated both in the home and at school (Nicholson 1984) and that such attitudes are transmitted in multiple ways, including discursive practices both at home, school and at work (Davies, 1989).

Research carried out by Fowles-Sweet & Barker, (2018) on the impact of degree apprenticeships in STEM subjects has pointed to a large uptake by women returning to study through this vehicle. They provide statistics showing that in degree apprenticeships, the demographic profile of programmes that have been traditionally underrepresented by women improves considerably. This is supported by Bradley et al., (2019) as well as Clarke, (2018). Providing an avenue for women who previously made the choice to not follow certain STEM paths (although they had the aptitude for them) to "re-do" their training through a degree apprenticeship appears to have worked well. In a New Zealand pilot of an engineering degree apprenticeship, this was confirmed by Mackay & Cadzow, (2024).

Other efforts to ameliorate the situation regarding the underrepresentation of women in STEM fields should include at least the following:

- Increase knowledge about STEM and STEM-related careers in schools, when girls make their career choices.
- Work consistently on the development of self-efficacy in terms of STEM-related subjects and the associated formation of a STEM identity.
- Think about teaching materials and use project-based, context-driven teaching materials wherever possible to help women identify with STEM programmes and develop a sense of belonging.

3.3 REPRESENTATION OF MĀORI AND PASIFIKA IN ENGINEERING STUDY

While there is some overlap between the issues affecting women in STEM and those affecting other minorities, at the heart of the underrepresentation of Māori and Pasifika in engineering study is the issue of foundation and culture. While women enter male dominated fields usually with a strong foundation in educational attainment, Māori and Pasifika do not. The latest NCEA results (NZQA, 2024) bear testament to this and show Māori and Pasifika trending low in terms of attainment when compared with other ethnicities in New Zealand. This points to a different systemic issue in school education than that experienced by women and so therefore a different solution is required. In what follows, we discuss the barriers that currently exist for Māori and Pasifika entering study in STEM fields.

Hook, (2007, 2008) acknowledges that Māori have always been underrepresented in STEM fields of study, but that there is some hope for the future as there has been growth for Māori in this area in the last 50 years. He makes the point that to live in socio-economic security in a country that is firmly positioning itself to be competitive in science and technology, it is imperative that Māori embrace STEM fields and that there be a concerted effort to increase Māori enrolments in STEM fields of study. In this part, we will look at barriers that prevent entry into tertiary study, as well as those that affect retention of Māori and Pasifika in tertiary study. Much of the research reviewed comes from university experience but aspects and experiences of this will be broadly similar to those at polytechnics in New Zealand.

Barriers to success in tertiary study

Reid, (2006) carried out an extensive study of barriers to Māori success at the University of Canterbury and confirmed amongst other things that the main barriers included personal and family issues, financial difficulties, lack of support and unwelcoming university environments, in addition to negative experiences at school and inadequate school qualifications. All this was framed by a rather entrenched monocultural system which was not welcoming to Māori students. Support was deemed inappropriate and drawn from a deficit ideology. While not specifically addressing Māori in STEM study, these barriers would affect all Māori to some extent or the other. Many of these factors listed above that affect Māori success have also been found by Theodore et al., (2017).

Part of the issue is that notwithstanding all the practical barriers listed by Reid (2006) above, Māori (and Pasifika) students must navigate a neoliberal model of education that in many cases is alien to them on entry into tertiary study. Amundsen (2019) interviewed students at universities, polytechnics and wānanga to investigate their journeys into tertiary study and found, perhaps unsurprisingly, that at wānanga, their identity was highly valued, while at polytechnics more could be done to include Māori culture into the curriculum. This might be especially true in STEM fields of study, where there is a strong reliance on Western ideas of knowledge and knowledge generation. What is clear from this extensive study is that more needs to be done in the field of cultural inclusion.

This is supported by other research, notably McAllister et al., (2022a) who studied the experiences of postgraduate students in STEM and found that overwhelmingly, Māori and Pasifika students struggled to develop a sense of belonging and that the university experienced low recruitment and retention rates as a result. McAllister et al., (2022b) found that poor experiences in STEM study at tertiary level translate into low employment rates for Māori and Pasifika scientists in New Zealand's publicly funded scientific workforce and that there was no "pull" to attract young Māori and Pasifika STEM professionals. Other researchers support the idea that a sense of belonging needs to be developed for Māori and Pasifika students, notably Naepi et al., (2021), and Leydens and Lucena, (2017), who focus further on the development of an engineering identity amongst Māori and Pasifika students. This integration of an engineering identity has some commonality with the experience of women in engineering study as discussed in part 1 of this review.

Finally, the Tertiary Education Commission (2023) in Aotearoa New Zealand has developed a Learner Success Framework, based on six key questions:

- Where do our learners come from?
- What do they do outside of tertiary education?
- What else could be happening in their lives?
- What do they need to succeed?
- What do we do that works for them?
- What do we do that doesn't?

This framework, centred on Te Tiriti o Waitangi, seeks to help tertiary education providers put in place programmes that have a holistic approach to education by identifying barriers that students have to success. This framework goes some way to providing context to the barriers that students experience and helps institutions put in place plans to address these barriers.

Knowledge accumulation and integration with Matāuranga Māori

Part of developing a sense of belonging in STEM is the integration of Mātauranga Māori and engineering knowledge to solve community problems. A criticism of tertiary education institutions is that Māori knowledge and ways of learning have been sidelined in the past, and that for students to feel more culturally connected there needs to be a connection, where possible, to the body of knowledge they are learning, as well as a connection to the way in which the learning takes place.

There has been some success in introducing culturally appropriate pedagogical practices (Hunter, 2023; Riley, 2017). Mathematics is crucial for many STEM fields of study and especially engineering. Meaney et al., (2013) have explored how the use of indigenous language infused the identity of the students into the curriculum in a school-based environment. This allowed the local context to have a positive influence on the students' learning.

Hughes et al., (2017) working with university students, have attempted to integrate a Māori world view with engineering with some success. This has been done using a project-based approach and with the help of a local community, students have developed design projects to address the community's needs. Similarly, success in engineering requires an indigenous approach to learning using the 5R approach mentioned below, has been found by Murray and Morgan, (2009).

Intervention case studies

If tertiary institutions intend to seriously address the underrepresentation of Māori and Pasifika in STEM fields, there needs to be a comprehensive set of interventions that address both the student experience at school level, as well as when they arrive at either polytechnic or university (and everything in between).

At the school level, Hunter, (2023) has proposed the development of culturally appropriate pedagogical practices to address the learning of STEM critical subjects like mathematics and physics. Apart from developing mathematical competence in a culturally appropriate way, PROTEC, an NGO in South Africa set up to address the shortage in African engineers in the country, has developed an extramural engineering programme for high school children that supports them both academically and in the development of their identities and engineers. They have had tremendous success with it and work with students in their last three years of high school and on to polytechnic and university study, often helping them get jobs. This is an intervention that is fully funded by the engineering business community.

Once students have completed their schooling and attained sufficiently high grades to be admitted into tertiary study, there have been interventions put in place to ensure that students are recruited, supported and retained by the education system. Leydens and Lucena, (2017) elaborate on a highly successful programme at the University of Auckland, called the '5R programme' – readiness, recruitment, retention, role modelling and research. Interestingly, this programme uses much the same approach as the PROTEC programme in South Africa does.

Karmokar et al., (2018) have described an outreach model that brings together business, government and researchers in what they refer to as the 'triple helix model' to engage Māori and Pasifika school students to develop their interest in STEM and its relationship to entrepreneurship. Other interventions targeting Māori and Pasifika include a teaching and learning model (REAPS) that places students in real world problem solving situations (Riley et al., 2017); a specific engineering career development intervention where engineers from the community provide extra tuition and enrichment for students from underrepresented communities (Hurley, n. d.); the use of role models and work-based micro-badging to encourage interest in STEM; and finally, the SciBoost programme specifically developed to enhance Māori and Pasifika achievement in STEM at the University of Waikato by providing a series of academic skills development workshops (Marsh & Eastwood, 2017).

Concluding remarks

While there seems to be several interventions to address the underrepresentation of Māori and Pasifika in STEM fields, there also appears to be a lack of co-ordination of such initiatives. A significant set of barriers exist to Māori student success in STEM and in these interventions it's important to address the issue of belonging as a priority, while at the same time supporting students in their academic, personal and community challenges. While this report focuses on barriers experienced by Maori and Pasifika, it should be noted that many of these barriers are experienced by all students. Putting in place interventions to ameliorate the situation should in principle improve the learner experience for everyone.

To do this, there possibly needs to be a longer-term change in approach, away from a deficit ideology to one that is more culturally appropriate. At that same time, the extent of the support should probably begin before the student reaches their tertiary destination and should involve the introduction of culturally appropriate pedagogical approaches. The integration (at least to some extent) of STEM knowledge with community problem solving and Mātauranga Māori could possibly help in contextualising knowledge and developing a strong STEM identity.

What might be of use is engagement by engineering schools with the Tertiary Education Commission's (TEC) Learner success Framework, which is centred on the Treaty of Waitangi. This would go some way towards addressing the broad range of issues that Māori and Pasifika students need to contend with in order to be successful in their studies.

4. RESEARCH DESIGN

4.1 RATIONALE FOR THE RESEARCH APPROACH USED

This investigation draws on both qualitative and quantitative data and the initial design centred around a simple mixed method approach to collect the data. However, after some thought, it was decided that a more appropriate methodology to use would be that of narrative inquiry (Creswell, 2020). The reason for this was that with a narrative enquiry approach, the researcher would be able to get participants to “tell the story” as to how they decided to get into engineering study, what they struggled with and what they found easy. In this approach, the interview sessions were tailored to get participants to open up about their own experiences in engineering study. The intention of these narrative conversations was to answer the first research question; barriers to success in engineering study.

The focus on engineering foundation was chosen as this is the most common intervention used by polytechnic engineering schools to address educational underperformance. While it is acknowledged that there are multiple factors that affect student performance (as highlighted in the TEC’s Learner Success Framework), engineering foundation programmes have been seen as the solution to these problems. What comes out of some of the data collected is that people see engineering foundation in many different ways and perhaps by exploring these different viewpoints, it’s possible to change the foundation pathway to be more like what is envisaged by the Learner Success Framework.

4.2. DATA COLLECTION PLAN

Figure 1 shows a schematic representation of the research plan.

