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IDENTIFYING MOTIVATIONAL FACTORS TO INCREASE THE SELECTION OF A CAREER IN THE ENGINEERING PROFESSION

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IDENTIFYING MOTIVATIONAL FACTORS TO INCREASE THE SELECTION OF A CAREER IN THE ENGINEERING PROFESSION

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The following sections are the work of the first author. After the first author's content has concluded, there follow two reflective accounts from the second and third authors, the first author's mentors.

INTRODUCTION

The shortage of skilled workers, specifically engineers, in New Zealand is well documented (Freeman-Greene, 2020) and further recognised by Immigration New Zealand, where an ongoing and persistent shortage of engineers and engineering technicians exists (Ministry of Business, Innovation and Employment, 2018). In addition to the graduates of the contemporary training programmes across New Zealand, further recruitment remains necessary to maintain industry survival and supplement the long-term skills shortage list (Immigration New Zealand, 2019).

The identification of the needs, influences, and motivators unique to engineering careers is a logical beginning to unlocking potential and increasing the capability of the workforce sustainably. Consequently, a comprehensive appreciation of these factors was undertaken on a Master of Professional Practice programme (Madden, 2022), with the key findings and discussion presented in this article.

Founded in social cognitive theory (Bandura, 1986), this research illustrates what specifically influences subsequent career decisions and considers what prior learning experiences may provoke that initial interest in engineering careers. Furthermore, it investigates the motivations essential for engineering to be considered as a desirable career choice and delves into the cause-and-effect relationship that supports the development of relatable learning experiences from the early cultivation of formative interests. These learning experiences are critical in career decision-making and emerge as the core category of the analysis (Madden, 2022).

MOTIVATIONAL THEORIES

In this paradigm, researchers have utilised a variety of theoretical approaches and methodologies. Although these approaches have differed, there remain underlying aspects and concepts of applied psychological motivation theories founded in social cognitive theory. Further associated relevant theories to this research have included the theory of self-determination, goal content theory and social cognitive career theory (Bandura, 1986; Lent et al., 2002).

The principle of triadic reciprocity is central to social cognitive theory. This principle describes the continuous interplay that occurs between the three key variables of self-efficacy, outcome expectation and life goals. Developed from these formative principles of social cognitive theory (Bandura, 1986), the social cognitive career theory model enables us to envisage the motivations behind the complex experiential decision-making processes that occur as young adults migrate from secondary school and into further tertiary education or directly into the workforce (Lent et al., 1999). Every case is unique, and each will have a similarly unique set of intrinsic and extrinsic motivations that can be observed as decisions and behaviours.

EDUCATIONAL PHILOSOPHY

The orthodox approach of our contemporary education philosophy utilises epistemology and ontology to select and support our elite talent in further academic pursuits exclusively (Lum, 2009). The effect of this epistemological filtering confines those that have been less academically successful into vocational training. This delineation dramatically influences perspectives and the decision-making process required to select a learning pathway supporting a subsequent career choice.

A similar demarcation exists between the knowing 'how' and the knowing 'why' within New Zealand engineering careers. Knowing 'how' is the application of engineering practices and principles, and is within the domain of vocational training. This level of training has several progressive levels and associated qualifications. However, an academic pathway into professional engineering at university explains the application of engineering principles in alignment with knowing 'why', as illustrated in Figure 1.

