May 2017

Science Technicians Workforce

Royal Society Te Apārangi

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Glossary

AAVA New Zealand Authority for Advanced Vocational Awards
EFTS Equivalent Full-Time Student
ICT Information and Communications Technology
IPENZ Institution of Professional Engineers New Zealand
ISO International Organisation for Standardisation

ITO	Industry Training Organisation
ITPs	Institutes of Technology and Polytechnics
MBIE	Ministry of Business, Innovation, and Employment
NEEP	National Engineering Education Plan
NZCE	New Zealand Certificate in Engineering
NZCS	New Zealand Certificate in Science
NZQA	New Zealand Qualifications Authority
NZQF	New Zealand Qualification Framework
OECD	Organisation for Economic Cooperation and Development
PTE	Private Training Establishment
STANZ	Science Technicians' Association of New Zealand
STEM	Science, Technology, Engineering, and Mathematics
TEC	Tertiary Education Commission
TRoQ	Targeted Review of Qualifications

Dr Val Orchard – a tribute

It is with great sadness that the Panel and staff of the Royal Society Te Apārangi contributing to this study and report record the passing of Dr Val Orchard in 2016. Val was an inspiration to us, and provided a valuable contribution to both the study and the early stages of the report writing. Her experience in the profession and practice of science in New Zealand, particularly during her time as a former Science and Research General Manager at ESR Ltd, has been invaluable. The Panel wishes to acknowledge her involvement in, and contribution to, this study.

Acknowledgements

The Panel thanks staff of the Royal Society Te Apārangi, particularly Carolyn Walker who undertook much of the detailed research and international comparisons analyses, Marc Rands who facilitated the Panel processes, and Andrew Cleland, Marc Rands and Roger Ridley who provided helpful critical review.

The Panel is grateful for the various meetings, interviews and discussions with members of the Expert Reference Group and the Key Persons in organisations employing science technicians listed in Appendix A of this report. The information they provided was essential to the development of this report.

Executive Summary

This report presents the findings of an Expert Panel of the Royal Society Te Apārangi on the future of the science technician workforce, their needs and opportunities, and their education and career pathways in New Zealand. It also considers the qualification structure underpinning New Zealand's science technician workforce and how to ensure it produces graduates suitable to meet the changing needs of employers.

The Expert Panel, and a supporting Reference Group, were appointed by the Royal Society Te Apārangi. The Panel consulted widely, including with business, to ensure the findings of this report reflect today's science technician environment and that the recommendations are plausible and compelling.

Science technicians bring a wealth of practical skills to the business and science sectors, and make essential contributions to New Zealand's economy. The variety of roles and opportunities available to science technicians has increased markedly in recent years due to the use of increasingly sophisticated equipment and procedures, automation, data processing, and computational methods. There has also been a greater emphasis on oral and written communication skills, and on regulatory and compliance requirements. The use of newly introduced innovative and leading-edge technology requires skilled technicians. A strong and resilient technician workforce is vital for a growing and increasingly technologically sophisticated economy.

It is desirable to maintain good alignment between the knowledge and skills of science graduates and those required by employers. A science technician needs a definitive understanding of scientific principles and methodologies, plus technical aptitude and transferable practical skills. Ideally these are gained through tertiary education funded by a combination of government and student self-funding. Training provided by the employer then properly adds the industry-specific requirements.

Even though science technician roles are very diverse, the Panel concluded there is an overarching requirement for the following attributes:

- strong technical aptitude
- transferable practical skills (plus the generic skills such as literacy and numeracy) that are directly work-relevant and of immediate use to a range of employers, allowing those employers to focus their in-house training on specific requirements
- adaptability, in order to respond to changing technologies and roles
- strong written and oral communication skills
- computational and data-handling skills
- workplace health and safety knowledge

- clear and worthwhile career pathways, from junior to supervisory and advanced roles.

The Panel found that over the last two decades there has been a growing and now significant mismatch between the knowledge and skills acquired through tertiary education to those needed in employment. The technical aptitude and transferable practical skills that employers are looking for in job applicants are now seriously lacking. The extent and breadth of the practical component of many qualifications from which graduates progress to a science technician role have been significantly reduced. This has shifted the responsibility for the transferable practical education from education providers to employers, many of whom are ill equipped to respond as trainers.

The Panel found that New Zealand Diploma of Applied Science qualification delivered through the Institutes of Technology and Polytechnics (ITPs) is fit-for-purpose, incorporating an adequate amount of transferable practical skill and technical aptitude development. However, numbers of graduates with this qualification nationwide are low. In discussions with employers of science technicians, the Panel was advised that most science technician job applicants hold a Bachelor of Science or a higher qualification, but this does not necessarily reflect a better fit for the role over other candidates.

Current statistics indicate that the portion of individuals attaining a Bachelor of Science degree in New Zealand is significantly higher than the average in OECD countries. A substantial number of these graduates apply for and gain science technician roles. It is not clear whether these individuals believe this higher qualification to be a prerequisite for such roles, or whether they are failing to secure work in the science sector at a higher level or in a different vocation. Such degree holders too often need further extensive training to be effective science technicians and then leave the role after a relatively short period of employment. Whatever the reason, the majority of present entrants to science technician roles do not hold the core attributes listed above.

In summary, the New Zealand Diploma of Applied Science is effective, but other qualifications are not adequately developing technical aptitude and transferable practical laboratory skills for science technician roles. This has negative implications for employers who bear the cost of extended training and, in many situations, poor staff retention. This failing must be addressed.

The Panel suggests a two-fold approach for the future:

- The ITP sector should establish a national network of provision for educating and training science technicians focusing on the Level 6 Diploma in Applied Science qualification, this pathway being most suitable for technicians who will enter employment in industry and service roles. To address any demand for additional laboratory skills and experience from existing technicians, a Graduate Certificate in

Laboratory Practice and short block courses run in conjunction with the national network of ITP providers or perhaps through private training establishments would be appropriate.

- Additionally, the degree-based pathway encompassing the Bachelor of Science qualification should be improved as a route to technician employment, especially for those seeking careers in research organisations. A suitable approach would include a core (compulsory) paper of 15 credits (points) on the basics of laboratory practice, and/or the introduction of a 40-60 credits (points) minor in laboratory practice within the degree programme. This would partly address the widespread concern employers have that students with Bachelor degrees often do not possess sufficient technical aptitude and transferable practical skills required for the science technician role.

The Panel suggests that a practice whereby employers provide practical work experience for students during their undergraduate training should be re-established. The benefit to employers is that such contribution would lessen the on-the-job training they otherwise have to provide to overcome the deficit of transferable practical skills of new employees.

The deficit of graduates with appropriate Diploma qualifications currently presenting to employers is serious and must be addressed by increasing enrolments to study Diploma qualifications. There is a shortfall in career guidance. Clear, realistic and unbiased information on both routes for becoming a science technician needs to be made available through all parts of the careers advice system. A good example is provided by the Engineering Education-to-Employment (E2E) programme. Such a programme would likely attract a larger number of suitably qualified students to meet the demand for science technicians and in turn would create a more visible career option, provide direct routes to employment and a professional identity for science technicians.

The Panel examined registration schemes for technicians as used in other countries but decided their approaches were not suited to New Zealand. Rather, consideration should be given to include an assessment of the qualifications and skills of the science technician workforce in the accreditation system for specialist testing and service laboratories, as well as assessment of the particular processes and procedures being carried out.

1 Introduction

1.1 Need for a review

Science technicians are an integral component of many educational, research and business sectors, bringing a wealth of practical skills to many New Zealand workplaces. They can work in laboratories and in the field. They are typically involved in activities such as sample collection and analysis, preparation of materials for experimentation, development, calibration and maintenance of measurements systems and equipment, and data capture and processing. Through their technical aptitude and practical and personable skills, they often have roles in laboratory management, health and safety systems, and are asked to contribute to planning of scientific work including research. Whilst there is no widely accepted definition of the term ‘science technician’, there is a wide understanding of their roles and skill base.

Over the last two decades, there has been a shift in the education and training system and programme offerings, as well as in the nature and needs of business and industry for science technicians. Science technicians contribute to the sustained and continued growth of New Zealand’s business productivity, research and education, prosperity of employees, and the long-term success of the country. However, to achieve these goals, it is necessary to have good alignment between the knowledge and skills base of science graduates emerging from our education system with those required by employers, across a diverse range of roles.

The diversity of the roles and opportunities for science technicians has increased due to the rapid progression towards the use of increasingly sophisticated equipment and procedures, automation, data processing, and computational methods, together with a greater emphasis on oral and written communication skills, and on regulatory and compliance requirements.

Since the demise of the New Zealand Certificate of Science in 1997, the science technician educational landscape has undergone considerable change. The variety of programmes and courses available to persons wishing to pursue such a vocation have increased significantly over the years, as has the number of organisations offering them, creating confusion in the education pathway required.

The majority of recent entrants to science technician roles hold Bachelor level qualifications, with employers supplying on-the-job training in the early stages of their career. This training provides not only specific technical skills, but also the broad-based technical aptitude and wide-ranging and transferable practical skills that characterised NZCS graduates.

To produce science technician graduates that are fit-for-purpose, both now and in the future, there should be a close and responsive synergy between the key skill areas and competencies required, with the broad-based and transferable competencies developed during education in the tertiary sector.

Following preliminary discussions with a number of representatives from tertiary education providers, and the research, manufacturing, industry, and service sectors, the Royal Society Te Apārangi Council convened an Expert Panel, with supporting Reference Group[i], to provide advice on the science technician workforce across such sectors, and their respective education and training programmes. Technicians in sectors governed by regulatory or professional organisations, such as information and communications technology (ICT), and engineering and health, were excluded from the review. The Panel aimed to consult broadly to ensure its findings, conclusions and recommendations are supported widely within the relevant stakeholder communities.