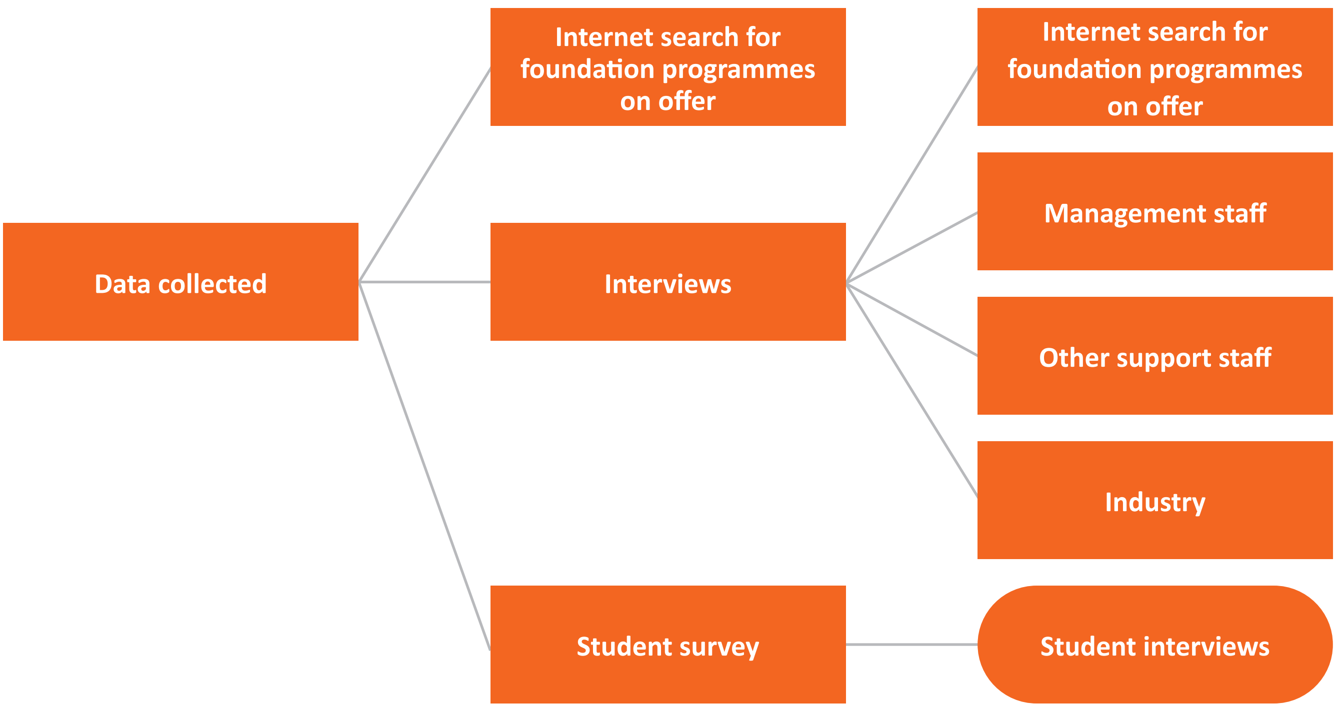

Figure 1: Research Plan

The timeline for data collection was originally intended to be from July to October 2024. However, due to the need to get secondary ethics approval for some institutions, along with other institutions not replying or agreeing to participate, the timeline for data collection extended into November which is of course the examination period. This meant that it was very difficult to get student survey data from many of the institutions that agreed to participate. The plan was to run the student surveys concurrently with the interviews, apart from those interviews which were to be conducted after the surveys by selecting those students who agreed and supplied contact details in their responses.

Breakdown of data collected by institution

The research plan involved the collection of survey data, interview data and data freely available from institutional websites. The planned data was initially intended to be collected from all 13 institutions offering either the NZDE or the BEngTech. However, in the end, only nine agreed to participate, of which five managed to collect student survey data. Table 1 below shows the differences between the sizes of the data sets it was planned to collect, compared with what was actually collected.

Table 1. Planned and actual collection of data.

Data Type	Participants	Size of data set planned	Actual data set size
Student survey	Students	13	5
Interviews	Engineering Teaching staff	13	9
	Students	13	0
	Engineering Manage-ment	5	5
	Polytechnic Learning support	5	3
	Industry	5	2
	Other institutions		1
Other data	School websites	14	14
TOTAL		**68**	**40**

Table 2 below gives a detailed breakdown of data collected by institution. In many cases, teaching staff had a management role as well and so the interview served more than one purpose. The coding of data (or data sets) for identification in the report was as follows:

Surveys:
Survey A (student identification no)
E.G. – A (12) means that this information was taken from student number 12 of group A.

For interviews:

- TS#- Teaching Staff
- MS#- Management Staff
- SS#- Support Staff
- OS#- Other stakeholders (Industry and other organisations)

Each interview was coded to avoid easy identification, and codes were determined by the predominant nature of the interviewee's role. For example, if someone was interviewed both in their role as a manager and a teacher, but they were primarily a manager, they would have the MS# prefix.

Engineering staff at each institution were asked to provide industry for follow up interviews. There was some reluctance to provide these contacts. It must be noted that the timing of this project coincided with the decoupling of institutions under Te Pūkenga and the re-emergence of a competitive environment, possibly having an impact on a sense of collaboration.

Table 2. Summary of data collected by institution.

ITP contacted	Student survey data provided	Staff / other stake-holder Interview data Provided	Interview Codes	Programme handbook survey data collected
Ara	16 responses (given face to face)	2 interviews (One is both teaching & management)	TS#1 TS#2	Yes
EIT	No programmes on offer	No programmes on offer		No programmes on offer
MIT	Did not respond to requests	Did not respond to requests		Yes
NMIT		1 interview (For teaching role)	OS#3	Yes
NorthTec	0 responses (gave survey online)	4 interviews (Teaching, management & Learning support)	TS#3 MS#1 SS#1 SS#2	Yes
Open Polytechnic	0 responses (gave survey online)	3 interviews (Teaching, Management & industry)	TS#4 MS#2 OS#1	Yes
Otago Polytechnic	39 responses (given face to face)	1 interview (Teaching & management)	TS#5	Yes
SIT	14 responses (given face to face)	1 interview (Both teaching & management	MS#3	Yes
Toi Ohomai	14 responses (given face to face)	1 interview (Management)	MS#4	Yes
UCol		1 interview (Both teaching & management	TS#6	Yes
Unitec	0 responses (gave survey online)	2 interviews (Teach-ing & management)	TS#7 MS#5	Yes
WelTec	24 responses (given face to face)	4 interviews (Teach-ing, Management, learning support & industry)	TS#8 TS#9 SS#3 OS#2	Yes
WinTec		1 interview (Both Teaching & management)	OS#4	Yes
WITT	Did not respond to requests	Did not respond to requests		Yes
Other		2 interviews (VEENZ)	OS#3 OS#4	
TOTAL	**107 survey responses from five institutions**	**21 interviews**	**No. Interviews: TS -9 MS – 5 SS – 3 OS - 4**	**Data gathered from 13 websites**

Student surveys

Of the three categories of data collected, the category that presented the most difficulty was student survey data. As can be seen from table 2, some institutions simply did not respond to any attempt to contact them and only five of the fifteen produced student responses to the questionnaires. This was partly due to delays in getting secondary ethical approval from the institutions in question, which in turn led to the suggestion by some institutions to put the survey online for their students. The survey was administered in two ways: face-to-face in a classroom setting and as a link sent out by the manager to selected students at some institutions. As can be seen from table 2, the online surveys produced nothing, whereas the face-to-face surveys (while onerous) produced 107 responses. The questionnaire used in the student survey is shown in Appendix 1.

Interviews of teaching staff and school management

It was initially intended that teaching staff would be interviewed at all 14 institutions, however, the researcherswere only able to interview representatives at 11 polytechnics. One (EIT) does not offer either the NZDE or the B Eng Tech, so after searching their website for any evidence of a foundation programme, it was decided to exclude them from the data set. Two institutions did not respond to repeated requests to participate, and the only data gathered from these institutions was drawn from their websites on the structure of the foundation programmes they offered. Thirteen of the 22 interviews were with staff who taught on the programmes on offer, while 10 out of 22 were with people who were actively involved in management roles within their respective engineering schools.

Interviews of other stakeholders

In the end, two sets of Māori office and learning support staff were interviewed. Only two industry representatives were interviewed, and these were contacts from two of the polytechnics participating in the study. While this is a bit limited, it seemed that polytechnics were not very keen to share their industry contacts. This would be something to work towards in the future. In addition, two directors of Vocational Engineering Education New Zealand (VEENZ) (one outgoing and the other incoming) were interviewed. Their contributions also shed light on practices at the two polytechnics they had been at prior to their roles at VEENZ.

Research instruments

The research instruments used can be seen in Appendix 1: the student questionnaire and the interview protocols used. The instruments were given to a colleague to comment on, adjusted and then passed to the ethics committee for their evaluation. After feedback from the ethics committee was received, changes were made in accordance with their recommendations and the instruments were then used.

Process of data collection

The focus of the investigation was to find out what barriers exist specifically for students entering engineering study in Aotearoa New Zealand and to do a needs analysis to put in place a flexible national approach that would draw more Māori, Pasifika and women students into engineering study. To do this, the data collection process was as follows:

1. Contact engineering schools and request their participation (first by email and then via a Teams conversation).
2. Participation was on two levels:
   - Staff interviews.
   - Student surveys (either administered by them or students directed to an online link).
3. Participants would sign consent forms and questions arising were generally answered via the Teams conversation.
4. Surveys were then administered to a sample of students at each participating polytechnic. The hope was for around 20 survey participants for each of the 13 polytechnics offering either the NZDE or BEng Tech.
5. Survey data from those administered via hard copy was scanned, emailed back and entered into a common database set up in Google forms. Survey data gathered online was to be entered directly by the participant onto the same database[1].
6. Interview data was recorded on Teams and transcribed.
7. Data on foundation programmes offered by institutions was collected from each institution's website.
8. School academic performance was taken from the NZQA website.
9. Participants interviewed were asked to provide industry or other contacts that might also be able to contribute to the data pool. These were then followed up and interviewed.
10. Some of those followed up were from either the Māori office or learning support in the same institution.
11. After the survey, individual student participants were purposefully selected for interviews based on information provided about them by their local polytechnic and their willingness to participate.
12. A follow up "confirmation" process was used to ensure that where the interview data was vague, it was then clarified.
13. Microsoft Excel was used for the thematic organisation of the qualitative data as well as the statistical analysis of the quantitative data.

Organisation of the data

Data from the Likert-style responses in the student survey was analysed statistically using a Student's t-test for small samples. This was then triangulated with qualitative data from the interviews as well as from the student survey. Survey data was collated using Google forms and then downloaded onto a spreadsheet for the statistical analysis.