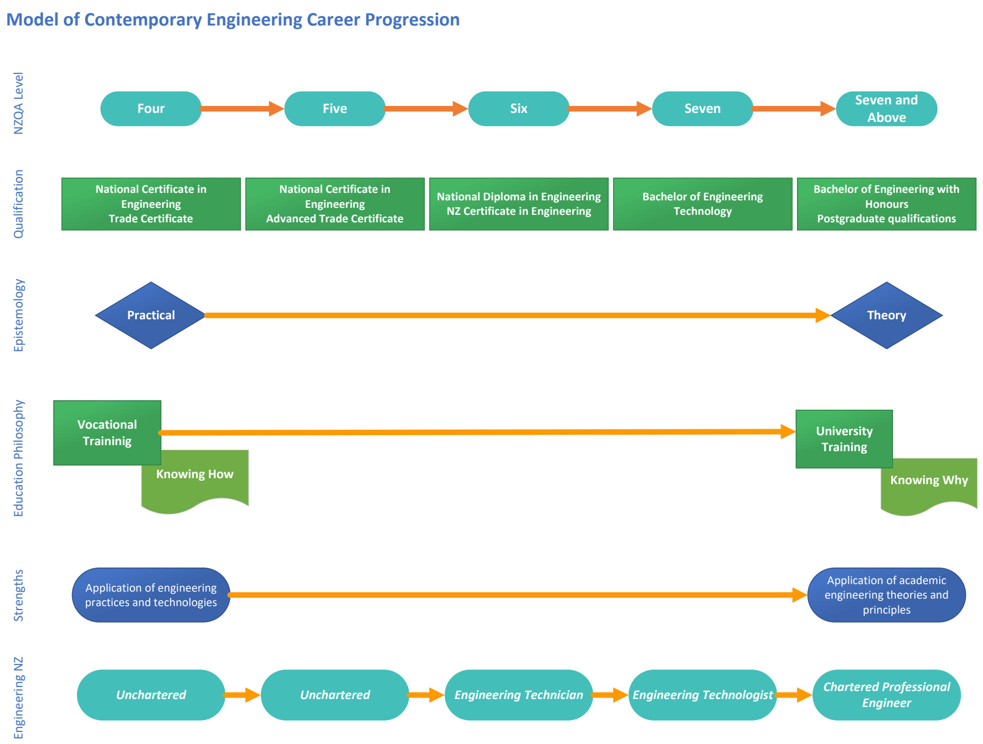

Figure 1. Model of contemporary engineering academic and vocational progression (Madden, 2022, p. 72).

The stereotypical view of the contemporary engineer is often imagined as a mathematician, a scientist, or a hybrid of both. Without surprise, this perspective is consistent with the educational pillars of the traditional learning journey preceding an engineering career. However, the prioritisation of these staple subjects has been slowly suffocating creativity, collaboration, and initiative; essential in meeting both student and social expectations (Goldberg et al., 2014).

The desire for corporates and public institutions to become more creative in thinking, behaviours and outcomes is becoming exponentially more urgent. We are more socially advanced and have more complex problems requiring more creative solutions (Robinson, 2011). Problem-solving remains at the heart of engineering careers and creativity is the deficient ingredient necessary to unleash the power of innovation in engineering.

Nevertheless, there are many capable young people across New Zealand suitable for education and subsequent employment in engineering vocations and other more advanced or complex career pathways. Individuals who can innovative, solve problems and have some self-efficacy in science, technology, engineering, and mathematics (STEM) fields are described as "capable" in an engineering career context (Reynolds et al., 2009). However, the attitudes toward the contemporary education philosophy remain, as does the workforce shortage of specialist and skilled employees.

RESEARCH INVESTIGATION

The project was initiated to investigate why capable people reject an engineering career for alternative pathways, to identify the motivational levers unique to engineers and to understand how interest in engineering careers could be promoted to address the shortfall. The purpose of this research was to provide a recipe, enabling the accurate application of resources to cultivate interest and attract home-grown talent into the engineering profession. Specifically, the research question was: what are the motivational factors influencing the selection of engineering as a sustainable career pathway?

Motivation remains a key ingredient in effective team leadership and management (Jensen, 2018). The knowledge of what uniquely motivates engineers in their career journey will enhance the leadership of engineering teams and promote engineering as a desirable and sustainable career choice.

METHODOLOGY

A process of elimination concluded that a grounded theory methodology was the most appropriate for this investigation. The purpose of a study using grounded theory is to explain the patterns and relationships that emerge from the collected data with bespoke substantive theories that provide insight and new knowledge of a process or action (Creswell & Poth, 2016). In alignment with the intent of this investigation, a constructivist grounded theory methodology (Charmaz, 2014) is both flexible and adaptable: it is less structured in data collection enabling the use of semi-structured interviews with open-ended questions to ask questions about the phenomena or process and the associated influences and circumstances (Willgens et al., 2016).