1.2 Terms of reference

The Royal Society of Te Apārangi Expert Panel was tasked with assessing the extent to which there is a national approach to science technicians' careers and training in New Zealand. Specific questions to be addressed were:

1. What are the future needs of the New Zealand economy for science technicians?
2. What is the likely future range of science technician roles?
3. What are the issues around career structure for science technicians?
4. What are appropriate developmental training processes?
5. How can meaningful and rewarding career pathways be provided?
6. What key skill areas and competencies are needed?
7. What would a national qualification structure look like and how could it be delivered?
8. How would the proposed qualification system interface with other related qualification systems, such as those for information and communications technology and engineering technicians, and specialised technicians within the medical workforce?

As part of the review, the Panel consulted with its Reference Group and other key persons[1] concerned with the education, employment, management, and activities of science technicians. This group represented a range of organisations and companies in the education, research, service, and manufacturing sectors, including tertiary and secondary education institutions, Crown Research Institutes, food processing, manufacturing and product development companies and organisations providing quality assurance, quality

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[i] Members are listed in Appendix A

control, and analytical services. The panel was satisfied it heard views that are representative of the wide range of stakeholders with interests in science technician occupational grouping.

The study focussed on science technicians in the natural and physical science sectors. It did not include technicians in the ICT, engineering or health science sectors, nor did it consider the gender diversity, and age distribution in the technician workforce.

1.3 Why science technicians matter to New Zealand's future

As outlined in the 2015 National Statement on Science Investment [1], science plays a central role in creating new knowledge and turning it into business opportunities that lead to wealth creation and problem solving for New Zealand's society and industry. New Zealand's wellbeing, economy, and environment all benefit from increased application of new scientific knowledge by businesses, government agencies, communities, and other end-users. Unique to New Zealand is the development of Mātauranga Māori as a body of scientific knowledge, particularly in understanding and embracing the natural environment and biological production systems in New Zealand. Science technicians may need to have the skills and knowledge to work with Māori enterprises and communities.

The New Zealand Treasury's Economic and Financial Overview for 2016 [2] highlights that New Zealand has a sizeable manufacturing and services sector, complementing a highly efficient export-oriented agricultural sector. An innovative science and technology sector is therefore an essential driver for economic growth, of which an important component is a suitably educated and qualified science technician workforce. The introduction of new innovative and leading-edge technologies to this country requires a proficient technician workforce. The knowledge and skills applied by technicians in a practical setting over a diverse range of areas, is an essential contribution to the health and well-being of New Zealanders.

For these reasons, it is important that appropriate, well-defined, sought-after, flexible, and rewarding career pathways are available so that the science technician occupational grouping can continue to contribute effectively to the manufacturing, service, research, and educational sectors in New Zealand and the economy as a whole.

2 The science technician workforce

Census data show the relative size of the science technician workforce in New Zealand is proportionally similar to that in Australia. In 2013, the number of science technicians employed in New Zealand made up 0.19% (3,771 individuals) of the total workforce [3]. Their distribution by field is shown in Table 1. This compares with science technicians projected to account for 0.15% (18,100 individuals) of the Australian workforce in 2017 [4].

Table 1: Distribution of science technicians over the age of 15 in key New Zealand employment sectors [3].

Employment sector	People
Life science	1224
Chemistry	1113
Science not elsewhere classified	726
Earth science	591
School laboratory	114

It is notable that the school Science Technicians' Association of New Zealand (STANZ) indicated to the Panel that it has about three times the number of members working as school technicians as reported in the Census. Following discussions with relevant employers, the Panel also became aware that where technician roles are filled by degree-qualified staff, those roles are often renamed to titles such as 'Research Associate', and would not necessarily be reported by the Census as technicians. The number of people with technician qualifications who have moved to roles that are more senior or have different job titles is not known. The total number of persons employed in science technician roles in each category is therefore almost certainly much larger than those shown in Table 1.

Whilst the terms of reference did not include consideration of workforce diversity, the Panel noted some themes that recurred in the feedback they received during their consultation with stakeholders:

- Some organisations are heavily reliant on a senior technician workforce nearing retirement;
- Where roles involve the biological sciences or are part-time, science technician positions are more likely to be filled by females;
- It is not uncommon for recent migrants with Masters Degrees and PhDs to seek technician roles to gain a foothold in the New Zealand employment market.

Science technician roles encompass an ever-widening range of activities, and associated skills and experience, such as:

- Involvement in research projects and programmes;
- Supporting the introduction of new innovative and leading-edge technologies;
- A wide variety of roles in primary processing and manufacturing industries;
- Various roles in health and biotechnology industries;
- Quality control, monitoring and quality assurance testing, and verification, particularly in service provider organisations;
- A variety of service work typically involving specialist analyses and measurements;
- Planning and carrying out field and environmental work including monitoring, sample collection, preservation, and storage;
- Managing and/or providing skilled contributions to the smooth, effective, and safe

operation of a diverse range of teaching laboratories at secondary and tertiary institutions, and research laboratories;

- The skilled operation and maintenance of scientific instrumentation with varying degrees of complexity, which can include experimental design and data analyses;
- Roles in electronic and mechanical workshops concerned with the design, fabrication, and maintenance of mechanical, electrical, and electronic devices and equipment, and;
- Health and safety compliance roles.

In summary, the technician workforce is diffuse, fragmented across sectors, diverse in terms of skills and knowledge required by employers, and may be significantly larger than the Census data suggest.

3 Technical qualification landscape

3.1 Some history in the context of the technician qualification

The need for formal training of technicians and trades people in New Zealand became apparent with the rise in industrial development following WWII, providing the impetus for the creation of the New Zealand Certificate in the mid-1950s. This qualification came into existence with the establishment of the Controlling Authority for the New Zealand Certificates in Engineering [5], the early predecessor to today's New Zealand Qualifications Authority (NZQA). Generic certificates in engineering (NZCE) [6] and science (NZCS) were introduced as mid-level qualifications that could be studied in a major discipline (e.g. civil, electrical, and mechanical engineering, physics, and chemistry). They became the dominant qualification for those wishing to pursue a career as a technician. Such qualifications were available at a variety of institutes (now called Institutes of Technology and Polytechnics [ITPs]) around New Zealand, or by correspondence [5].

By the early 1980s, the controlling authority had evolved into the New Zealand Authority for Advanced Vocational Awards (AAVA) [7] and offered a variety of vocational qualifications, including technician certificates (three stages), intermediate certificates, New Zealand certificates (five stages), New Zealand diplomas, and the degree. Less than a decade later, the Education Act 1989 was passed and the New Zealand Qualifications Authority (NZQA) emerged, taking over the work of the former Universities Entrance Board, the Trades Certification Board, and the AAVA [8]. With the establishment of the NZQA came Industry Training Organisations (ITOs), agreement on a national nomenclature, and the adoption of a New Zealand Qualifications Framework (NZQF) [8] that is still in existence today. The initial model was for ITOs to develop qualifications, delivered by so-called 'providers' which included ITPs [5], and Private Training Establishments (PTEs). Although some Level 6[ii]

[ii] Level 6 on the NZQF education framework. Level descriptors are in Table 5 of Appendix B.

qualifications were developed, the primary focus of the ITOs was at Level 5 and below, targeted towards the needs of particular industries. However, many ITPs chose to develop their own local qualifications rather than deliver those designed by ITOs. Within the decade, a wide range of technical qualifications was available, recognised by a variety of organisations, and provided by a number of institutes, causing much confusion [5].

In the late 1990s, the NZQA decided to disestablish the NZCS and NZCE, as they did not fit the new nomenclature for Level 6 qualifications. Phasing out of the former commenced in 1997 [9], and the latter around 2000 [5]. The NZCS was replaced by the Level 5 (Technician) and Level 6 (Advanced Technician) National Diplomas in Science [9]. The NZCE was replaced by a number of two-year diplomas in engineering qualifications, which were consolidated in 2009 into the current New Zealand Diploma in Engineering (NZDE) [5]. Due to an oversight in the transition timeline (the New Zealand Certificates could be studied part-time, and with practical and theoretical components undertaken at different times), it was possible to be awarded these qualifications several years after their disestablishment [9]. The final NZCS and NZCE qualifications were awarded in 2003 [9] and 2008 [5], respectively. Consequently, by the early 2000s there was no widely recognised and used national Level 6 technician qualification in science or engineering.

3.2 Present education landscape

In contrast to the NZCS and NZCE, which were mainly studied part-time whilst in employment, tertiary education in New Zealand today has moved towards being full-time and self-funded. As employers now rarely assist in the study they have limited or no direct input into the composition of the qualification, and may merely wait until graduates emerge. Hence, there was a significant change from a person studying whilst employed in a science technician role to that where the person first studies and achieves a qualification before becoming employed as a science technician.

The removal of on-the-job training, an essential component of the NZCS and NZCE qualifications, meant graduates are likely to emerge with a lower level of technical aptitude and transferable practical skills. Practical training desirably includes work experience in an organisational structure and in a team or project-based setting. This supports the development of interpersonal skills in a workplace, and relevant Health and Safety training, which are either rarely or not available in the new qualification structures.

3.2.1 New Zealand's tertiary providers

Historically, the distinction between New Zealand's tertiary and vocational training organisations was more clearly defined. Academic-orientated individuals were educated at universities and technical or trade-orientated individuals were qualified at technical colleges (now called ITPs), teacher's colleges or through apprenticeships [10]. Nowadays, the distinction is less clear. There is a plethora of vocational training organisations (Table 2) and many of them offer qualifications that were once the explicit domain of universities.