The interview data was organised along themes that emerged from the data. These themes were then grouped. Information on foundation programmes was collated with interview responses of engineering staff as well as comments made in the survey. Finally, data was drawn together along two broad themes for analysis and discussion: women in engineering study and Māori and Pasifika in engineering study.

[1] It must be noted that Qualtrics was the first choice for setting up the survey and the database of responses, but this was deemed impractical early on as there was little institutional support for the software.Google forms was used instead.

Limitations of the data collection process

The face-to-face collection of student survey data is labour intensive and understandably, many staff members were reluctant to do the task and asked for an online survey to be administered. This was done in three places but yielded zero responses. The setting up of student interviews intended to triangulate the data collected from the surveys was contingent on surveyed students agreeing to be interviewed. As this process expanded into the examination period, setting up student interviews became unfeasible. This was a weakness of the data collected, but some indication of student sentiment can be gleaned from the qualitative (commentary) data gathered in the survey. This was then triangulated with the Likert-style data gathered in the same questionnaire as well as the interviews of staff. Sadly, this has also meant that the use of a narrative enquiry approach was limited to the data collected on the staff interviewed and not the students.

The low response rate by Māori and Pasifika students is concerning and while staff presented their opinions as to what the reasons were, perhaps it is evidence of low representation rates as well as the possibility that while there might have been more Māori and Pasifika students enrolled, there was an issue with engagement.

Lastly, the study could have been enhanced by more use of quantitative data, such as participation and educational outcomes by ethnicity and gender. However, this data was not collected as there was difficulty getting institutions to agree to provide it. One polytechnic did provide some of their statistics but the others who agreed to participate did not provide the data.

4.3 ETHICAL CONSIDERATIONS

Ethics for the study was granted after some adjustments to the research design, out of concern for the participants. The committee's concerns were addressed by adapting the research design to follow a narrative enquiry approach rather than the simple mixed methods approach that was initially conceived. The adoption of this approach reduced concerns regarding the safety of the participants.

The ethical argument for using a narrative enquiry approach comes from the focus of the investigation, which is to find out what barriers exist specifically for students entering engineering study. Some participants may feel vulnerable if they have not succeeded in engineering study and might not wish to talk about it, identify themselves or answer questions. To address this, relationships with students, whānau, iwi, employers and engineering teaching staff should be developed first. There should usually be an initial meeting before any data is collected.

Ethics approval (No. 1027) was granted for the study in June 2024 by the Otago Polytechnic ethics committee. Data collection was started in August 2024. In keeping with standard ethics approvals, information sheets were given to and consent forms gathered from participants. Survey data was anonymised and where appropriate, confidentiality agreements were signed by those administering surveys at their institutions.

5. ANALYSIS OF DATA COLLECTED

This section reports on the findings from each of the categories of data collected and is an attempt to make connections between the programmes on offer and the impact on students, through the student surveys and the interview data sets collected. Each data set will be described separately and analysed through two lenses: the impact of foundation pathways on women entering engineering study, and the impact of foundation pathways on Māori and Pasifika students entering engineering study. In this first part however, an overview of the different models of engineering foundation is provided, along with student and staff views of these models.

5.1 MODELS OF ENGINEERING FOUNDATION AT POLYTECHNICS ACROSS AOTEAROA NEW ZEALAND.

For almost all institutions offering the three-year BEngTech degree (a level 7 qualification), the foundation provided for those not making the entry requirements was the diploma. This has meant that all foundation programmes on offer by polytechnics across New Zealand have entry into the two-year level 6 NZDE as their focus. There was one institution that had a flexible arrangement so that if a student did remarkably well in the foundation programme, they could be admitted into the degree. This might well be the practice for other institutions offering foundation in engineering but was not explicitly stated on their websites. Engineering foundation programmes on offer by New Zealand polytechnics fall into four categories as shown in table 3 below. A more detailed breakdown of data collected from websites can be found in Appendix 2. The common models found are as follows:

Table 3. Common models of foundation programme used.

Model	No. Institutions	Main focus of the pro-gramme
No foundation programme offered	4	107 participants from 5 in-stitutions
Non-certified pre-diploma block course (e.g. summer school) data	2	Mathematics
One-semester maths course	1	Mathematics
One-semester pre-diploma certifi-cate with multiple courses	6	Mathematics, physics,
Other	1	Aeronautical engineering

One-semester pre-diploma certificate

This is by far the most common programme on offer and takes between 15 and 17 weeks of study, depending on the institution. The structure across the institutions offering the programme is similar: four courses that always include mathematics and usually physics, along with other subjects that could include engineering communication, a study skills course of some sort and possibly other electives that orient the student towards the engineering major they are interested in (civil, electrical or mechanical). Entry requirements for these programmes ranged from open entry to the high school entry requirements needed for the diploma and the level of these programmes is either level three or four, depending on the institution. The benefit of a full one-semester programme is that in addition to having mathematics at the centre of the programme, it also has courses that address the learning needs of the students as well as inducting them into engineering study.

Non-certified pre-diploma block courses

These courses can last from one to four weeks and usually have pre-diploma mathematics as their focus. They are intensive courses that immerse the student in the mathematics required for the diploma and spend time "getting students up to speed "so that they can cope with the level of mathematics at the diploma level (and then later at the degree level, should they wish to progress). This is good for those students who want to enter engineering study but who have not done enough mathematics (or the wrong type of mathematics – e.g. statistics instead of calculus). It is also good for those students who have been out of study for a prolonged period, forgotten all the mathematics they have learned, but wish to retrain as an engineer. While these courses have had success, the learning of mathematics sometimes requires time to develop a mathematical way of thinking and for this, acquiring the same knowledge over a longer period of time such as a semester is sometimes preferable.

Single one-semester pre diploma mathematics course

This was only offered by one institution: the Open Polytechnic, an open distance education polytechnic which is not regionally based but serves the whole country. As with other foundation programmes and courses, there is a recognition that performance in mathematics is fundamentally at the heart of successful engineering study. Unlike other polytechnics, the Open Polytechnic is not constrained by teaching resources such as staff availability and the semester system. Students have a more flexible curriculum experience and so the one-semester mathematics course can be taken at any time, unlike the offerings of mathematics block courses and fuller one-semester programmes offered by the other regional polytechnics. In a sense, the flexible one-semester mathematics course comes halfway between the fuller 60 credit programme and the single intensive summer programme. It has the benefit of allowing mathematical development over time, but it does not address any of the additional needs that foundational students generally have.

Feedback from staff

All teaching staff interviewed agreed that engineering foundation programmes were an important part of the engineering education pathway. All mentioned mathematics as a key component to engineering foundation. This is largely due to the poor preparation students get in mathematics at school:

> “So what you find is that the big limiting factor for most students is the maths, and that’s because of their schools.”
> *(Teaching staff interviews)*

However, what might seem contrary to this is the fact that if students are given a decent foundation in mathematics, then they are able to cope with most courses that follow.

> “Our guys are saying that if they’ve got good strong algebra then they can teach them whatever they need to know.”
> *(Teaching staff interviews)*

Similarly for physics:

> “They don’t get a chance of doing physics at high school.”
> *(Teaching staff interviews)*

One respondent coupled poor mathematics with poor language skills:

> “They’re typically weak in both maths and English. To be honest, many start off by being very willing and very motivated in the beginning but then lose hope. The problem that we have across the board is that people don’t like teaching basic maths and basic English.”
> *(Teaching staff interviews)*

Maths anxiety was also mentioned as an issue for concern:

> “And then you’ve got all the maths phobia and stuff like that, you know?”
> *(Teaching staff interviews)*

Online learning was seen as something students did not want, particularly after their bad experience during the COVID pandemic. Face-to-face was seen as the preferred model of instruction, particularly for weaker students (who would make up most of any foundation class).

> “I don’t wanna be online, so interestingly a lot of those students, a lot of our students in the Auckland region, all of them can’t learn online, didn’t learn online, don’t know how to learn online and absolutely hate it…..and so it’s avoided as much as possible by a lot of people.”
> *(Teaching staff interviews)*

At least two smaller polytechnics used to have foundation courses or programmes which have been cut due to financial constraints. These necessary changes have meant that the foundational aspects of mathematics that are necessary to succeed in the NZDE are now integrated into the mainstream diploma mathematics curriculum.

> “We used to have a maths foundation. Yes, we used to teach it in summer school and it would start with things like integers and fractions and manipulation of those. And then we would proceed with more algebraic concepts. Now what we’ve done, and a lot of other institutions have followed suit, is we’ve built that aspect into maths- we make that formally part of our maths. The first week or two of maths is when we devote time to that cause.”
> *(Teaching staff interviews)*

While teaching staff focused primarily on academic support in foundation programmes, management had a broader perspective. Their concern was in terms of general barriers that students faced as well as the strengths they brought to the learning environments. Interestingly, their perspectives confirmed the teaching staff view that there is a significant portion of students who need to have foundational support on entry into the NZDE. This is aptly demonstrated by the following two quotes:

> “In terms of initial barriers or things that I’ve noticed that are coming through to our engineering programmes, the biggest issue we’ve got up here is just lack of adequate education from the school system. When they arrived with us, we find that most coming from school are coming in at level two or three realistically, and there’s a lot of catch up that needs to be done to get them up to level 5 in most cases. There are a few that are coming through ready to go at level 5, but they’re definitely the minority. So that’s the first issue we’ve got is their initial pathway and we are working on some strategies to strengthen pathways.”
> *(Management staff interviews)*

In terms of the strengths that students bring to the learning environment, mature students bringing their life experience into the classroom was seen to enhance learning, not just for themselves but also for others. Similarly, neurodiverse learners were considered an asset to engineering programmes. Apart from it being positive reinforcement for learners who may have difficulty adapting to a new learning environment, it signals an attitudinal move away from the deficit model of foundation, even if the teaching staff still adhere a little to that model.

> “We tend to get a lot of older learners returning to education up here and they bring with them life experience and find a connection to their studies. This is an aspect that they bring to the classroom that would otherwise be missing, which is really valuable. Another strength that I’ve noticed is that we do tend to have a lot of neuro diverse learners who seem to gravitate towards subjects like engineering or social services.”
> *(Management staff interviews)*

Feedback from students regarding foundation programmes

Barriers to successful study experienced by the respondents

From the survey, 57% of the respondents reported having at least one barrier to their studies. By far the most identified barrier to successful study mentioned by the students was that of personal issues. These mostly included family and relationship issues, health and what was referred to as "mental" issues in the comments provided. The second largest category was the impact of having a job while studying. A breakdown of the most mentioned barriers to successful study is shown below in table 4.