A total of 19 participants for the data sample were selected to achieve theoretical saturation (Birks, 2015). Participants were selected to provide a diverse representation of New Zealand society in age, gender, ethnicity, and geographic location.

FINDINGS

Primary theoretical categories

During the data analysis phase of the project, it became apparent that the data and consequent emergent themes were comparable to the contemporary view of the social cognitive career theory choice model as illustrated in Figure 2.

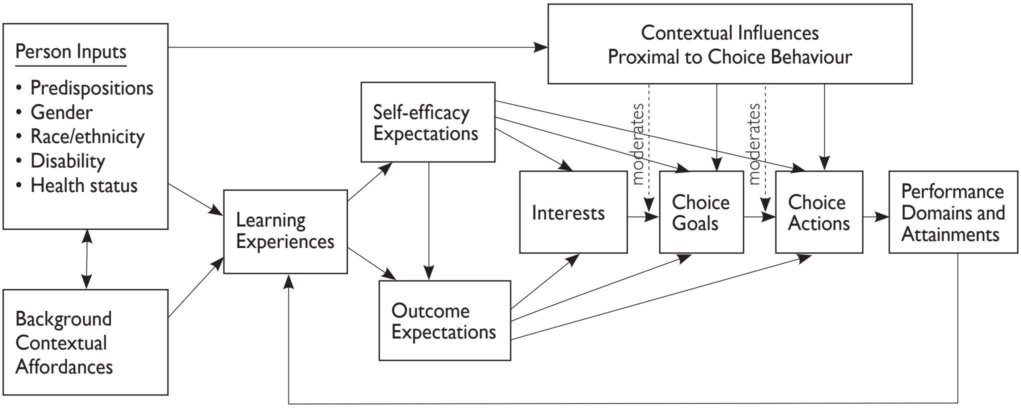

Figure 2. Model of person, contextual, and experiential factors affecting career-related choice behaviour (Lent et al., 2002, p. 269).

The individual components of this model are grouped into three areas of theoretical influence:

1. Cultural influences include background contextual affordances, person inputs, and proximal choice behaviour.
2. Cognitive influences include self-efficacy expectations and outcome expectations.
3. Contextual influences include interests, choice goals, choice actions and performance domains and attainments (Truyens, 2019).

Data analysis corroborated these three streams of influence, and they were consequently confirmed as primary categories.

CULTURAL INFLUENCES

In the context of this investigation, a cultural influence is described as a condition or circumstance that the participant or individual has little or no control over. These considerations reflect their unique position in both life and society and influence their career journey. This includes gender, cultural beliefs, ethnicity, and parental influences.

The career selection and decision-making process of parents and immediate family members are closely monitored as a vicarious learning experience. Children observe closely to assimilate a detailed appreciation of the career choices made by parents. Correspondingly, an engineer is most likely to emerge from a family where a parent or immediate family member can demonstrate the benefits and pitfalls of either professional or vocational occupations.

Tertiary education offerings supporting comprehensive engineering career pathways are both inconsistent and limited throughout New Zealand. Although in some instances students prefer to travel away from their home locations to access study, the majority prefer to study locally. These geographic constraints complicate or restrict potential students' access to engage in their study preferences.

For Māori, the importance of whānau is deeply ingrained. This adds to the already complex demands of leaving home and distancing the connection to associated support networks. Consequently, it is reasonable to suggest that this factor specifically impedes involvement in engineering careers for this group.

Where a lack of comprehension regarding engineering careers exists in students, similar deficiencies will be present in associated support and guidance roles (Bowen et al., 2003). In the context of this investigation, career advice and research include learning acquired through self-motivated inquiry. Participants consistently indicated they received limited or no guidance on potential engineering career choices during their time in secondary school. Additionally, information is difficult to source and interpret independently and any guidance they did receive was generally considered to be of little value.