Table 2: Primary New Zealand tertiary providers that receive government (TEC) funding, and their allotment of full-time equivalent tertiary students (EFTS) [11].

Provider	Description	Number of providers	Portion of EFTS	Provision
PTEs	Offer qualifications in 'niche occupations' across a wide range of disciplines.	244 plus 240 †	16%	69% of EFTS provision is Diploma and Level 3-4 Certificates
ITPs	Offer vocational training, and foundation and degree level programmes. Over 50% of their intake are mid-career individuals seeking to up-skill [10]. ITPs now have the capability to deliver Bachelor-level degree programmes; however, the number of students taking such qualifications is low compared with universities, whose entrants are primarily school-leavers [10].	16	27.5%	56% of EFTS provision is Diploma and Level 3-4 Certificates
ITOs	Develop qualifications on behalf of industry organisations.	11	7%	90% of EFTS provision is Certificate Level 1-4
Universities	Offer degree level qualifications and above.	8	48%	69% of EFTS provision is Bachelor degrees
Wānanga	Provide tertiary education based on Māori principles and values.	3	9%	77% of EFTS provision is Level 1-4 Certificates

Note: PTEs are private training organisations, ITPs are institutes of technology and polytechnics, and ITOs are industry-training organisations. †Non-government funded PTEs.

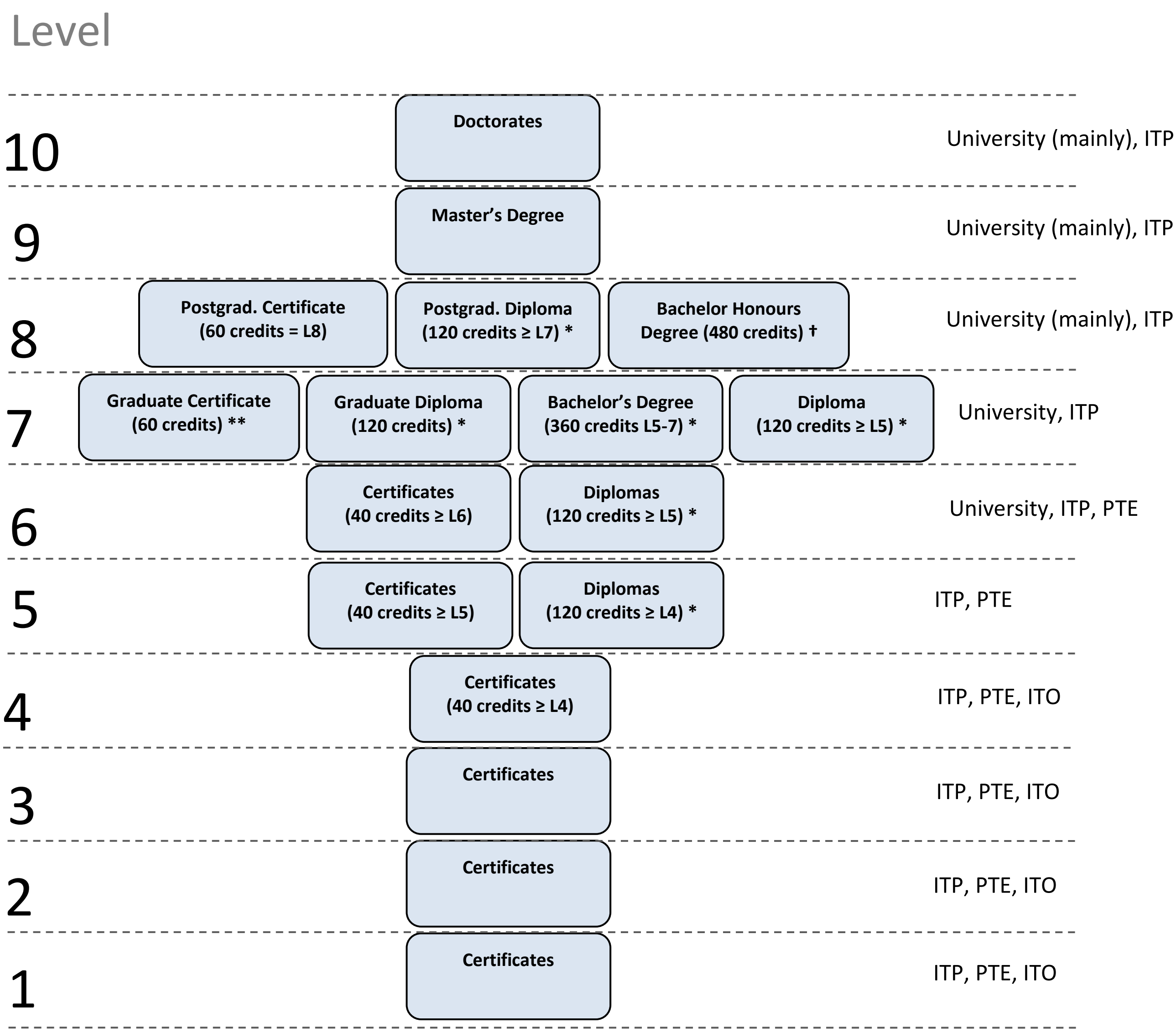
3.2.2 The New Zealand Qualification Framework

The qualifications relevant to technician training today[iii] fit within the New Zealand Qualification Framework (NZQF) which incorporates ten levels (Figure 3.1) [11]. In brief, Levels 1-4 are predominantly pre-degree qualifications, mainly delivered by ITPs and PTEs. Levels 5-7 predominantly represent studies aligned with diploma or undergraduate degree qualifications and are delivered mainly by the university and ITP sectors, with some additional PTE provision. Level 8 and above represents postgraduate study, delivered

[iii]Excludes the National Certificate of Educational Achievement, NCEA, taught in secondary schools

predominantly by the university sector. Detailed level descriptors are in Table 6 of Appendix B.

Figure 3.1: Schematic of the New Zealand Qualification Framework established in 2010

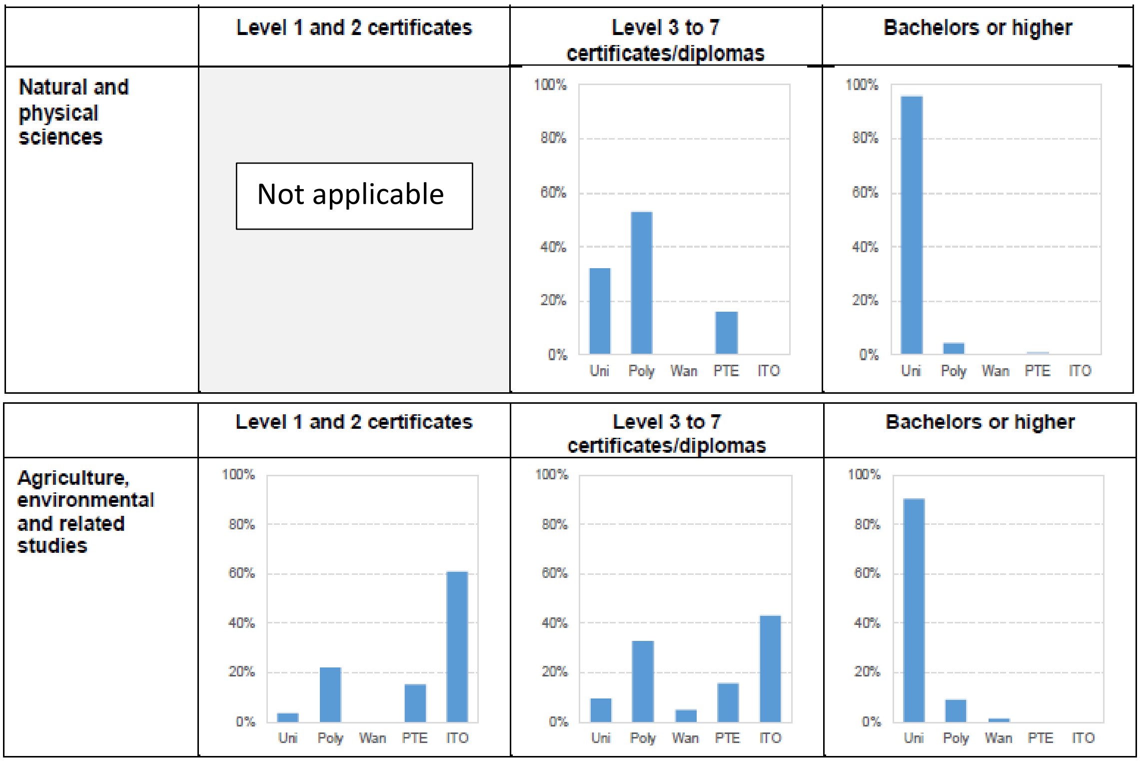


Note: Minimum credit requirements for qualification Levels 4 - 8 are shown in parentheses. 120 credits is 1 year full-time. *Including at least 72 credits at the diploma/certificate level or above. ** Including a minimum of 40 credits at Level 7 or above. † Or a minimum of 120 credits at Level 8, with a research component that represents at least 30 credits at that level (Table 5, Appendix B).

3.2.3 The role of tertiary providers in science education

Figure 3.2 shows the present science education provision in New Zealand. The ITPs, PTEs, and ITOs are the dominant providers of Level 1-2 Certificates in agriculture, environmental, and related studies. In the natural and physical sciences, the provision of Level 1-2 Certificates is essentially non-existent. Levels 3-7 are taught at ITPs and Level 7 Bachelor's degrees are predominately at universities (with some PTE provision of specialised courses). University provision dominates above Level 7 Figures 3-1 and 3-2).