Table 4. Barriers to success identified by the students

Most mentioned barriers	No. comments
Personal issues like family and health	22
Having to work while studying	9
Academic issues like needing remedial maths or physics	6
Poor teaching	5
High workload	4
Poor or lack of resources	3
Diversity issues	2
Financial	2
Language	2
Being a mature student and being out of practice in terms of study	2
TOTAL	**57**

Factors leading to success in engineering study

There was a wide range of factors that students pointed to as reasons why they felt they had been successful in their studies. Of the 107 respondents, only nine did not provide any reasons for their successful study. The other 98 gave at least 110 suggestions. Of those, 49 credited polytechnic teaching and tutors for their success. This was by far the most common reason given and it fits well with tutor comments that students by far prefer face-to-face teaching over the provision of resources (similar to their COVID experience). Supporting this were 16 comments outlining that what has helped them succeed is interaction with peers in the classroom. Table 5 below gives an indication of the relative emphasis placed by the students on factors affecting their success. An interesting one is reliance on their own abilities and their belief in themselves, which was the second most common factor mentioned.

Table 5. Factors influencing successful engineering study

Most mentioned factors	No. comments
Teachers and teaching provided by the polytechnic	49
Self-belief, self-reliance and good study skills and time man-agement	20
The effect of classmates, peers and working as a team	16
The provision of good learning materials and resources	15
Strong mathematics and ophysics background	5
The influence of their job and experience from past work envi-ronments	5
TOTAL	**110**

General comments from students:

It should be noted that in general, the students' responses to their engineering study are positive, as evidenced by the far greater number of positive factors influencing their success than the number of identified barriers to their success. This is further supported by the general "have you anything to add?" comments by the students, some examples of which are listed below:

> "Everyone around me has been so helpful and supportive, e.g. lecturer, classmates, family"
> *(Student survey comments)*

There is also reference to the difficulty of the content, something that students might not expect when they entered engineering study for the first time.

> "Studying engineering is hard, but it'll be worth it at the end. Still have some fun and also study well at the same time. Have proper time management."

> "This second semester has gone very fast; the first semester I found very difficult- like learning a new language"
> *(Student survey comments)*

The first of the two comments above highlights the view of reaping rewards from hard work, as well as hints of the common idea of "work hard, play hard".

5.2 WOMEN IN ENGINEERING STUDY

The underrepresentation of women in engineering is a worldwide issue and has roots in the underrepresentation of women in STEM fields in general. In this section, student survey data is connected to interview data gathered from both teaching staff as well as other stakeholders. It has been clear that efforts in the past have not had a major impact on female representation, however, there have been initiatives mentioned in the interviews that are worth expanding upon.

Statistical analysis of student survey data

Of the 107 students surveyed (the questionnaire can be found in Appendix 1), 15 (14%) identified as female while 89 (83%) identified as male. The other three identified either as transgender or non-binary or preferred not to answer this question. As was expected, the cohort is unsurprisingly male. However, based on the work by Fosnacht et.al (2017), who maintained that 10% of a student survey population is enough to make reasonable assumptions, a sample of 15 was considered sufficiently large to conduct a t-test to compare the means of some of the Likert items with either the population as a whole, or with the male part of the population. The gender breakdown of the survey population is shown in table 6 below.

Table 6. Breakdown of survey population by gender

Identified Gender	No. Responses (%)
Female	15 (14.0%)
Male	89 (83.2%)
Non-binary	2 (1.9%)
Prefer not to say	1 (0.09%)
TOTAL	**107**

Two types of data were taken from the 107 students surveyed. These were statistical data on the Likert-type questions pertaining to their engineering study experience. The second were answers to open-ended questions that revealed some of the reasons behind the choices the students had made. Analysis of the Likert-style responses showed that there were indeed differences in students' levels of confidence in their abilities in some areas coming into engineering study, based on both gender and ethnic identity. These data are represented in table 7 below.

Table 7. Survey data – Women in engineering study

	Population surveyed	Female	Male	Female vs. Male
Sample size	107	15	92	t (105), p (< 0.05) ^{t}critical =1.984
Selected Likert-type responses (1 – 5)				
Confidence in mathematics	3.38	3.67	3.30	-4.093
Confidence in physics	3.26	3.50	3.20	-3.325
Confidence in learning abil-ity has increased	3.95	3.99	3.91	-1.207
Felt well supported in their studies by provider	3.89	4.06	3.83	-3.797
Felt well supported by family and/or community	4.09	3.93	4.09	2.287
Improved in ability to under-take study tasks	4.05	3.86	4.04	2.616
Non-Likert-type questions				
Felt they needed a founda-tion programme	24 (22%)	5 (33%)	19 (21%)	
Felt they had NO barriers to their success in engineering study	46 (43%)	6 (40%)	40 (43%)	

The Likert-type responses were out of five, with five being allocated to the most confident and one to the least. The "average" response (neither confident nor unconfident) would be three. Means of each group's Likert scores for an item were then tested using a simple t-test for small samples to see if there existed a significant difference between the mean of each group and the mean of the whole population. In the case of differences in response for gender, a t-test was also conducted to see if there was a significant difference between the responses of the male and female populations. Items that exhibited statistically significant differences between the means are shaded in table 3, and these are discussed below.

While there were no statistically significant differences in overall response patterns between female respondents and the total respondent population, a notable gender disparity was observed in self-reported confidence levels. Specifically, male respondents reported significantly higher confidence in mathematics and physics at the commencement of their engineering studies compared to their female counterparts. Females were significantly more confident [$t(105) = 4.093$, $p < 0.05$] in mathematics than males as well as in physics [$t(105) = 3.325$, $p < 0.05$]. Similarly, they felt significantly better supported in their studies by their providers than did their male counterparts. This is not that surprising as there are consistently 8% to 10% more females obtaining excellence endorsements in NCEA and that according to NZQA, girls appear to outperform boys at level 1 mathematics, at least in high school.

This paints a rather different picture as is shown in the study by Smith and Evans (2024), who used the TIMMSS data from 2019 to analyse data relating to the STEM gender gap in school performance. They showed that girls at low decile schools outperformed boys, whereas at higher decile schools, the boys outperformed the girls. A similar effect was shown in the sciences. According to them, this dependence on decile ranking (decile 1 indicates low socio-economic area, whereas decile 10 indicates high socio-economic area) might have has a significant impact on the performance in mathematics and science at high school level, which makes the relative confidence levels of females in this study in mathematics and physics seem somewhat anomalous. Clearly, further work needs to be done in investigating confidence in mathematics and physics on entry into engineering study.

Interestingly, 33% of female students indicated that they needed to have a foundation programme compared with 22% of the population, perhaps indicating that there is an issue of self-efficacy when it comes to mathematics and physics. This is supported by Mann and Shaw (2019) who point to the impact of maths anxiety amongst girls in high school. Possibly this could be the cause of low self-efficacy picked up in this study.

Feedback from students

There was some feedback from students pointing to specific sexist practices that were seen to be a barrier to their learning.

> "This isn't related to a Polytechnic, but as one of very few girls in my class I have experienced not being taken seriously."
> *(Student survey comments)*

The student went on to report that when she asked questions, she had been ignored by the tutor in class and that even the boys noticed this and helped her by repeating the question so that it could be answered for her. While this seems anomalous, it is symptomatic of system that undervalues women in the engineering context. The lack of specific examples could highlight an underlying acceptance of the status quo, which might lead women students to try not to "rock the boat".

Nine out of the 15 female respondents (60%) indicated that engineering had been their first choice as a career, around the same proportion as the data collected for male respondents (58%). This could indicate that there are no excessively different societal pressures on males and females in the years prior to making career choices. However, this would need to be tested with a much greater sample and more probing questionnaires.

A total of 60% (9/15) of female respondents reported experiencing barriers to their success in engineering. This is similar to the overall proportion. What was interesting was that one female respondent reported the feeling of discomfort at being a female student in a predominantly male class. (This was not the same respondent who complained about not being taken seriously in class).

> "Being one of few females, only barrier--> feeling uncomfortable"
> *(Student survey comments)*

While there appears to be little pressure on selecting engineering as a female student on entry into the polytechnic, the experience of being in a predominantly male environment could be a barrier to successful learning for female students.

Even though the sample is small and female student feedback pointing to barriers to learning is sparse, there does seem to be some underlying reason why female students might not feel comfortable in the overwhelmingly male-dominated polytechnic engineering environment. To address this perception, there have been interventions by mainly female staff that will be discussed in the next section.

Feedback from staff

The low representation of women in engineering study, particularly in polytechnics, has not gone unnoticed and there have been several interventions. These range from institutional initiatives such as arranging Women in Engineering showcases to initiatives taken by individuals to try and create a sense of engineering identity amongst female engineering students. Such initiatives are illustrated through the staff comments below:

> "[undisclosed name] tried to set up a "Women in STEM" group led by students. This worked when there was a very driven female leading it, but it's not running now. We are going to try and set this up again soon, but no details just yet."
> *(Staff interview comments)*

One tutor, a member of Auckland University's "Women in Engineering" group, occasionally arranged get-togethers for her female students and even took them along to one of the group meetings.

> "I used to bribe my former (female) students with pizza and at lunchtime, they would come in and share pizza with my current class and they would just sit around and talk for, you know, 20 minutes before they all had to go to classes and were interested in these sorts of questions."
> *(Staff interview comments)*

Such initiatives often stop because they are not part of the institutional plan and are reliant on one person's interest and energy. At one polytechnic in the North Island, there is a formal intervention that happens annually, where prospective female students are invited to an engineering showcase. The same institution puts on similar events for Māori and Pasifika students.

Of concern to many interviewed is the experience of female Māori and Pasifika students as illustrated by the comments below:

> "The number of Pasifika, Māori and women students we are getting has been low the last couple of years. We've had a few more female students, but not everyone that comes in there wants the Diploma of Engineering…
>
> ...the other thing that gets in the way, particularly for our young Pacific woman, is family expectations."
> *(Staff interview comments)*

The comment above alludes to the double impact of gender and culture on a student's success in engineering study. The expectations of the community and family, particularly of female students, was also mentioned by other interviewees at other institutions. One interviewee made the case that there should be closer relationships developed between Māori and Pacific Island communities and engineering schools to get community leaders on board to try and help female students navigate the way between their studies and community and family obligations.