Sadly, a participant was able to recount a series of events in which sexism hindered her involvement and advancement in engineering careers at the trades level. Although sporadic at the trades level, female professional engineers did not perceive a strong gender-based stigma.

Attending a vocational training institute to pursue studies towards a trades-level engineering career, incurs the social stigma of failure to succeed. Consequently, a trades-level career is viewed as secondary and suitable for those who are incapable of learning anything else. This sentiment was overwhelmingly consistent across the data sample.

COGNITIVE INFLUENCES

A cognitive influence is a learning experience that regulates responses and behaviours. The diversity, access, and value these learning experiences hold are unique to the individual. Moreover, cognitive experiences regulate outcomes including the decision-making process. Therefore, this investigation describes a cognitive influence as a learning experience that occurs either inside or outside of the educational sector that influences the characteristics of the individual.

An individual's outcomes from the contemporary secondary education system have an enduring impact on subsequent career choices and direction. An individual's reflection upon a failure to achieve academically limits their opportunities upon departure from secondary school and can become a lifelong barrier to further educational experiences.

Contemporary education offers the student much more flexibility and ownership in their learning. A student can direct their learning and studies towards a particular career through subject selections. These subject selections are crucial and can potentially limit access to an engineering career. These selections, in many instances, are made as early as Year 8, often devoid of any informed support.

Many of those who eventually follow an engineering career pathway have not been immediately successful academically. Conventionally, this is portrayed through poor outcomes from secondary school. However, these outcomes cannot be attributed to academic ability or potential for an engineering career in every instance. Some individuals simply lose interest in school, while others may have explored different subject areas without full appreciating the long-term career implications. Furthermore, others may have encountered life challenges outside their education that have a significant impact. A multitude of distinctive learning and life factors can impede successful outcomes.

Although the traditional expectations to select a career pathway after secondary school have been debunked (Carpenter, 2010), for the majority an opportunity to pursue a professional engineering career pathway will occur once in a lifetime. A critical intersection in career decision-making exists before the accumulation of additional responsibilities such as financial obligations, family commitments and lifestyle costs. The importance of this stage cannot be understated.

At first glance, contemporary engineering education in New Zealand appears to be well structured, aligned, and progressive. However, the limited offerings and negligible integration between professional and vocational engineering education discourages advancement and endorses delineation at this point. The current suite of programmes is disjointed and restricts advancement for vocational students.

Prior exposure to STEM learning experiences and interests incorporating positive feedback building into a mastery experience promotes self-efficacy (Rittmayer & Beier, 2008). This concept is most relevant in professional undergraduate engineering pathways but has less significance for those seeking a vocational engineering career. In those instances where self-efficacy for some specific STEM components may be deficient, a confident learner with a strong sense of self-efficacy in general terms can overcome these challenges.

Contextual influences

A contextual influence is an additional dimension reflecting a participant's beliefs and perspectives of the world we live in. In this investigation, the participants' aspirations and interests are explored in conjunction with individual motivations to appreciate fully their impact on the development of career goals and the enabling choices required for success.

Early interest and curiosity are the initial first step. Commonly, engineers have had relevant prior learning experiences and extracurricular interests or pursuits that relate to sciences. Examples of these include drone racing, internet of things, Minecraft, science fairs or working on the family car.

Those who select an engineering career seek a challenging role that enables them to utilise their specialist skills and knowledge in meaningful work. Continuous improvement in learning and development is essential for an engineer to remain at the forefront of their profession and ahead of rapidly advancing technologies. Additionally, continual learning and the opportunity to engage in a rewarding and enjoyable career are key intrinsic motivators and remain integral components of an engineering career.

Extrinsic motivation is an external factor that includes incentives, recognition, or penalties. A balance that includes both intrinsic and extrinsic motivation is the ideal approach. Consistently, across disciplines, engineering career pathways are perceived to be well remunerated. There is a further expectation that professional engineers should be additionally rewarded to recognise additional academic progression and responsibilities.