Figure 3.2: Distribution of domestic students in the fields of natural and physical sciences, agriculture, environmental and related studies, across tertiary providers.



Note: The height of the individual bars for each graph represents the relative percentage of the total provider offering, which collectively sum to 100 percent. ‘Uni’, ‘Poly’, and ‘Wan’ denote universities, ITPs and Wānanga, respectively. Reproduced from [12].

3.2.4 The TROQ process and present qualifications in applied science

In 2008, the New Zealand government established the ‘Targeted Review of Qualifications’ (TRoQ), for programmes delivered at Levels 1-6 [13]. The review aimed ‘*to ensure that New Zealand qualifications are useful and relevant to current and future learners, employers and other stakeholders*’ [13]. The review resulted in consolidation of, and a substantial reduction in the number of, qualifications offered. Being industry-driven, it aimed to ensure that the qualifications offered were work-relevant. However, the needs analysis for science proceeded quickly, providing less opportunity for employer consultation than the process for engineering, and information and communications technology (ICT) qualifications that preceded the TRoQ.

When the TRoQ process for science commenced, there was a national Level 6 Diploma that was delivered by just three ITPs and four PTEs, illustrating that the capability of the ITP sector to deliver Level 6 science technician programmes had reduced. In 2015, NZQA launched a national suite of applied science qualifications relevant to the role of technicians, delivered primarily by the ITP sector (Table 3). The Ara Institute of Canterbury (formerly the Christchurch Polytechnic Institute of Technology) is the ongoing qualification developer for New Zealand Certificates in Applied Science (Levels 3 and 4), New Zealand Diplomas in

Applied Science (Level 5 and 6) and a New Zealand Certificate in Laboratory Systems Management (Level 6). In addition, New Zealand Diplomas in Environmental Management (Levels 5-6), developed by the Skills Organisation (http://skills.org.nz/), provide qualifications that focus on environmental science capabilities relevant to certain technician roles.

Table 3: Applied science qualifications registered on the NZQA framework following the TRoQ process

Qualification	Credits
Certificate in Applied Science (Level 3)	60
Certificate in Applied Science (Level 4)	60
Diploma in Applied Science (Level 5)	120
Diploma in Applied Science (Level 6)	120
Certificate in Laboratory Systems Management (Level 6)	60
Diploma in Environmental Management (Level 5)	120
Diploma in Environmental Management (Level 6)	120

Note: 120 credits is 1 year full-time.

Although the TRoQ review of science qualifications led to the development of applied science programmes spanning Levels 3 - 6, only the Level 6 New Zealand Certificate in Laboratory Systems Management overtly focuses on the role of a laboratory-based science technician. The purpose of this qualification is to provide commercial enterprises in New Zealand with people who are able to manage systems, including data integrity and security, in a science laboratory according to international standards and protocols. This qualification is intended for people who have significant experience in a scientific workplace and who want to develop skills and knowledge in the management of laboratory systems. Fully utilised, programmes such as this are able to provide work-ready graduates with technical aptitude and transferable practical skills. The employer only needs to provide training in industry-specific requirements. However, student enrolments in Levels 5-6 science qualifications tend to be low [14], challenging their viability, and creating a risk that ITPs will lose their capability to provide training equivalent to that delivered through the earlier New Zealand Certificate in Science. The provision for such training currently exists within ITPs, including the Universal College of Learning (UCOL), Ara Institute of Technology, Eastern Institute of Technology, Northtec, and Wintec, as well as the PTE provider, Real World Education.

4 Intended versus actual qualification-career pathways

A suggested qualification pathway for science technicians presented by Futureintech, an IPENZ initiative funded by Callaghan Innovation and the Ministry for Primary Industries, is shown in Figure 4-1. This schematic shows that in contrast to 20 years ago, when the NZCS was the dominant qualification for those wishing to pursue a career as a science technician, a Certificate, Diploma, or Bachelor degree qualification can now lead to such a career. In industry, a Level 5-6 Diploma in Science/Applied Science is purported to be the primary qualification required for a science laboratory technician. Contrarily, this study has shown that a Bachelor's degree is now the most common entry qualification for such roles and this or a higher qualification is required for a person to work as a science technician in the research sector.

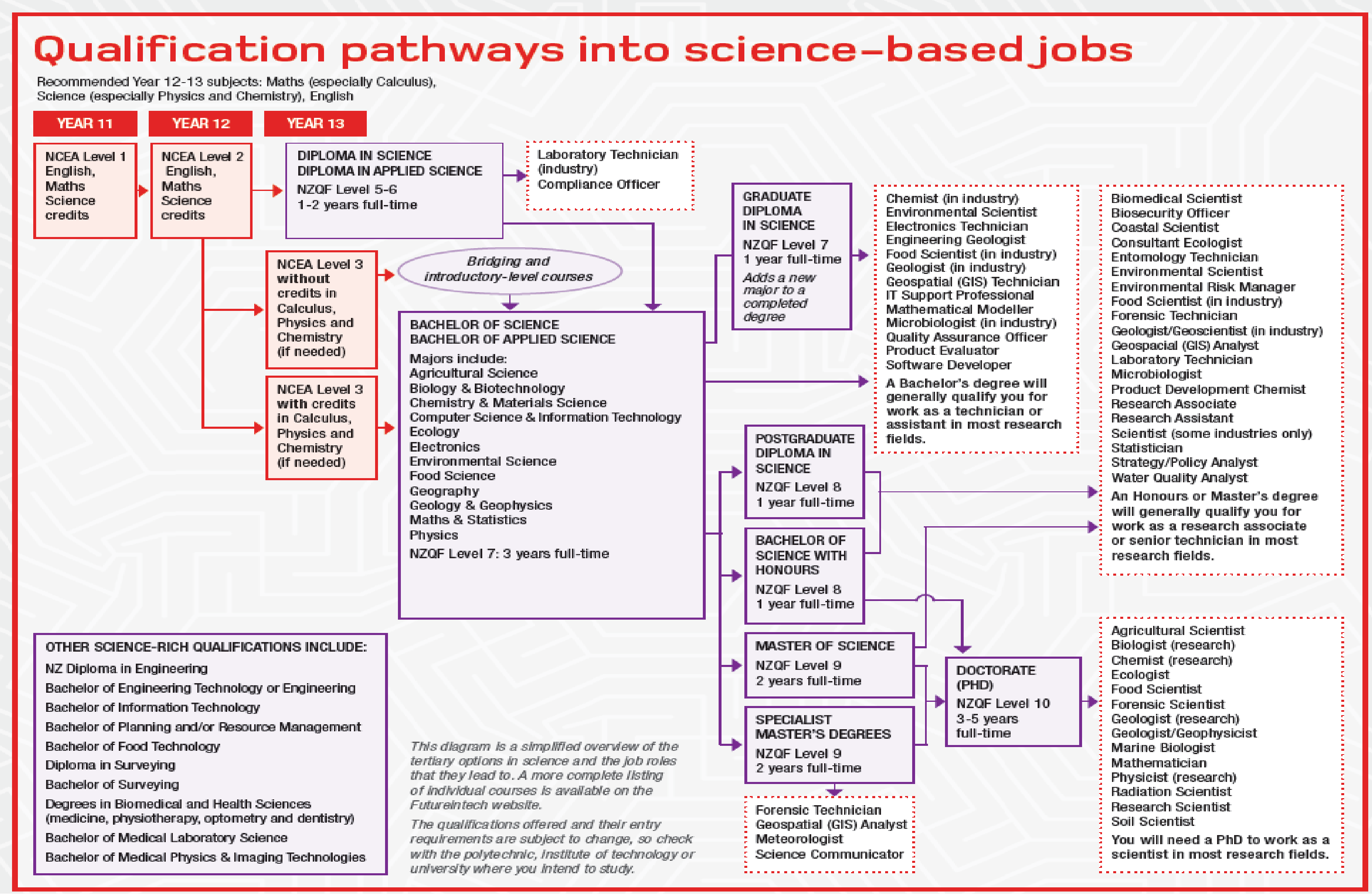
Overall, the information gained from the Panel's interviews supports Futureintech's qualification pathway for technicians in the research sector. However, for the industry sector the Panel was concerned to see 'education inflation', with a large number of individuals employed as science technicians that are educated to the university degree level, without there being a clear need. The Panel also noted that for more research-oriented technician positions and those associated with complex instrumentation and procedures, Masters, and PhD level qualifications are becoming increasingly common.

4.1 Qualification mismatch

According to a 2016 survey commissioned by the New Zealand Ministry of Education and the Ministry of Business, Innovation and Employment (MBIE), our nation ranks amongst the highest of the OECD countries for qualification to job mismatch [16], where individuals are accepting jobs that are not well matched to their qualifications. Twenty nine percent of the technician and trades workers surveyed believed they were over-qualified for their job [16]. These statistics support the Panel's observations of the occurrence of education inflation for science technician's roles. This phenomenon indicates that following the disestablishment of the NZCS there has been a paradigm shift towards employers hiring science technicians with bachelor degree qualifications. The reasons for this include:

- A deficit exists in the supply of individuals with appropriate Level 5-7 Diplomas for science technician roles.
- Employers are preferentially employing individuals that have attained a Bachelor's degree or above, either consciously or unconsciously.