> "And Māori women [has] a huge dropout rate. You know, they're expected to go and do far more duties (than the men). If there's a tough time in the whānau you see, they then have to leave this study and go and look after a whole lot of children and things like that."
> *(Staff interview comments)*

5.3 MĀORI AND PASIFIKA IN ENGINEERING STUDY

Statistical analysis of student survey data

The bar graph (figure 2 below) shows the predominance of those identifying as NZ European / Pakeha in engineering study in the sample, with only one identifying as Māori and five identifying as Pasifika students. It should be noted that the next highest group are Asians, many of which are possibly international students. Four did not provide an answer to the question at all. This low participation rate itself tells a story of underrepresentation of both Māori and Pasifika students in engineering study.

Figure 2: Breakdown of survey population by ethnic identity

Since the sample of Māori and Pasifika students in this survey was only six (five Pasifika and one Māori), drawing general conclusions is a little difficult and so the calculated t-values should be considered with caution. However, the t-test for small samples did show a significant difference between this group and the survey population in the confidence in their abilities in mathematics and physics coming into their engineering studies. While there appeared to be some lack of confidence in their perception of their abilities to improve in their studies, the t-test showed that this was not significant. These data are shown in table 8 below.

Table 8. Survey data - Māori and Pasifika students

	Population surveyed	Māori & Pasi-fika	
Sample size	107	6	t (5), p (< 0.05) ^{t}critical = 2.571
Selected Likert-type responses			
Confidence in mathematics	3.38	1.83	-5.043
Confidence in physics	3.26	2.00	-4.887
Confidence in learning abil-ity has increased	3.95	3.83	-0.390
Felt well supported in their studies by provider	3.89	3.67	-0.447
Felt well supported by family and/or community	4.09	4.00	-0.181
Improved in ability to under-take study tasks	4.05	3.50	-2.445
Non-Likert-type questions			
Felt they needed a founda-tion programme	24 (22%)	4 (66%)	
Felt they had NO barriers to their success in engineering study	46 (43%)	0 (0%)	

Feedback from students

This lack of confidence in themselves, particularly in mathematics and physics which are the foundations of engineering, must surely influence performance. This is possibly why two thirds of the (admittedly small) cohort reported needing to do a foundation programme before embarking on an NZDE or BEngTech.

Barriers to their studies reported by this cohort included the following:

> "Family, culture, religion, work"
>
> "Flatting, feeling different, can't study properly, then having my own flat"
>
> "Working full time while studying full time. Proper delivery of classes by some tutors - hard to understand/learn"
>
> "Having not done any academic study before. Have not been to school for almost 30 years"
>
> "Having a pre-maths course to bring people up to the base diploma level of engineering maths and physics would be helpful "
>
> "Personal issues / health"
> *(Student survey comments)*

While it is a small sample, it does emphasis a few things: first is the impact of non-academic issues on their study and the second is the explicit need for some foundational mathematics to be provided as part of the curriculum. It is interesting too that all of the Māori and Pasifika students mentioned a barrier, but in the survey population as a whole, only 58 / 107 (54%) mentioned a barrier to their studies. This is a marked difference and while there is some commonality between the nature of the barriers reported in the Māori and Pasifika group, what demands attention is the fact that close to 50% of the population reported having no barrier, whereas 100% of the Māori and Pasifika cohort reported one barrier or another.

On the positive side, five of the six respondents reported that the thing that helped them succeed was the support provided by others, mainly their tutors and the institution, and in one case a family member. One reported that personal motivation helped them in their success. In the final comments given, the following suggestions were made:

> "Maybe any free classes in the beginning of the year use them to give assignments or tests earlier rather than later. Help students prepare for exams rather than submitting assignments they just learnt and have no time to study."
>
> "This second semester has gone very fast; the first semester I found very difficult- like learning a new language"
>
> "Enjoyable experience, large exams looming overhead does create stress"
>
> "Having a pre-course to help get up to diploma level of maths and physics"
> *(Student survey comments)*

Again, there is mention of the need for some foundational intervention in addition to two comments regarding exams, possibly indicating that assessment practices need to change. Given the low levels of self-efficacy shown in these responses, it is perhaps of little surprise that there is an underrepresentation of Māori and Pasifika students in engineering study.

Feedback from staff

The programme structure for all those offering a foundation pathway into the NZDE usually follows a one-semester programme that combines a course in mathematics with other courses such as physics, language skills and learning skills. Two of the eight offer shorter foundation programmes (one or two weeks in the summer that usually focus only on mathematics). The following themes emerged from the analysis of the interview data.

STEM & mathematics

The emphasis on mathematics as an important foundational component is supported by data gathered from the interviews of the teaching staff, where mathematics was identified as a particular weakness in students enrolling in the NZDE in general. When asked what was seen as a reason why there were so few Māori and Pasifika students in engineering study, one interviewee, a programme leader, simply stated:

> "Mathematics" *(Interview with engineering programme lead)*

One participant who had extensive industry experience maintained that the mathematics taught in engineering programmes was at an unrealistically high level and acted as a barrier to progression of Māori students.

> "So, there's a calculus issue or the usual stuff that everybody has, but that's not representative of a particular Māori problem. It's representative of a of a population issue, which is exacerbated with lower overall educational outcomes for Māori. *(Industry / polytechnic management representative)*

Academic preparation for engineering study at school was mentioned by some interviewees. There was concern that Māori students were not engaged at school in STEM subjects and consequently, they didn't see themselves as engineers in the future.

> "At school, kids are disengaging from STEM and making decisions about their careers (that do not involve STEM), so they will go: Oh, I'll become a sports person."
> *(Industry / polytechnic management representative)*

The view that mathematics and STEM knowledge in general is a problem appears to primarily come from the teaching and engineering management staff, and not the learning support or Māori office staff. Learning support staff who generally deal with learning difficulties and provide support for students who have a range of issues affecting their studies from family to work to finance, report that the biggest barrier to Māori and Pasifika students' success is not necessarily under preparedness as implied by the engineering academics, but rather culturally-based expectations of their communities and families. There were also multiple other factors that had an impact on students enrolling and succeeding in their studies.

Access to learning and engineering study

Access to learning was highlighted by multiple interviewees. The argument put forward was that often Māori students come from lower decile schools and often these are in rural areas. Since engineering programmes are typically face-to-face, this means that students need to move to towns to study, which is often not possible, given financial and family constraints.

Accommodating working students

Since many Māori students need to work, access to learning becomes a problem. This was highlighted by learning support staff at two polytechnics and is encapsulated by the quote below.

> "I think the biggest benefit that removes a barrier is the model of delivery and that they deliver to the industry needs so they deliver night classes so people can go to work and they work in the industry and then they come to do their studies at night.
> These are the things that I see as barriers that I have seen that I know exist.
> So the first one is pathways to employment." *(Learning support representative)*

Changing the model of delivery to become more flexible was seen as necessary to making changes to accommodate Māori and Pasifika students

Creating safe learning environments

Learning spaces in an academic environment can be alienating and counterproductive. Some suggestions included changing workspaces to accommodate a team approach where students could make mistakes without feeling vulnerable. With one representative, this was linked to the way mathematics was taught.

> "You know they found it quite good for their confidence because they were able to make mistakes and not in front of people. They were able to access the resources and then run over it just to get the hang of it, but they weren't making any mistakes in front of anybody." *(Learning support representative)*

The implication of this comment is that work needs to be done in changing the pedagogy, particularly for students who feel vulnerable with mathematics.

Seeing themselves in engineering

Seeing the possibilities of an engineering career was highlighted as a barrier to Māori and Pasifika students even considering engineering as a career.

> "They've got to be able to see themselves in a career in a pathway.
> And then, because there's, there's plenty of, you know, when you talk to families and there's plenty of examples where they see this support." *(Learning support representative)*

Role of community

The role of community was emphasised by several respondents who pointed out that if there was a goal to increase Māori representation in engineering, this would need to be done hand-in-hand with Māori and Pasifika communities. Community leadership can interest and influence young Māori to pursue studies in engineering.

> "We go into the community and say, hey, we've got a shortage of money. In this industry, we've got a shortage and we desperately need them, you know, especially in the design part of it, especially around water especially, you know around those components are really, really important. We need water engineers who are marrying a different view." *(Industry / polytechnic management representative)*

> "You know, and it's for Pacific communities. It has to be driven by them.
> So you get the Pacific community leaders on board, they drive it and they push.
> They are the voice and we are coming behind, and because they hold the relationships, they are the voice. And for Māori, it's very much the same. We've got to go to the people. We can't sit at this end and wait for them to come." *(Learning support representative)*

This is further supported by teaching staff views in the same institution. In some areas, cultural issues pertaining to family and community have a large impact on student studies.

> "Well, I think the one that we've noticed is not generally noticed, and that is iwi's attitude towards members of their whānau and study. I've had Māori students come to me and say, you know, I've got a problem with my whānau because they don't think that I should be studying." *(Teaching staff representative)*

Reasons for this attitude appear to range from the necessity for students to be available to the family or community for work that needs doing at the home, for example preparation for tangi and child caring. As mentioned in the preceding section, this is particularly onerous for women. However, one member of the teaching staff confirmed that having a good working relationship with the community was a benefit in helping young Māori students navigate between their studies and their family / community commitments. This is illustrated in the quote below:

> "Now we find that we have an ally in the Māori elders. They are very well aware of the value of good education and training and life skills, and they help elevate people and support us. We have very close relationships with some of our Māori elders in this area."
> *(Teaching staff representative)*

Finally, there has been some success in developing better outcomes for Māori engineering students. See this quote from a staff member who runs a foundation programme:

> "I put all the data that I had access to, which was about four or five years, and I found that roughly our Māori students were above average. And their own net scores and a lot of our Pacific students will often be well below and certainly our English-as-a-second language students were lower again than everybody together, which was interesting….
> …And I think again it comes back to choices being made at school, seeing it as a viable option….
> …It is like anything if you are not familiar with the tools, everything else is hard and I always say in matters at all that you use to achieve all those other things, and I think we're kind of unique."
> *(Engineering Foundation Programme co-ordinator)*

6. CONCLUSION AND RECOMMENDATIONS

Foundation programme provision by polytechnics in Aotearoa

Of the 14 institutions investigated, one did not offer either a degree or a diploma in engineering and of the other 13, nine offered some version of a foundation programme. Across Aotearoa New Zealand, three different models of engineering foundation are currently available. These include:

- Non-certified pre-diploma block course (e.g. summer school).
- One-semester mathematics course.
- One-semester pre-diploma certificate with multiple courses.

It was found that at least two institutions had previously offered foundation courses but that these were cut and in one case it was reduced to integrating some mathematics foundational concepts into the first-year mathematics course.