LEARNING EXPERIENCES

The core category is the overarching theme or concept that emerges from the data and subsequent analysis. It is both obvious to the researcher and apparent within the data (Mills et al., 2006). The data analysis indicated 400 instances where learning experiences have been illustrated in initial substantive codes and subcategories. Learning experiences are the core category for this investigation and are clearly representative of the links and relationships between codes, subcategories, and categories.

Learning experiences and learning outcomes are causal factors of self-efficacy. The learning experiences presented in this research have fallen into three streams: individual, educational and workplace. It is exposure to relatable and associated learning experiences that provokes initial interest in engineering and is later drawn upon in career decision-making. Social cognitive career theory illustrates how these prior learning experiences are evaluated to support future decisions and actions in the context of career decision-making (Lent & Brown, 2019).

DEVELOPING A MODEL

The model shown in Figure 3 has been established to illustrate the cycle of continuous improvement that engineers seek throughout their careers. Learning experiences are cumulative and directly impact the cultural, cognitive, and contextual influences referenced for career decision-making. As time elapses and banked learning experiences increase, the consequent decision-making is further refined. The importance and influence of extrinsic and intrinsic motivators such as salary projections, employment in challenging roles, access to learning, and progression of professional knowledge are inconsistent and fluctuate throughout a career.

Career development and progression are further elements illustrated in Figure 3. The progressive career pathway available for engineers is incremental. An engineer's position on this pathway is reviewed in conjunction with its associated learning experiences and influences future career decisions.

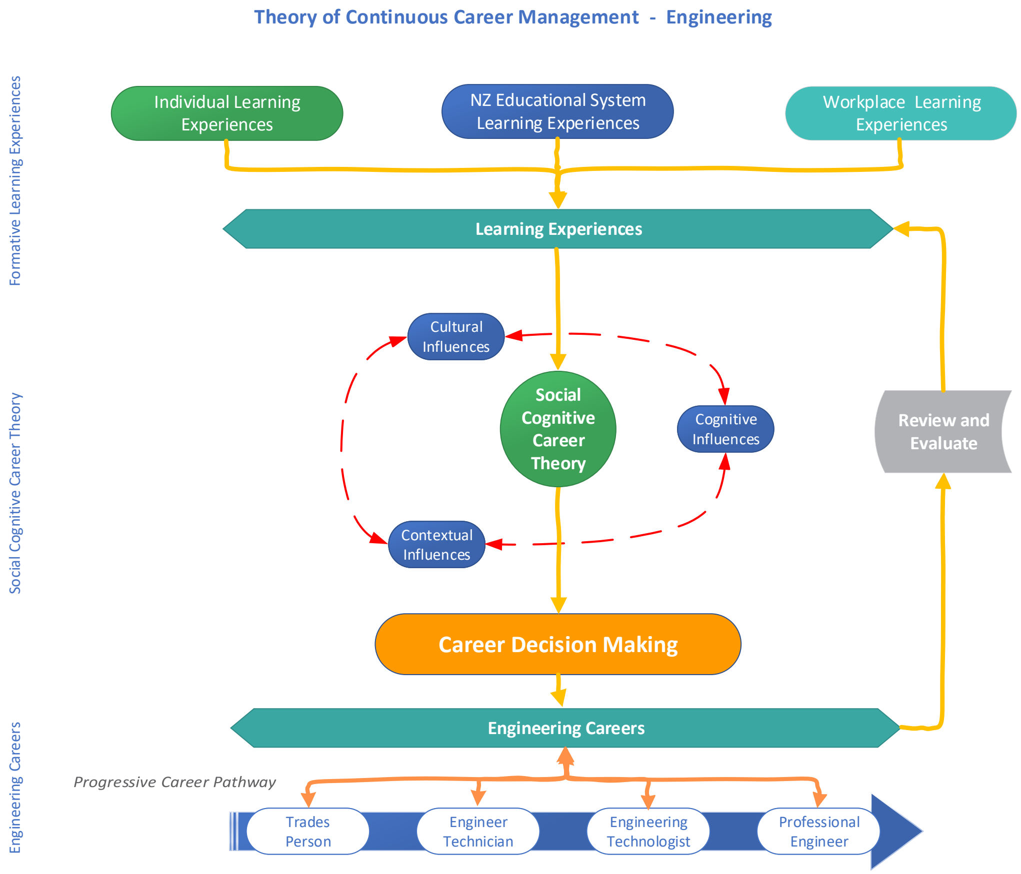

Figure 3. Theory of continuous career management – Engineering (Madden, 2022, p. 91).