Figure 4-1: The current science career pathway as illustrated by Futureintech [15]



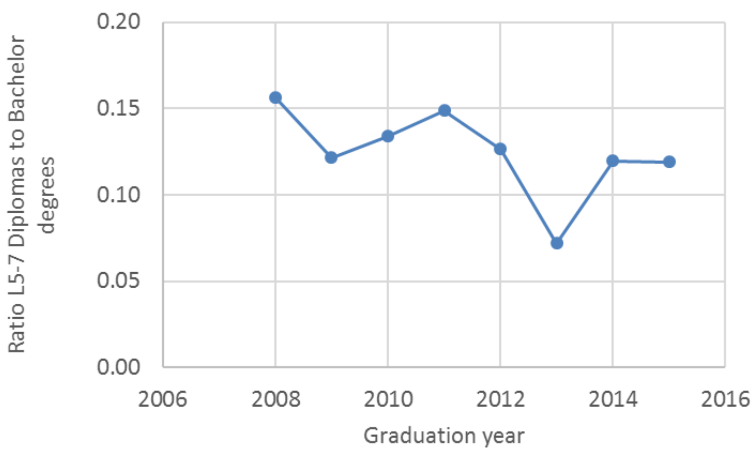
Note: The qualification level descriptors addressed here are those used within the New Zealand Qualifications Framework, reproduced in Table 5, Appendix B. An electronic copy of this figure is available at http://www.futureintech.org.nz/science-pathways.cfm.

4.1.1: Is there a deficit in the supply of graduates with Level 5-7 Diplomas?

Compared with the average in OECD countries, New Zealand has a significantly higher ratio of Level 6/7 science graduates in life/biological sciences [17]. Furthermore, data provided by the Ministry of Education [14] indicate that the average number of students who graduated with a Bachelor's degree in natural and physical sciences between 2008 and 2015 was almost 9-fold higher than those who graduated with a Level 5-7 Diploma in the same field (Figure 4-2). This indicates a low supply of the latter graduates and confirms the information received by the Panel from representatives of relevant employers (including from the industry and research sectors) that too few graduates are presenting with Level 5-7 Diplomas.

It is notable that there is a downwards trend in the ratio of graduates with Level 5-7 qualifications to those attaining Bachelors' degrees, suggesting that, without mitigation, the low supply of the former graduates will deepen in the future. This poses the question of why few students are choosing a career as a science technician through the more practical Diploma qualification route. Exploring this question in detail is outside of the scope of this report, but some important observations and practices are noted.

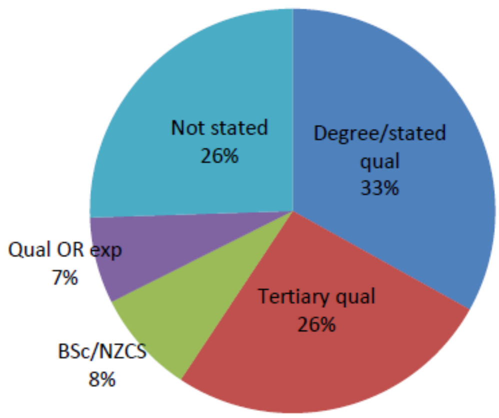
Figure 4-2: The ratio of New Zealand domestic and international students completing Level 5-7 Science Diplomas to those completing Bachelor's degrees, by year [14].



4.1.2: Are employers of science technicians preferentially appointing graduates with Bachelor's qualifications?

In 2014, the NZQA produced a needs analysis report reviewing science qualifications [18]. This review looked at a representative sample of science technician roles advertised online in New Zealand in 2013 with respect to the qualifications requested by employers. The data indicates that 33% of employers specifically requested a university qualification such as Bachelor's or Master's degree (Figure 4-). A further 26% requested a tertiary qualification (i.e. Bachelor of Science, NZCS, Diploma, or equivalent). The 26% of advertisements that did not state any qualification requirements related to either less demanding roles or those that provided in-house training. These numbers suggest that employers are casting the net wide in their advertisements, being unsure whether people well aligned to their roles will apply. Information received by the Panel from representatives of the relevant employment sectors corroborates this finding.

Figure 4-3: Qualifications listed for laboratory technician roles based on a survey of 145 online advertisements between May-August 2013 [18].



The information received by the Panel also indicates that some employers who were familiar with the NZCS are unfamiliar with the replacement qualifications and thus turn to employing the applicant with the most common or best-known qualification. Moreover, there is a perception by some employers that more highly qualified candidates (in terms of years of tertiary study) are better long-term employee prospects. Indeed, some employers appear to view degree qualifications as a benchmark for subsequently moving into more management-oriented roles. This is likely due to the wider knowledge base and educational attributes associated with a Bachelor's degree as compared with the more specialised Certificate and Diploma qualifications.

New Zealand ranks third highest in the OECD for the proportion of adults that have attained a Bachelor's degree[iv]. In science, our nation produces more Bachelor's degree graduates[v] than the average of the OECD countries[vi] [19]. The information available to the Panel indicates that in order to find employment some of these graduates are embarking on science technician careers, just to get a start in the job market.

[iv] 25% of adults aged 25-64. Year of reference 2010

[v] 12% of New Zealand graduates. Year of reference 2014.

[vi] An average of 9% of graduates in OECD countries. Year of reference 2013.

Recent data produced by Universities New Zealand indicate the net value (employment opportunity) of a Level 7 qualification in biological sciences ($50,800)[vii] is lower than for a similar level qualification in physical sciences ($59,900), and significantly lower than most engineering or ICT fields ($55,600 - $86,000) [20]. This suggests that there is an oversupply of graduates in the biological sciences areas and hence such graduates may look to compete for roles that are lower paid, and for which they are over-qualified. These data support the feedback from the interviews undertaken by the Panel.

There are a number of hypotheses in the literature for the drivers of qualification mismatch. These include individuals *'choosing to accept a job for which they are overqualified because it offers them compensating advantages, such as less stress' and 'employers actually preferring overeducated workers because they are more productive and learn more quickly, thus reducing training costs'* [21].

Overall, holding a Bachelor's degree qualification has become increasingly common for people in science technician roles in spite of those graduates lacking the general technical aptitude and transferable practical skills of graduates from a Level 5 or 6 technician qualification. Such qualification mismatch carries with it potential negative consequences for remuneration, employee job satisfaction, staff retention, productivity, and the New Zealand economy as a whole [21] [22], and as such, is highly relevant for policy makers.

4.2 Are science technicians emerging from education fit-for-purpose?

The feedback received from representatives of relevant employers indicates that the tertiary education that graduates receive today is not ideally suited to the tasks required of a science technician. This is especially true for individuals with Bachelor's degrees. The feedback received by the Panel reflected that:

- The nature of the present technician workforce is very diverse in terms of the skills and knowledge required;
- Despite the wide variety of qualifications currently on offer, many present entrants into science technician roles lack the technical aptitude and required proficiency in transferable practical laboratory skills (listed in section 6.1);
- Technicians are presenting with insufficient or no knowledge in some specialist areas that are of particular relevance to the employer; and
- Employers welcome improvements by education providers to address the skill deficiency.

Most employers overcome the skill gap by extending their own on-the-job training to develop transferable practical skills and technical aptitude in much the same way as that of

[vii] Mean annual income (all workers part time & full time aged 15-65+ in 2013. Age standardised)

the former NZCS qualification[viii]. This observation is supported by OECD statistics that show New Zealand currently has the highest participation rate in on-the-job training (43% compared with 29% for the OECD average) [16]. In discussion with a PTE the Panel noted that the PTE addressed this skills gap through arrangements with their partnering laboratories. The number of students in the PTE programme is very small when compared with university and ITP programmes. It also largely targets international students.

It is worth noting that an important distinction exists between accredited[ix] laboratories that have quality assurance, standards, and/or regulatory roles, and those that do not. Science technicians working in accredited laboratories are managed in the context of an ongoing and monitored competency standard that must be achieved for the laboratory to maintain the accreditation status. This means that these laboratories undertake significant and ongoing technician training programmes customised to their documented requirements.

Because service and specialist laboratories can gain accreditation through largely satisfying procedural requirements and training programmes as a whole without being required to demonstrate individual staff competencies, a relatively *ad hoc* approach in determining the suitability of particular qualifications for a person to enter the science technician workforce can prevail. The focus is more on the holistic assessment of the competency of the technician workforce to carry out a range of procedures, rather than being on the competence of the specific person undertaking a task. However, in practice, these components are interlinked.

5 Discussions with the education sector

The Panel held separate discussions with representatives from the ITP sector, the universities and one PTE, which resulted in the following findings.

The Level 6 Diploma programmes run at some ITPs for educating science technicians, such as those under the New Zealand Diploma of Applied Science label, appear to have excellent fit to employment opportunities. Where the programme includes supervised practical work, it is common for students to gain later employment in the same laboratories. These findings corroborate the feedback from employers, with one referring to these technicians as '*pure gold*'. Such smart arrangements that nest technician programmes beside one or more synergistic science-informed vocational programmes appear to be viable.

The PTE representative affirmed the need for monitored practical work in industry as a key developmental component of the model qualification. The need is for a well-designed

[viii] Some employers get around this skill gap by outsourcing their laboratory requirements.

[ix] e.g. IANZ, International Organization for Standardisation Certifications

preparation programme providing monitored laboratory experience that is documented (i.e. in a student portfolio), and assessed.

Both the PTE and ITP representatives further emphasised that whilst the Level 6 New Zealand Diploma of Applied Science was a suitable vehicle within which to develop and deliver a science technician qualification, the Diploma curriculum is written generally and its use as a technician qualification is only one possible application.