What is interesting is that all foundational courses / programmes on offer relied on the same pedagogical model i.e. a pre diploma course not integrated into the NZDE curriculum. There may be an opportunity lost here as by integrating mathematics (and other) foundational courses into the NZDE to create an extended curriculum, it may be possible to retain government funding for these foundational components.

The second opportunity that seems to have been lost is the benefit of collaboration.

While it might not be cost effective for a smaller institution to offer foundation programmes, engineering foundation could be offered online through the Open Polytechnic with local polytechnic support.

There is some agreement between students, teaching staff and management as to what the barriers are academically. However, feedback from students highlighted a much wider range of barriers to their learning, but what is pleasing is that there were many more factors that they had identified as influencing their success.

Recommendations:

1. Using a modular approach, make it possible for the NZDE to have foundational components integrated into the curriculum. This should ensure that government funding is available for such courses and that student allowances are available for students who undertake an extended curriculum at a slower pace than mainstream students.
2. Smaller institutions partner with the Open Polytechnic to share the delivery of foundation programmes where they are needed. This would include use of Open Polytechnic materials and assessment alongside local institutional academic support. Base this programme on the principles of self-paced mastery.
3. Modularise the NZDE so that the assessments move away from a high stakes single exam at the end of courses (particularly mathematics) and instead set up a system where credit is given on the basis of performance in a combination of smaller assessments. In this approach, courses would be broken into smaller modules, each assessed separately, which would allow those students who are taken away from their studies during term time to not sacrifice a semester's work because they needed to deal with family matters for a short period in the middle of their studies. The modularisation of some courses like mathematics is already being trialled by Unitec, Toi Ohomai and WinTec and based on their experience (which has been a positive one), it should be rolled out at other polytechnics.
4. Make government funding available for foundation programme enrolment in engineering foundation programmes, even if these are short one-month courses. This should also include student allowances.

Women in engineering study

While in general female students appeared to not be disadvantaged in terms of academic preparation on entry into engineering study, the impact of a predominantly male-oriented environment has affected some female students. There is much concern regarding the success of Māori and Pasifika women students given some of the cultural expectations. This intersection of gender and culture has been discussed earlier by Kachchaf et al., (2015), Lakin et al., (2019) and Hinsdale, (2015). What seems clear is that some of the initiatives designed to induct female students into engineering should be made part of the mainstream, particularly if the focus is on Māori and Pasifika women in engineering. In addition, while it may never be true that we have a 50:50 ratio between male and female engineers in society, it is essential that women have an equal opportunity to select programmes that they prefer and that their experience in these programmes should be a positive one.

Recommendations

1. Raise funds to set up projects aimed at encouraging women into engineering across the country. Use these funds to set up regular events based at polytechnics around Aotearoa. Institutions should also partner with regional Women in Engineering groups at a regional level to expose students (both male and female) to local role models.
2. While this is a wider institutional competency, establish mechanisms to support female Māori and Pasifika engineering students in particular to help them navigate between family and community responsibilities on one hand and their studies on the other. This could include greater flexibility in course delivery as an attempt to alleviate pressure on students in general.
3. Ensure that in all engineering schools there are mechanisms for female students to voice their concerns over issues regarding discriminatory practice, including what makes them feel uncomfortable in an overwhelmingly male environment.

Māori and Pasifika students in engineering study

Māori and Pasifika students were a small portion of the population surveyed, and so generalisation should be cautious. The Student's t-test for small samples was used on the Likert-style responses and these were compared with the whole population. In these, significantly low levels of confidence were reported by the students in three areas; mathematics and physics ability on entry into the programme, and confidence in their perception of their ability to improve in their studies. This is confirmed by interviews with teaching staff as well as engineering school management, who have pointed to academic issues being at the forefront of Māori and Pasifika student performance. Students lacking self-efficacy in mathematics, physics and their own ability to complete tasks are less likely to succeed than those who come into the programme with higher levels of self-efficacy.

Unlike the engineering academics' response that focused on mathematics as an issue with student success, learning support provided by the Māori and Pacific offices took a broader view of the barriers to success for Māori and Pasifika students. Their suggestions emphasised some of the non-academic barriers that were also highlighted by the students, including finance, workload, travel and community and family expectations. These barriers were acknowledged by students but also seen as a strength in some cases. When there was support provided, for example by a family member, it was mentioned. While there may be some instances in some institutions where support is insufficient, it seemed from the qualitative data collected that institutions have a good system of non-academic support, particularly for Māori and Pasifika students.

Recommendations

In this study, Māori and Pasifika students reported lower levels of confidence in mathematics and physics and two thirds reported needing a foundation programme. There was also mention in some of the student comments that exams were an issue. In order to address these needs, the following suggestions have been made:

1. Develop school-based programmes to emphasise STEM subjects and engineering in particular. Some of these exist, but having a nationally co-ordinated project such as the Saturday School model employed by PROTEC in South Africa from 1982 to present would be good. A focus on lifting numeracy levels in schools should also be a priority and this could happen with such a national programme.
2. Develop an intervention to help school science and mathematics teachers develop engineering context teaching and learning materials to help engage students in meaningful engineering problem solving. This could be linked to the Saturday School programme in recommendation 1 above.
3. Set up direct relationships between engineering schools and communities from where engineering students are drawn. Include whānau and community members in engineering showcase events so that they can see the successes of their own community members. This could extend to including whānau and community members in presentations of some course assessments and not just the final projects students produce at the end of their diplomas anddegrees.
4. Use inspirational Māori and Pasifika engineering students as role models for other students. This could include the use of a peer-mentoring or supplemental tutorial system, where inspirational Māori and Pasifika students also benefit by being employed as tutorial assistants.
5. Integrate curriculum delivery with the Tertiary Education Commissions Learner Success Framework, particularly in terms of working in partnership with communities.

General Recommendations

There are several limitations to this study. These limitations necessitate a cautious approach to the data collected. While there is a substantial volume of data collected, there were gaps which need to be acknowledged.

Insufficient student data

The initial intention was to interview selected students to “dig deeper “into the factors affecting representation in engineering. This deep dig was not possible because despite the large amount of work that was given over to collecting surveys, only one of the 107 students identified as Māori. In addition, due to the timing of the survey close to exams, it was very difficult to set up interviews with students and so none were carried out. This meant that the researchers had to rely on comments from student surveys and interview data from staff.

While there was a sufficiently large subsample of female respondents to the survey to carry out a reasonable statistical analysis, the small sample of Māori and Pasifika respondents made reliance on a statistical analysis problematic. This, in turn, reduced the pool of respondents the researchers would have been able to interview. In both cases, it would have been better to have been able to confirm some of the sentiments displayed in the comments made by students in the survey through more in-depth follow-up interviews.

Getting a national picture

Persuading all 13 institutions to participate in collecting survey responses and giving over enrolment data was quite difficult. In the end, only five polytechnics carried out the survey and only one of those was comfortable sharing their enrolment data. It would be very useful to use the VEENZ infrastructure to collect student views on their experience of engineering study on a regular basis, possibly annually. Operating through VEENZ would allow researchers to have a regular sample of what the issues are with students and be able to make timely recommendations for amelioration.

Specific recommendations:

1. Based on the survey just completed, set up an annual survey of students to gauge their feelings about various aspects of engineering study specifically.
2. Complete the interview process using the current data set to “dig deeper” into factors affecting Māori and Pasifika success, as well as issues that affect women in engineering study.

7. REFERENCES

The AAUW Report. (1992). How schools shortchange girls. AAUW Educational Foundation.

Al-Sanad, H. A.& Koushki, P. A. (2001). In Pursuit of Excellence and Gender Equality: Engineering Education at Kuwait University. Journal of Engineering Education 04//4/1/2001 2001;90(2):253-259

Amundsen, D. (2019). Student voice and agency for Indigenous Maori students in higher education transitions. Australian Journal of Adult Learning, 59(3), 405-434.

ARA Institute https://www.ara.ac.nz/study-interest-areas/engineering/ (Downloaded 3/03 2025)

Aronson, E. Wilson, T.D. and Akert, R. M. (2005). Social Psychology. New Jersey: Pearson Educational International.

Atkinson, S. (2006). Factors influencing successful achievement in contrasting design and technology activities in higher education. International Journal of Technology and Design Education. 16, no. 2: 193-213.

Babiar, T. C. (2011). Exploring Differential Item Functioning (DIF) with the Rasch Model: A Comparison of Gender Differences on Eighth Grade Science Items in the United States and Spain. Journal of Applied Measurement 12(2) 144-164

Bandura, A. (1994). Self-efficacy. In Encyclopaedia of human behaviour, ed. V.S. Ramachaudran, vol. 4: 71-81. New York: Academic Press.

Bradley, J., Newhouse, C., & Mirza, N. (2019). Driving social mobility? Competitive collaboration in degree apprenticeship development. Higher Education, Skills and Work-Based Learning, 9(2), 164–174. https://doi.org/10.1108/HESWBL-07-2018-0077

Brainard, S.G. and Carlin, L. (2001). A six-year longitudinal study of undergraduate women in Engineering and Science. In The Gender and Science Reader, ed. M. Lederman and I Batsch, 24-37. London: Routledge.

Brewster, B. J. & Miller, T. (2024). Women's mathematics anxiety: a mixed methods case study. International Journal of Lifelong Education 2024 43(1) 2-23

Cardiff University Website https://digital.ucas.com/coursedisplay/courses/ec61973e-0152-9344-bb78-5fe822c55f5c (downloaded 4 / 10 2024)

Carnegie, D.A., Watterson, C., Browne, W.N., and Mackay, J. (2012). Strategies to improve engineering retention. Global Engineering Education Conference (EDUCON), Marrakech, 17-20 April 2012, 1- 10.

Chopra, S. (2022). Gender Differences in Engineering: A Data-Driven Study [PhD, University of Waterloo]. https://dspacemainprd01.lib.uwaterloo.ca/server/api/core/bitstreams/dba2fb62-938b-4fb5-ac36-0974980fdcd0/content

Clarke, J. (2018). Invited presentation for the Tertiary Education Commission on degree apprenticeships at Manchester Metropolitan University. Wellington, New Zealand. 2018.

Creswell, J. W. (2020). Educational research: Planning, conducting, and evaluating quantitative and qualitative research. Pearson Higher Ed.

Davies, B. (1989). The discursive production of the male/female dualism in school settings. Oxford Review of Education. 15(3): 229-41.