DISCUSSION

Engineering career pathways

Although training for an engineering career can begin through a university professional engineering programme, for many those initial steps are taken through vocational engineering programmes. The existing model of contemporary engineering career progression (Figure 1) suggests that career advancement and growth is a linear process that is integrated and progressive. However, upon closer investigation, it is evident that this is merely an implication. Whilst the educational framework exists, the significant sacrifices necessary to progress through the recognised stages can be complicated and pose considerable challenges. Inconsistent offerings of programmes, and delivery modes that require of students full time on-campus attendance, further restrict engagement.

To increase engagement in tertiary engineering education, we need to review and improve the delivery modes at all levels. The orthodox preference for on-campus delivery of theoretical components remains; alternative delivery modes, including mixed and distance delivery, should be available for those who are more geographically isolated. The focus should be on what can be delivered remotely, rather than why it cannot.

The journey to commence a professional engineering career at university is precarious, and most people will have one opportunity to reach the start line. This highlights the importance of this intersection, where one must choose between an academic or a vocational path in engineering.

A fully integrated engineering career pathway

The current suite of engineering programmes requires a comprehensive review that considers all potential career paths in the field. An integrated linear career pathway that provides various entry and exit points, which begins with practical knowledge and advances to theoretical understanding, is necessary. Progression is built upon prior knowledge, and easily accessible through multiple delivery methods. This approach encourages engineers to continue learning and evolving throughout their careers, with education serving as a key intrinsic motivator. By integrating these pathways, we can eliminate the divide between professional engineers and trades, thereby reducing any associated stigma.

CONCLUSIONS

Stigmas

Although a pervasive perception of engineers being male remains, the culture that has supported sexism within the engineering profession is changing for the better. Engineering New Zealand has committed to increasing its female membership by 20 per cent in alignment with its commitment to the Diversity Agenda initiative (Engineering New Zealand, 2020), setting a benchmark for the profession. However, in the absence of comprehensive professional bodies, the various associated trades remain divided, and some of the behaviour reported by members is unquestionably discriminatory. Much work is still needed in this area to attract and support women into engineering careers as equal and valued employees.

Career decision self-efficacy

In comparison with alternative careers such as nursing, accountancy or teaching, the application and relevance of a professional engineering career is socially ambiguous. Furthermore, experienced engineers in New Zealand are underappreciated, and their problem-solving skills are often concealed from those outside the profession.

While tradespeople are more visible, the link between advanced engineering skills and their associated roles and occupations is generally invisible.

Access to the career advice that is needed to fill this gap in understanding is generally inadequate. In the absence of intervention to provide comprehensive informed guidance and direction, from organisations such as Engineering New Zealand with initiatives such as Young Engineers, the problem will persist. Provision of and engagement in relatable learning experiences remain key strategies to socialise engineering careers.

Aspirations and interests

The analysis clearly illustrates the links between the development of interests relatable to engineering and consequent aspirations. Development of these interests during the formative stages is essential. At this stage, parents can also play a significant role in supporting and encouraging their children with technical experiments, construction projects, automotive repairs, and other learning experiences that will be referenced in future career decisions. They can do so by sharing their knowledge, investing in resources, and providing guidance to help their children develop the necessary skills and confidence.

If early interests are encouraged and associated learning experiences are nurtured, along with further support from STEM educators, a student's perspectives on engineering careers will be vastly more refined, which could potentially inspire aspirations in this field.

Ethnic minorities

The momentum towards achieving a more diverse workforce has led to an increased focus on engaging and supporting individuals from a range of ethnic backgrounds. However, in this investigation, the sample size was not sufficient to collect definitive data on smaller ethnic groups. For those who identify as Māori, the preservation of their connection to their whānau and associated support network is a crucial factor in their decision-making process. For some, the desire to maintain this connection and remain close to their hau kāinga takes priority over any travel requirements for tertiary study.