The discussion with university representatives reinforced that a Bachelor of Science is a general degree qualification, enabling a student to obtain a specialised knowledge in a major discipline area together with a broader based education in other subject areas. Students choosing a physical or natural science area for their major typically include other subjects such as mathematics, computing, psychology, commerce, social science or a language in their degree structure. Bachelor of Science students can also take a major in a non-experimental science area and other experimental science subjects to a lesser level to provide the required breadth. The combination of a major discipline area and a broader discipline base has generally led to constraints on the actual time students in the physical and natural sciences can spend in the laboratory. Hence, not all Bachelor of Science students graduate with extensive laboratory experience. A number of representatives from the various universities stated that they intended for their programmes to develop some of the generic laboratory practice skills, yet the feedback from employers was that emerging graduates were often lacking technical aptitude and sufficient transferable practical skills. Extensive on the job training that goes well beyond industry-specific needs was inevitably required. Universities with smaller classes and a culture of strong applied science programmes were more likely to emphasise laboratory practice skills.

Overall, these discussions confirmed the Panel’s view that from the plethora of qualifications available, a Level 6 science technician qualification delivered under the New Zealand Diploma of Applied Science label provides the best match to the needs of employers, albeit only for industrial technician and service laboratory roles. Research technicians do benefit from the broad knowledge gained in a Bachelor of Science, so for them this qualification from a university is satisfactory preparation, although sub-optimal in some specific areas. The arrangement one PTE has with partnering laboratories for Level 5 and 6 qualifications provides specialist training in particular areas.

The panel also concluded that the diversity of qualifications and delivery arrangements was also a contributor to the mismatch of qualifications and employment opportunities. This led the Panel to question whether a national network of provision of a Level 6 science technician qualification, in a similar vein to the ITP-based national network for delivering the New Zealand Diploma of Engineering, would be a suitable means to address the observed mismatch.

6 Future career pathways

6.1 Why pathways matter

The Panel's view is that effective and meaningful qualifications need to be available which enable entry into, and support progression within and then beyond, the wide-range of science technician roles in New Zealand. Without this, we will be unable to stem either the continued mismatch of knowledge and skills of science graduates emerging from our University and ITP education system with those required by employers, or the concomitant negative impacts on employee prosperity and business productivity.

Support for this career pathway needs to start within schools and colleges, encouraging potentially interested students to see the value of a science technician qualification to commence a worthwhile career, and choose appropriate subjects. The Productivity Commission's 2017 report on New Models of Tertiary Education advises that the student decision-making process can be broken into three stages:

- *The predisposition stage*, which is influenced by a person's family background, parental disposition to tertiary education, degree of self-belief, and the school they attended. Numerous studies have found that family, peer, and societal influences are important in shaping individuals' predisposition towards tertiary education.
- *The search stage*, which occurs when the individual is investigating post-school options, based on their career aspirations, interest in a field of study, prior academic achievements, and access to information and contact with tertiary institutions.
- *The third stage* is where students make choices to pursue specific tertiary programmes at chosen providers. Here, student choices are constrained by a variety of factors, including admission requirements, the availability of preferred courses, geographic proximity to tertiary providers, and affordability concerns.

These stages indicate that in order to ensure a coherent and work-relevant pathway for science technicians, clear educational and career pathways, together with appropriate guidance, are needed.

In spite of the rapidly evolving nature of science technician roles, particularly with respect to automation, computerisation, specialised skills and knowledge outsourcing, there are commonalities in the educational requirements that emerge, such as:

- Strong technical aptitude;
- Transferable practical skills that are directly work-relevant and of immediate use to a range of employers, allowing those employers to focus their in-house training on specific requirements;
- Adaptability, in order to respond to changing technology and role;
- Strong written and oral communication skills;

- Computational and data-handling skills;
- Workplace health and safety knowledge; and
- Clear and worthwhile career pathways, from junior to supervisory and advanced roles.

For there to be worthwhile career pathways, the Panel concludes that it is important that the education programmes, as well as opportunities for science technicians, are nationally and internationally credible, adaptable and relevant to meet the requirements of New Zealand industries, both now and in the future. The changing and developing nature of the industries' requirements mean the educational programmes for science technicians must be similarly dynamic and provide definitive science and technology education as well as the development of a wider skill base incorporating aspects of IT, communications, management, and health and safety components.

6.2 Selecting a career path

The current qualification pathways that direct an individual into a particular career path have been summarised in Section 4 and are shown in Figure 4-1, which schematically outlines the current matrix of training, education, and experience that maps onto a series of career development paths for technicians, technologists, and scientists. This generic career structure diagram is intended to be a useful guide for entry-level technical staff to envisage their future career path(s) and may help manage expectations. Exemplars of technician job categories, roles, and career scope are given in Section 6.4. Selecting the right educational pathway is important for minimising/avoiding the occurrence of qualification mismatch later in an individual's career.

The Panel recognises that when selecting or embarking on a pathway through this map, prospective entry-level technicians need to be realistic about the scope and duration of the education that will enable them to progress along any given path. The model shows that a degree-qualified individual operating in some well-defined technical roles may be overqualified for that role. Equally, for every technical career path we can envisage, there will always be those individuals who are outliers, whose interpersonal skills and sheer hard work can compensate for a relative lack of initial educational qualifications, enabling them to achieve and deliver at a higher than expected level within their specialist field of science and technology.

Realistic career guidance is essential to enter this map at the correct point in relation to an individual's skills, and motivation, and the changing nature of the employment market. It is the Panel's view that for an entry-level student, parental guidance to 'reach for the stars' must be tempered by the reality of the individual's own high school success and competency. A third party, such as a school careers counsellor, may provide more objective guidance than parental or peer opinions.

6.3 Post-education opportunities

Career pathways for the technician workforce are many and varied, with some inter-related. In the first instance, career paths are often defined (or constrained) by the specific work sector the technician is employed within. Beyond this sector constraint, the quality of the individual's technical, professional, and interpersonal skills could see them advancing through a succession of incrementally challenging technical roles within their existing sector/employer structure and/or potentially transferring to administrative and managerial roles. This is why the Panel is strongly of the view that science technician education should focus on providing the appropriate science knowledge base in a particular discipline(s), as well as technical aptitude and transferable skills, rather than industry-specific needs. It is the Panel's view that the greatest scope for technician career advancement, whether via technical or managerial paths, lies within the larger employers such as government and the larger private enterprises. Technical staff within smaller enterprises may find their career paths limited by a fixed scope of work, which is deemed sufficient to meet the needs of the employer and their product or service offering. In some cases, there will be reluctance by the employer to promote an individual within their current technician job structure or to encourage a transfer to another arm of their business once the individual is fully trained and delivering value to the enterprise at the level required by their employer. In such circumstances, the employee faces a decision to stay or go, and the employer faces a decision with respect to the value already invested in the individual and the cost and disruption of training a new employee. Some employers expressed concern about retaining good science technicians in whom they have invested time and money in training and regarded them as a very valuable asset. Consequently, they did not want to see them being lured away by other companies or organisations.

In smaller regional centres, where employee choices are limited and where family and economic circumstances may constrain relocation options, the employee may have limited leverage to bring to any employer negotiation. In an employment market where there is a potential oversupply of science graduates competing for technical roles, the employer may choose to accept higher staff rotation to limit their exposure to higher salary costs, albeit at a penalty of additional training costs.

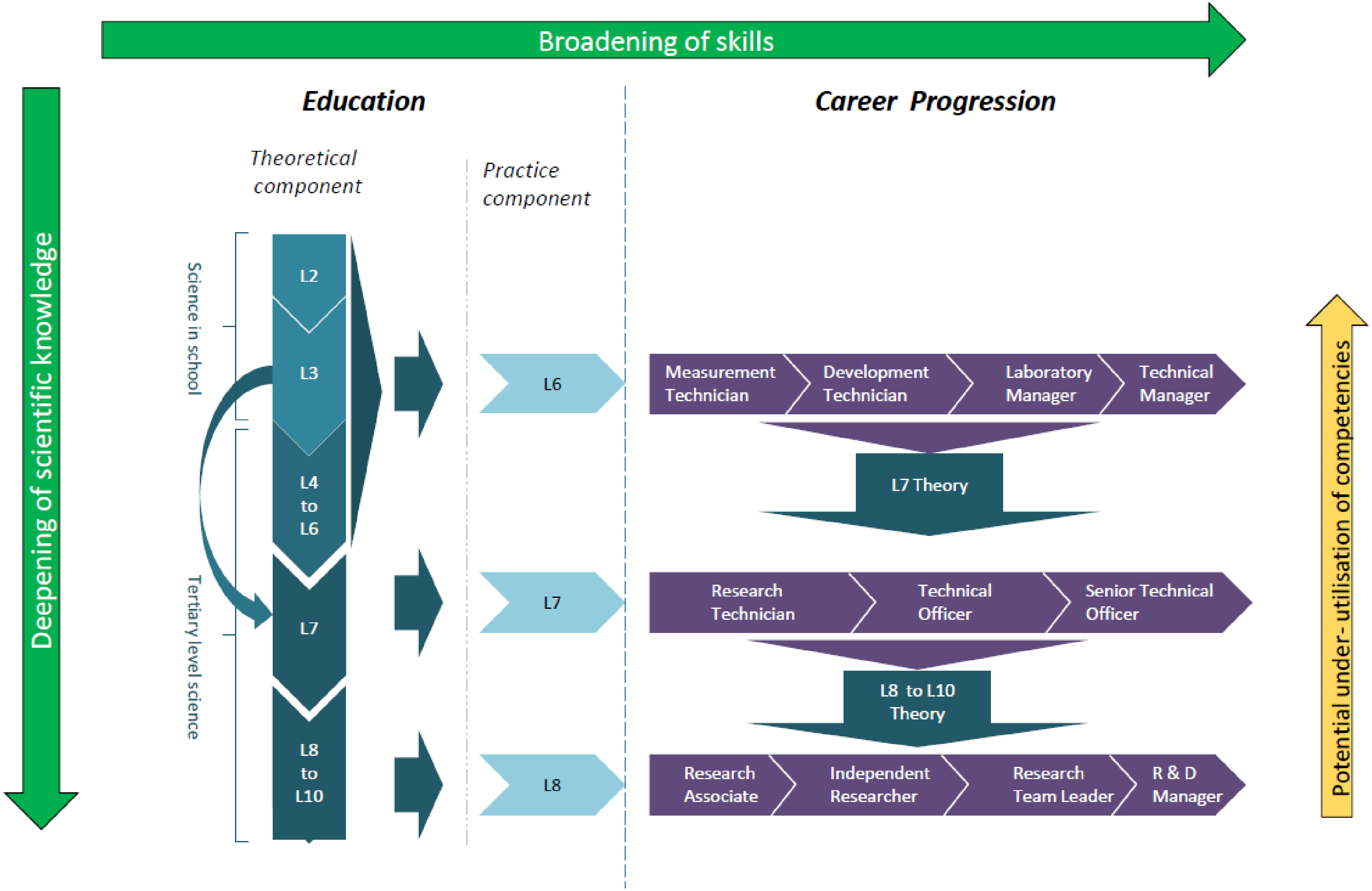
6.4 The changing nature of the role of technicians