Davies, T. and Elmer, R. (2001). Learning in design and technology: impact of social and cultural influences on modelling. Journal of Technology Education. 12, no. 2:5-20

Davis-Hall, D., Farrelly, L., Risteff, M. & Magin, C.M. (2022). Evaluating How Exposure to Scientific Role Models and Work-Based Microbadging Influences STEM Career Mindsets in Underrepresented Groups. Biomedical Engineering Education (2023) https://doi.org/10.1007/s43683-022-00096-x

Eastern Institute of Technology https://www.eit.ac.nz/ (Downloaded 3/03 2025)

Francis, B. (2000). Boys, Girls and achievement. London: RoutledgeFalmer.

Fosnacht, K., Sarraf, S., Howe, E., & Peck, L. K. (2017). How important are high response rates for college surveys? The Review of Higher Education, 40(2), 245-265.

Fowles-Sweet, W., & Barker, J. (2018). Widening participation and social mobility: Encompassing and integrating learning opportunities. Widening Participation and Lifelong Learning, 20(2), 69–95. https://doi.org/10.5456/WPLL.20.2.69

Goodyer, J., & Soysa, I. B. (2017). A New Zealand national outreach program–inspiring young girls in humanitarian engineering. International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship, 12(2), 1-14.

Hango, D. (2013). Gender differences in science, technology, engineering, mathematics, and computer science (STEM) programs at university (Insights on Canadian Society, Issue 75-006-X). Statistics Canada.

Hinsdale, M. (2015). Empathy Blues at the Colonial Difference: Underrepresented Undergraduate Women in STEM. Philosophy of Education Yearbook 01// 2015;():236-244

Hook, G.R. (2007). Māori Technology Capacity II: Science in the Universities and Polytechnics of New Zealand. MAI Review, 2007, 3, article 3

Hook, G.R. (2008). Māori Students in Science: Hope for the Future. MAI Review, 2008, 1, article 2

Hughes, M.W., Bello-Mendoza, R., Cunningham, M., Sharp, K., McMeeking, S. & Manning, R. (2017). Towards integration of the Māori world view and engineering: A case study on student design projects for the Koukourārata community, Aotearoa/New Zealand. AAEE2017 CONFERENCE Manly, Sydney, Australia

Hunter, R. (2023). Tracing the threads of research to establish equitable and culturally appropriate pedagogical practices within mathematical interactions and discourse for all learners. Theory Into Practice //Winter2023 2023;62(1):79-89

Hur, J. W.; Andrzejewski, C. E.; Marghitu, D. (2017). Girls and computer science: experiences, perceptions, and career aspirations. Computer Science Education 06// 2017;27(2):100-120.

Hutchings, C., & Garraway, J. (Eds.). (2009). Beyond the university gates: Provision of extended curriculum programmes in South Africa. Rhodes University.

Ilumoka, A., Milanovic, I. & Grant, N. (2017). An Effective Industry-Based Mentoring Approach for the Recruitment of Women and Minorities in Engineering. Journal of STEM Education: Innovations & Research 07// 2017;18(3):13-19

Johnson, I. R., Pietri, E. S., Fullilove, F., Mowrer, S. (2019). Exploring Identity-Safety Cues and Allyship Among Black Women Students in STEM Environments. Psychology of Women Quarterly 43 (2) 131-150

Jones, A.T. and Kirk, C.M. (1990). Gender differences in students' interests in applications of school physics. Physics Education. 25: 308-13

Kachchaf, R., Ko, L., Hodari, A. & Ong, M. (2015). Career-Life Balance for Women of Color: Experiences in Science and Engineering Academia. Journal of Diversity in Higher Education 09// 2015;8(3):175-191

Karmokar, S. & Shekar, A. (2018). Outreach programmes using the Triple Helix model to encourage interest in Science and Technology among underrepresented youth. Design & Technology Education, 2018, 23(1)88-103

Kloot, B., Case, J. M., & Marshall, D. (2008). A critical review of the educational philosophies underpinning Science and Engineering foundation programmes. South African Journal of Higher Education, 22(4), 799-816.

Kodate, N., Kodate, K. & Kodate, T. (2010). Mission Completed? Changing Visibility of Women's Colleges in England and Japan and Their Roles in Promoting Gender Equality in Science. Minerva: A Review of Science, Learning & Policy, 2010 48(3) 309-330

Leydens, J. A., & Lucena, J. C. (2017, June). Mechanisms by which indigenous students achieved a sense of belonging and identity in engineering education. In 2017 ASEE annual conference & exposition.

Lewis, S. (1996) Intervention programmes in science and engineering education. In Equity in the Classroom, ed. P.F. Murphy and C.V. Gipps, 192-213. London: Falmer Press and UNESCO.

Liu, Y, Lou, S. & Shih, R. (2014). The investigation of STEM Self-Efficacy and Professional Commitment to Engineering among female high school students. South African Journal of Education 2014 34(2) 1-15

Mackay, J. & Cadzow, H. (2023). The Village Raising the Engineer: Report on the Degree Apprenticeship BEngTech (Asset Management) Pilot. Commissioned report for Tertiary Education Commission.

Mackay, J., & Cadzow, H. (2024) The impact an engineering degree apprenticeship in New Zealand has had on industry and the institution delivering the programme. WACE International Research Symposium, University West, Trollhättan, Sweden June 12-14.

Major, D. N. (2017). "Everything has shaped you": Contributors to young Māori university students' ability to flourish (Doctoral dissertation, University of Waikato).

Male, S. A., Gardner, A., Figueroa, E., & Bennett, D. (2018). Investigation of students' experiences of gendered cultures in engineering workplaces. European Journal of Engineering Education, 43(3), 360-377.

Mammes, I. (2004). Promoting girls' interest in technology education: A research study. International Journal of Technology and Design Education. 14, 89-100.

Manukau Institute of Technology https://www.manukau.ac.nz/study/areas-of-study/ (Downloaded 3/03 2025)

Marsh, J.D. & Kevin R. Eastwood, K.R. (2017). SciBoost: A collaborative approach to enhancing Māori and Pacific achievement in Science and Engineering. ATLAANZ Journal 2(1): 82-101.

Marshall, J. A., & Berland, L. K. (2012). Developing a vision of pre-college engineering education. Journal of Pre-College Engineering Education Research (J-PEER), 2(2), 5.

McAllister, T., Naepi, S., Walker, L., Gillon, A., Clark, P., Lambert, E. & Alipia, T. (2022). Seen but unheard: navigating turbulent waters as Māori and Pacific postgraduate students in STEM. Journal of the Royal Society of New Zealand, 52(sup1), 116-134.

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, DOI: 10.1080/03036758.2020.1796103

Meaney, T., Trinick, T. & Fairhall, U. (2013). One Size Does NOT Fit All: Achieving Equity in Maori Mathematics Classrooms Journal for Research in Mathematics Education, 2013, 44(1) 235-263

Mullis, I., M Martin, A Kennedy, P and Foy. (2007). PIRLS 2006 International Report: IEA's Progress in International Reading Literacy Study in Primary Schools in 40 countries. Boston: TIMMS & PIRLS International Study Centre, Boston College.

Murray, M.R. & Morgan, Te Kipa Kepa B. (2009). An indigenous approach to engineering effective learning opportunities. 20th Australasian Association for Engineering Education Conference University of Adelaide, 6-9 December 2009

Naepi, S., Wilson, E., Lagos, S., Manuela, S., McAllister, T.G., Kidman, J., Theodore, R. & Kokaua, J. (2021). Where are we now? Patterns of Māori and Pasifika enrolment in the Natural and Physical Science and Society and Culture fields in Aotearoa. New Zealand Higher Education Research & Development, 40:1,90-103, DOI:10.1080/07294360.2020.1857345

Nelson Marlborough Institute of Technology https://www.nmit.ac.nz/study/our-study-areas (Downloaded 3/03 2025)

Nicholson, J. (1984). Men and Women: How Different Are They? Oxford University Press.

NorthTec https://www.northtec.ac.nz/study (Downloaded 3/03 2025)

NZQA (2024). Annual Report NCEA, University entrance and NZ Scholarship data and statistics 2023 NZQA. May 2024 ISBN: 978-1-877444-12-8

Open Polytechnic of New Zealand https://www.openpolytechnic.ac.nz/qualifications-and-courses/ (Downloaded 3/03 2025)

Otago Polytechnic https://www.op.ac.nz/explore/find-a-course (Downloaded 3/03 2025)

Perry, H. and Fleisch, Brahm. (2006). Gender and educational achievement in South Africa. In Marking Matric ed. V. Reddy, 107-126. Cape Town: HSRC Press.

Peterson, E., Kulakowski, E., Mendez, S. L. (2024). "I Need to Do Better": The Promotion of Undergraduate Women's STEM Identity by Engineering Faculty. Journal of Advanced Academics. 35(3)461-481

Protec website https://protec.org.za/about-us/ (downloaded 4 / 10 2024)

Reid, J. (2006). Barriers to Māori student success at the University of Canterbury.

Riley, T., Webber, M. & Sylva, K. (2017). Real engagement in active problem solving for Māori boys: A case study in a New Zealand secondary school. Gifted & Talented International 07// 2017;32(2):75-86

Shiefele, U. Krapp, A. and Winteler, A. (1992). Interest as a predictor of academic achievement: A meta-analysis of research. In The Role of Interest in Learning ed. K.A. Renninger, S. Hidi, and A. Krapp, 183-212. New Jersey: Lawrence Erlbaum.

Sifuna, D.N. (2006). A review of major obstacles to women's participation in higher education. Research in Kenya Post-Compulsory Education 03// 2006;11(1):85-105

Silverman, S. and Pritchard, A.M. (1996). Building their future: Girls and technology education in Connecticut. Journal of Technology Education. 7, no. 2: 41-54.

Snyman, L. W., & Kasirye, M. (2021). The impact of science foundation programmes on the success rate of first-year students in a blended teaching and learning environment. South African Journal of Higher Education, 35(5), 277-295.

Southern Institute of Technology https://sit.ac.nz/Courses (Downloaded 3/03 2025)

Spooner, K., & Clear, T. (2016, March). A foundation programme preparing students for future study in Computing and Engineering Degrees. In 2016 International Conference on Learning and Teaching in Computing and Engineering (LaTICE) (pp. 66-70). IEEE.

Tertiary Education Commission Website. (2023, March). Learner Success Framework. https://www.tec.govt.nz/oritetanga-learner-success/new-oritetanga-tertiary-success-for-everyone/learner-success-framework

Theodore, R., Gollop, M., Tustin, K., Taylor, N., Kiro, C., Taumoepeau, M., Jesse Kokaua, J., Hunter, J. & Poulton, R. (2017). MĀORI UNIVERSITY SUCCESS: WHAT HELPS AND HINDERS QUALIFICATION COMPLETION. Alternative: An International Journal of Indigenous Peoples, 13(2), 122-130. doi:10.1177/1177180117700799

Toi Ohomai Institute of Technology https://www.toiohomai.ac.nz/study (Downloaded 3/03 2025)

Trevelyan, J., Baillie, C., MacNish, C., & Fernando, T. (2010, January). Designing an integrated engineering foundation course. In 21st Conference of the Australasian Association for Engineering Education.