RECOMMENDATIONS

Subject selections

Beginning in Year 8, it is recommended to engage students in a basic careers programme which presents a diverse range of potential occupations supporting these early selections. This should include opportunities such as career expos and outreach initiatives.

Promotion of engineering careers

Contemporary engineering students aspire to develop their careers further as technology entrepreneurs, cool technologists, or social entrepreneur/activists (Goldberg et al., 2014). (A "cool technologist" has an interest in, and preference for, the most recent gadgets and technology trends (Madden, 2022)). However, without knowledge of its existence, access to the start line of an engineering career is nearly impossible. Targeted promotion and socialisation in these domains to the widest possible audience is both necessary and a logical first step. A logical potential leader and advocate in this area is Engineering New Zealand, the professional body for engineering in New Zealand.

Further, promote outreach style programmes

In other regions, outreach programmes have effectively countered the declining enrolments in engineering courses. To achieve similar results, it is necessary to increase the number of current programmes, broaden their variety to reach a wider audience, and continually update the content to align with emerging interests and best practices (Bowen et al., 2003). Organisations like the New Zealand Cadet Forces are well-positioned to provide supplementary training in this field. Moreover, a review of the national curriculum should be conducted to incorporate practical activities that support the application of STEM concepts. This investment in the development of STEM-related learning experiences will promote engineering careers and increase the self-efficacy of individuals in making informed career decisions.

AUTHOR 2 CONTRIBUTION

Engineering is not well promoted or understood by adolescent learners, and these learners need to be encouraged into STEM related activities at primary school, as this appears to be when learners formulate career decisions (Madden, 2022). Madden's research suggests a number of cultural, cognitive and contextual influences of adolescent learners; including modelling behaviour (Bandura, 1986) of parents and the mentoring behaviour (Daloz, 2012) provided by role models such as teachers and cultural leaders, together with practical engineering related activities undertaken at school, cadets, scouting or related learning environments, that may formulate engineering career decision-making. Madden's model for engineering career decision-making suggests an incremental progression towards an engineering career, rather than a 'one opportunity career decision.' This poses a significant issue for engineering career progression in the New Zealand context, illustrated in Figure 1, due to the huge chasm that exists between practical vocational learning (Levels 4 to 6) and theoretical university learning (Level 7 and above). The difficulty in a smooth transition for learners wanting to pathway from a diploma to a degree in engineering, is seen as a major barrier for engineering career advancement, especially for some learning groups, such as Māori, who are reluctant to move away from the support network of their local whānau. Providing a more nationally accessible, blended delivery learning environment for all learners wishing to transition from lower level to higher level engineering education, would seem a major priority for Engineering New Zealand.

AUTHOR 3 CONTRIBUTION

Madden's (2022) findings provide some clear reasons as to why science and engineering career options are challenging for a number of demographic groups in New Zealand.

There are however two other significant issues which are outlined but need further research going forward:

1. Firstly, access to technological resources in primary and secondary education that span the increased range of engineering disciplines for young people to be able to use in current science and technology curricula.
2. Secondly, the artificial educational barrier that prevents easy progression between vocational and professional qualifications at any career stage. This persists between craft and technician roles that use practice-based development compared with professional roles that require extended academic preparation ahead of practice. This is well described by Lum (2009) and personal doctoral research which show how a generic problem-solving process can provide seamless progression between such work roles. This cyclical and iterative structure underpins many design, quality and agile project processes that define modern work practice (Harrison, 2019).

Evan Madden, BEngTech, MProfPrac has accumulated multiple trade qualifications and 25 years of industry experience in a variety of technical engineering roles focused upon industrial automation, instrumentation, and electronics as both a technical expert and leader. For the past three years, he has been supporting both trades and engineering students as an electrical engineering educator at Southern Institute of Technology. Evan enjoys the challenges associated with academic studies, the journey into postgraduate education and the new learning that comes from research projects.

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