To understand how the role of science technicians may change in the future, it is helpful to look at the nature and direction of change that has occurred in the recent past. Rapidly advancing technology, instrument automation, advancing computing interfaces, changing communication processes, and more rigorous health and safety requirements, dictate that skills, workplace methodologies and attitudes must keep pace. Enterprises that employ technicians to undertake tasks with a high manual or repetitive content have in many cases opted to invest in instrumentation and/or robotics to enhance quality, accuracy, reproducibility, and speed of these tasks. The role of the technician may be to operate, calibrate, maintain, and sometimes analyse data from such instrumentation. Increasingly, with the growing sophistication and cost of such instrumentation, some enterprises are opting to outsource this work to larger accredited service laboratories, moving the responsibility for capital investment, maintenance, training, and instrument upgrading out to these laboratories. For smaller enterprises that require high quality data to support their operation, yet have insufficient workload for a specific suite of instruments to justify the investment, then outsourcing is a logical and cost-effective decision. In such circumstances, the career opportunity for suitably qualified technical support may then migrate to the outsourcing laboratory.

It is worth noting that the dynamics and career structures of technicians within the New Zealand 'industrial' system are very different to those in the New Zealand 'research' system and offer quite distinctive career paths as indicated in Figure 6-1. The differences between some selected technical roles are highlighted below, but even within these roles the job content and on-the-job training and career opportunities are very sector and employer dependent. Examples of the diversity includes:

- Measurement technician
    - The larger laboratories have career paths – technical assistant, technician, senior technician, principal technician/technical officer, team leader/senior technical officer, and routes to technologist/scientist roles. Such laboratories and employers accept that many career driven staff will progress through these grades on differing timelines, accepting a consequent overhead in managing staff training protocols.
    - The smaller laboratories operate in a more *ad hoc* manner with limited scope for technician career advancement. While more versatility may be required of the individual technician, there is likely to be some degree of outsourcing of tasks that lie outside of the core business for strategic or financial reasons.
    - Entry to this role type is typically at Level 6 Certificate or Diploma although it is the Panel's opinion that there are many applicants for such roles with Level 7 qualifications including those with Bachelor's degrees. Infrequently, companies will take on recruits directly from secondary school.
    - Service laboratories, which generally support the work of industry and business as well as regulatory organisations, employ science technicians in a range of specialist analysis and measurement roles, which utilise particular well-defined (standard) procedures and specialist equipment not normally present in the contracting entity. Quality control and quality assurance measurements are important components of this work.

Figure 6-1: The Royal Society Te Apārangi science technicians' career model.



- Research technician
    - Research technicians provide specialised support in research programmes. This often includes developing new experimental methodologies and using sophisticated equipment and instruments. The position is often seen as a pathway by persons who are actually over qualified for the particular role, but aspire to be research associates or research scientists. Here they perceive a technician role as a stepping-stone to a more elevated career pathway. This may involve subsequent postgraduate training and/or the progressive acquisition of specialist skills over an extended career timeline. Sectors/employers of research technicians include the Crown Research Institutes (CRIs), Callaghan Innovation, the universities and to a lesser extent in industry.
    - The CRIs and Callaghan Innovation now have established career pathways for technical staff, often fully integrated within their 'Scientist' or 'Engineer' career progression paths. While the step descriptor labels vary between organisations, the structures provide capacity for a skilled technician to progress to the level of a senior research scientist (or engineer) in some specialist fields. There are numerous current examples of such career progression among Callaghan Innovation and GNS Science staff recorded from the fields of (for example) optics, metrology and applied electronics. These career paths have typically built upon backgrounds of the (prior) NZCE/NZCS qualification set superimposed on some decades of experience.
    - The universities are less likely to operate such an integrated system, using a more classical division of labour with technicians providing laboratory support and experimental development work for teaching programmes, lecture demonstrations, and selected instrumental/analytical support (such as in electron microscopy) to research staff and post graduate research students/postdoctoral fellows. The research students and postdoctoral fellows themselves often fulfil some 'research technician' tasks for the short-term duration of their degree programmes. A consequence is that capability and skill retention is often on a 2 - 4 year rotation relating to the MSc and PhD timeframes, a process that is not without risk and requires regular training. Such training comes at a cost of time and quality until normal service resumes. Maintaining in-house know how is an essential component here. The teaching structure of the university system has learned to adjust to and fund this mechanism.
    - Research technicians in industry are essentially concerned with the R&D of new technologies, materials, products and processes. They usually have a high level of skills and knowledge in specific areas and contribute to the design and operation of a research programme.

- Field technician
    - Field technicians are a highly variable group with very diverse skills. They tend to be innovative fixers and problem solvers. Many have an outdoors attraction that aligns to the tasks in hand. They are often employed by regional councils and local water boards, and by CRIs, universities and the Department of Conservation who operate land, freshwater, marine and environmental sampling and monitoring programmes across our flora, fauna, hot springs, geological formations, mineral deposits, Antarctica etc. The tasks include an overlap of roles - sample collection, analysis, instrument operation, maintenance and calibration.
    - In the larger organisations, there are career steps as for measurement technicians. In the CRIs and universities, the career structures may align more closely to those of the research technicians.
- Education/laboratory technician
    - Within the secondary school structure, this tends to be the same job for 'life'. The roles are typically occupied by part-time staff and especially by those who have children progressing through the education system or former teachers who wish to take on a lighter workload and who know a particular secondary school and its protocols well. Consequently, many are degree qualified. Employment hours are usually limited to the school term. Secondary school laboratory technicians would normally operate in a narrowly defined area and report to the appropriate Head of Department. There is often little scope for career progression in this role.
    - Within the tertiary sector, some career progression may be possible in tertiary teaching laboratories, particularly in the university medical and health science departments. In these cases, the entry qualification is likely to be at least a Bachelor of Science degree and potentially an MSc, superimposed on a high level of practical laboratory experience.

These examples show that the nature of career opportunities and career development for those in the technician workforce is asymmetric across the New Zealand employment spectrum. For most motivated technicians a rewarding career path can be found, although for some this may need to be achieved by transferring between employers and/or employment sectors. The Panel acknowledges that the larger employers, including Government laboratories, are increasingly acknowledging the value and role of the science technician workforce by complete integration within their science or engineering career structures; recognising that the loss of unique or critical skills affects all staff and hence compromises the success of the business.

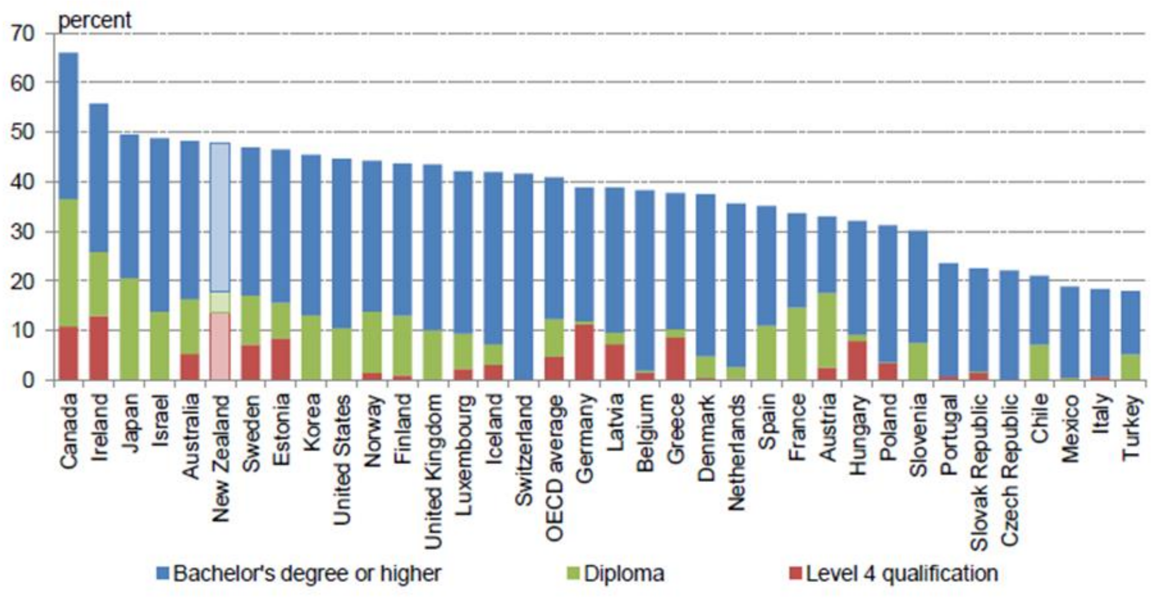
7 What can we learn by comparison to others?