Veldman, J; Van Laar, C; Thoman, D. B.; Van Soom, C. (2021). "Where will I belong more?": The role of belonging comparisons between STEM fields in high school girls' STEM interest. Social Psychology of Education 10// 2021;24(5):1363-1387

Universal College of Learning https://www.ucol.ac.nz/programmes (Downloaded 3/03 2025)

Weber, K. and Custer, R. (2005). Gender-based preferences toward technology education content, activities and instructional methods. Journal of Technology Education. 16, no. 2: 55-71.

Wellington Institute of Technology https://www.whitireiaweltec.ac.nz/study-programmes (Downloaded 3/03 2025)

Western Institute of Technology https://www.witt.ac.nz/study/ (Downloaded 3/03 2025)

Wint. N. (2023). Why do students choose to study on engineering foundation year programmes within the UK? European Journal of Engineering Education, 48 (1), 157–179 https://doi.org/10.1080/03043797.2022.2047895

WinTec https://www.wintec.ac.nz/study-at-wintec (Downloaded 3/03 2025)

Yangqiuting, L. & Singh, C. (2022). How Engineering Identity of First-Year Female and Male Engineering Majors is Predicted by Their Physics Self-Efficacy and Identity. International Journal of Engineering Education 2022 799-813

Young, I.M. (1990). The ideal of community and the politics of difference. In Feminism/Postmodernism ed L.J. Nicholson, 300-23. London: Routledge

8. APPENDICES

Appendix 1: Research instruments

1.1 Draft student survey

Survey Design Template

This survey helps us understand your experiences in engineering study and the factors that have had either a positive or negative impact on your study.

The information gathered here is for research purposes only and no identifying information or statements will be shared. Participation in the survey is voluntary, and you can choose not to take part without any disadvantage to you or your studies.

The survey should take you around 5-10 minutes to complete.

Section 1 About you	
1. How old are you?	
2. What ethnicity do you identify as?	
3. What gender do you identify as?	
4. What region of Aotearoa / New Zealand do you call home?	
5. What region of Aotearoa / New Zealand do you study in?	
Section 2: About you and your career choice	
1. What tertiary provider(s) have you studied with?	
2. What made you choose to study engineering?	
3. Was engineering your first choice of career – if not, what was your first?	
4. Now that you have studied engineering, is it still your choice of career? If not, what would be your career choice now?	
5. Have you had any employment in an engineering environment? If so, what was it?	
6. Do you have any family or community members who work in an engineering environment?	
7. What is your ambition in engineering? How far in the profession would you like to go?	

Section 3: About you and your engineering learning experience					
Please indicate how much you agree or disagree with the following statements and tick yes or no to those questions that have only yes/no options.					
Over the course of your engineering study...	**1**	**2**	**3**	**4**	**5**
1. I felt confident in my ability in mathematics before starting and engineering degree / diploma					
2. I felt confident in my ability in Physics before starting an engineering degree / diploma					
3. I needed to do a foundation programme before starting an engineering degree / diploma.					
4. I have felt well supported in my studies by my tertiary provider.	Yes			No	
5. I have had enough time to study.					
6. I have been well supported by my whānau and community in undertaking my studies					
7. I have improved in my ability to undertake study tasks or projects.					
8. My confidence in learning has increased over the course of my studies.					
9. I feel that I have become more reflective of the way I learn as my study has progressed					
10. Have there been any barriers to your success in engineering study? If so can you list them.					
11. What has helped you to be successful in your engineering study?					
12. Is there anything else you'd like to tell us about how your experience of engineering study – feel free to give any recommendations to help us.					
KEY 1. – Strongly disagree 2. – Disagree 3. – Neutral (neither agree nor disagree) 4. – Agree 5. – Strongly agree					
I am willing to participate in an interview: **My contact details are as follows:**					

1.2: Interview Protocols

1.2.1: Draft Staff Interview protocol (individual or focus group):

This protocol was designed for interviewing all staff (teaching administrative and management).

Possible Interview Question	Supporting documentation & evidence
1. What is your school's performance?	
2. What barriers do you see existing for Māori, Pasifika and women students in engineering study?	Completion data, results
3. Have you put in place any measures to address these barriers?	
4. If so, can you describe them?	Policy, handbooks etc
5. What strengths and weaknesses do you see in students on entry?	
6. Do you offer a foundation programme to support engineering study	Programme documentation
7. What do you consider to be the strengths and weaknesses of your programme?	
8. Have you any suggestions to help ameliorate the issue of underrepresentation of Women, Māori and Pasifika students?	

1.2.2: Industry interview protocol

Possible Interview Question	Supporting documentation & evidence
1. Can you give me an overview of your organisation and the work that you do?	
2. Are there any specific issues that you encounter in recruiting staff?	
3. With respect to diversity, do you have any issues in attracting staff to engineering positions?	
4. If not, what do you have in place (if anything) to ensure that you have sufficient qualified Māori, Pasifika and women engineers?	
5. Where do you usually find your engineers?	
6. What are the desirable skills, knowledge and behaviors that you need in an engineering recruit?	
7. Are there any gaps that you find in the knowledge, skills and behaviours of your new recruits, that you would like to see fixed?	
8. Have you any suggestions to help ameliorate the issue of underrepresentation of Women, Māori and Pasifika students in engineering study?	

1.2.3: Student interview protocol (narrative conversations):

The interview conversations that we intended to have with students were designed to elicit stories pertaining to the student's engagement with engineering study, from the first decision to become an engineer through to enrolment and finally either successful graduation and finding an engineering job, or being redirected into another employment field.

Possible Interview prompts	Notes
9. Tell me about when and how you decided to embark on engineering study? What things attracted you to engineering as a field for study at the beginning?	
10. What barriers do you see existing for those starting out in engineering study? What advice would you give to someone (a sibling or friend) if they said that they wanted to study engineering?	
11. How did your study habits change over time as you embarked on studying engineering?	
12. What things did you feel the polytechnic could have done better to help you with your studies?	
13. What do you see as your What strengths and weaknesses as a student?	
14. What things did your whanau do to help you with your studies? Thinking back, is there anything that they could have done?	
15. What do you consider to be the strengths and weaknesses of the programme that you enrolled in what could have been done better?	
16. Have you any suggestions to help increase the representation of Women, Māori and Pasifika students in engineering study?	
17. Onwards (follow up questions from the survey and the previous eight questions)	

Institution	Foundation Programme Name (from the website)	Level	Entry requirements	Structure of the foundation prog.	Purpose of the foundation prog.	NZDE prog. offered	BEngTech prog. offered	Other Eng. Prog. offered
WITT	Introductory Engineering Mathematics Training scheme	Not listed	NCEA L1 including Literacy and numeracy requirements	15 weeks	entry into NZDE	Civil		Grad Dip (L7)-Highways
Ucol	Academy Foundation electrical engineering (Wairarapa) & foundation mechanical engineering (Palmerston North)	2		1 week block course	Open to school learners to see if they are interested in pursuing a career in electrical engineering	Electrical		
WelTec	No Programme currently offered			One week pre-diploma maths course		Mechanical & Civil		
Unitec	New Zealand Certificate in Study and Employment Pathways (Level 4)-Engineering Pathway	4	UE numeracy or equivalent; 48 NCEA L2 credits including 12 credits in mathematics (pref. algebra, calculus or trigonometry) & 12 in English L1	16 weeks FT	Entry into NZDE (Civil & electrical)	Civil & electrical	Civil & electrical	B. Applied Technology (Electrotechnology)
MIT	Engineering foundation study	3	Open entry for domestic students; International students: English language entry requirements	60 credits over 17 weeks includes 15 credits Mathematics, 15 credits communication & pathway projects	Entry into NZDE (Civil, mechanical & electrical)	Civil, Electrical & Mechanical	Civil, Electrical & Mechanical	Grad Dip (L7) Civil, Electrical & Mechanical
NorthTec	No Programme currently offered					Civil		

Institution	Foundation Programme Name (from the website)	Level	Entry requirements	Structure of the foundation prog.	Purpose of the foundation prog.	NZDE prog. offered	BEngTech prog. offered	Other Eng. Prog. offered
Toi Ohomai	No Programme currently offered					Civil, electrical, mechanical & surveying	Developing a BEngTech	Developing a BengTech
EIT	No Programme currently offered							
Open Polytechnic	Certificate of Achievement in Fundamentals of Mathematics	2	NCEA L2 with 14 Level 2 mathematics credits	20 credit course	Entry into NZDE (Civil, mechanical & electrical)	Fire & Mechanical	Civil	
ARA	New Zealand Certificate in Study and Employment (Level 4) Engineering Pathway	4	NCEA L2 40 credits including 10 L1 literacy and 10 L1 Mathematics credits	60 credits - 4 courses; Developing Rangatiratanga, Mathematics, Literacy skills, technical skills	Entry into NZDE (Civil, mechanical & electrical)	Civil, mechanical electrical & electronic	Civil, mechanical & electrical	
Otago	New Zealand Certificate in Study and Employment Pathways (Level 3) with a focus on Engineering	3	Open entry with IELTS 5.0 or UE	60 Credits over 17 weeks FT; 4 courses- Carrer & study skills, communication, maths, physics	Entry into NZDE (Civil, mechanical & electrical)	Civil, Mechanical & Electrical	Civil, Mechanical & Electrical (Incl Asset Management Pathway by apprenticeship	Grad Dip in Asset Management
SIT	No Programme currently offered					Civil & Mechanical	Civil & Mechanical	Grad Dip

Institution	Foundation Programme Name (from the website)	Level	Entry requirements	Structure of the foundation prog.	Purpose of the foundation prog.	NZDE prog. offered	BEngTech prog. offered	Other Eng. Prog. offered
NMIT	Some lower-level courses for aeronautical engineering but not specifically for engineering (NZDE)					Civil, Marine & aeronautical		
WinTec	NZ Certificate in applied science (L3 & L4)	L3 & L4	No entry criteria	1 semester programme of 60 credits; 2 compulsory modules of 15c each followed by two elective modules	L3 is to enable entry into NZDE; L4 is to enable entry into BEng Tech	Civil, electrical & Mechanical	Civil, electrical & Mechanical	Grad Dip- Civil, electrical & Mechanical