Many of the challenges faced by the science technician workforce today that have come to light in preparing this report are not unique to this workforce, or to New Zealand. Confusion over choices resulting from a plethora of courses offered by a variety of providers, weak links between education and the labour market, and qualification mismatch, amongst other issues, have been identified in a variety of technical fields [5], and in a number of countries [23], [24]. In determining the best path forward, it is useful to look within and beyond New Zealand to provide insights into how the technician workforce here at home could be supported.

7.1 How qualified are we compared to the OECD?

New Zealand ranks in the top six countries for tertiary graduation rates in the OECD (Figure 7-1). In 2015, just under half of adults aged 25-64 in New Zealand were Level 4 qualified or higher, compared to an average of 41% of adults in the OECD (Figure 7-1). As a nation, we also have the third highest proportion of adults with a Bachelor's degree qualification (25% vs OECD mean of 16%), behind Korea and Japan [19]. However, New Zealanders are less likely to undertake a Master's degree (4%; vs OECD mean of 11%) [22].

Figure 7-1: Percentage of 25-64 year olds with a minimum of Level 4 qualification in 2015. Source: [25].

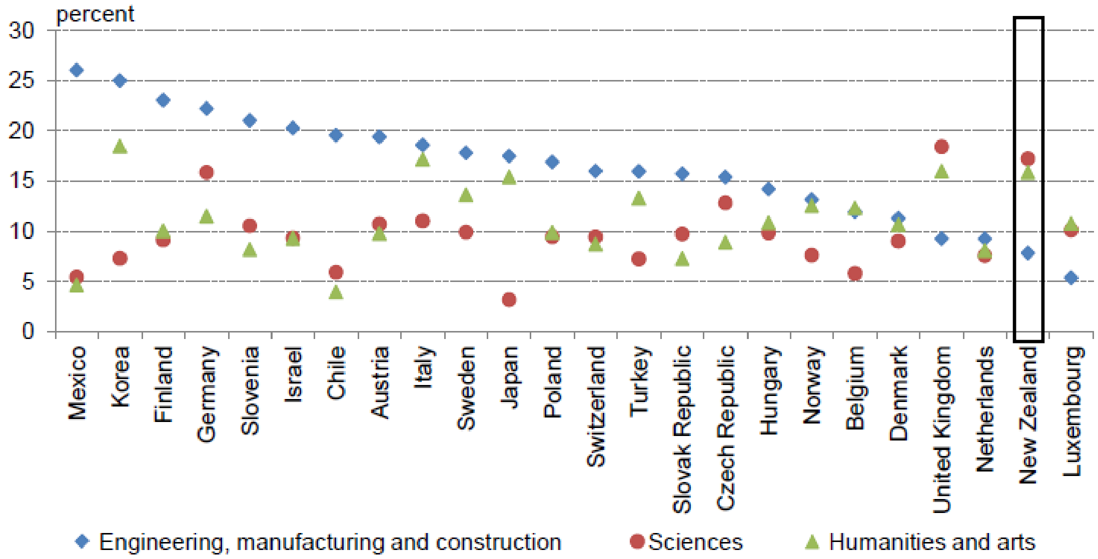


7.1.1 The relative ratios of science, engineering, and ICT graduates

New Zealand has the highest ratio of science to engineering entrants at tertiary level in the OECD (Figure 7-2). At Levels 6 and 7, the qualification levels most relevant to technician roles, we produce significantly more graduates in the sciences (science, mathematics, and computing), relative to our graduate population, than the OECD norm (Table 3). The number of New Zealanders attaining a Level 6 computing qualification is almost three times the OECD norm, and reflects the strength of the growing ICT sector. In contrast, the portion of tertiary students attaining engineering, manufacturing, and construction qualifications is the second lowest in the OECD, ahead of Luxembourg (Figure 7-2).

The data are slightly affected by what, compared to the OECD norm, is a larger contribution from international students. From a domestic viewpoint, our STEM (Science, Technology, Engineering and Mathematics) participation is lower than the OECD norm. In STEM, international students are very significant at Masters and PhD levels, but less so (about 10-15% of the total depending on the discipline) at Levels 6 and 7 in the life and physical sciences. Many of the international students in STEM endeavour to stay in New Zealand and therefore contribute to lifting our overall participation in STEM to just below the OECD mean.

Figure 7-2: Percentage of persons entering tertiary education programmes (Level 5 Diplomas and above) by field (2013)



Note: Sciences include physical and life sciences, mathematics and computing. Adapted from [25].

The study fields most relevant for science technician roles are the life and physical sciences. In these fields, the relative number of Level 6 and 7 graduates in New Zealand is anomalously high in comparison to the OECD average (Table 3). Table 3 shows that in 2013, 1.1% of New Zealand graduates attained a Level 6 qualification in life and physical sciences, compared to the OECD average of 0.8%. At the Bachelor's level, 6.5% of New Zealand graduates attained a qualification in these fields, compared to the OECD average of 4.3%.

Overall, these results indicate that not only are more New Zealand graduates attaining life and physical science qualifications at Bachelor's level than at Level 6[10], as mentioned in

[10] With the exception of Level 6 physical science qualification, for which the percentage of New Zealand graduates that

Section 4.1., but that we are also producing a significantly higher proportion of Level 5-7 science graduates in these fields than the average of OECD countries.

Table 3: Percentage of domestic and international graduates in 2013 by field. The OCED column is the average value.

Level of Education	NZQF Level 5-6		NZQF Level 7 (Bachelor's or equiv.)		NZQF Level 9 (Master's or equiv.)	
	NZ	**OECD**	**NZ**	**OECD**	**NZ**	**OECD**
Life Science	1	0.5	4.5	2.6	7.1	2.8
Physical science	0.1	0.3	2.0	1.7	2.6	2.2
Total	1.1	0.8	6.5	4.3	9.7	5.0

Source: [17]

7.2 What can we learn from other countries?

7.2.1 UK technician workforce

As the UK has similar relative rates of science, engineering, and ICT graduates (Figure 7-2) and exhibits a complex technical education system [26], it may be instructive to look to their methods of reform. The UK Government has identified that weaknesses in the UK's professional and technical skill base have contributed to the country's poor productivity relative to other OECD countries (e.g. France, Germany and the US) [23].

The current perception of technical education in the UK is a system that is flawed as it *'does not deliver enough people with the right skills and technical knowledge of high enough quality, and is not seen as an attractive option by employers, young people, or their parents'* [23]. The challenges faced by the technical education system in England very much echo our own. The primary issues identified are [23]:

- Standards and qualifications are rarely set by employers;
- Qualifications are many, overlapping, and often low-value, and do not ensure a clear pathway to employment;
- The system is complex and difficult to navigate for individuals wanting to retrain;
- There is a paucity of apprenticeship opportunities;
- The current network of colleges[11] and other training providers is financially unsustainable (there is no definitive evidence of this situation in New Zealand), and;
- Technical education programmes are not always designed to deliver what is

attained this qualification in 2013 was just one third of the OECD norm. This may reflect the relative paucity of offerings of Level 6 qualifications in the physical sciences by ITPs in New Zealand, which results in candidates pursuing Bachelor degree qualifications at universities.

[11] UK 'colleges' are commonly vocation-focused higher education institutes that typically take students from 6th form year onward.

needed to move to skilled employment.

Recognising these challenges, several major studies and reviews have been undertaken in the UK to identify the driving factors and provide a resolution. It should be noted that the term ‘technician’ is used in the United Kingdom to embrace the group called technicians and workers in New Zealand who would be referred to as ‘trades’ workers.

7.2.2 The Gatsby Foundation

The UK Gatsby Foundation has supported a number of major studies that recognise the importance of technicians across the breadth of Science, Technology, Engineering, and Mathematics (STEM) fields [27]. Some key observations from these studies mirror the situation in New Zealand, including:

- There is an increasing need for newly qualified technicians, with the UK struggling to ‘*replace those retiring each year, let alone fill the new opportunities opening up to meet the demand of employers*’;
- Qualification levels of STEM workers are generally higher than average with approximately 61.8% of the STEM workforce holding a NZQF Level 5 or higher qualification, compared to 40.4% in the non-STEM workforce;
- Technicians are most likely to be qualified to UK Level 3 (NZQF Level 4), with nearly 31% of the technician workforce holding this level of qualification. However, nearly a quarter of technicians, hold either a UK Level 1 or Level 2 qualification (NZQF Level 2 and 3 respectively), indicating there is a large potential base of people who may benefit by recognition through a technician register;
- All STEM roles command a higher weekly average salary than those employed in non-STEM roles, with technicians generally being paid £106 per week more than the non-STEM average of £420 per week
- Pathways to becoming a technician are considered confusing and ‘*young people are not aware of the tens of thousands of great technician jobs that could be open to them*’.

The studies also observed that within laboratory technicians, one-third hold a Bachelor’s level qualification (NZQF Level 7), 16% a higher qualification, and the remaining half a Level 6 Diploma or lower level qualification. The Foundation’s work followed an earlier 2011 study of the university technician workforce [28]. They found that in mechanical and workshop technician roles there was still a tendency to employ those with advanced trade skills. General support, laboratory, and analytical services technicians tend to have qualifications equivalent to a Level 6 Diploma, but younger entrants to these roles are more likely to be degree-qualified. Teaching technicians and research technicians are likely to hold higher degrees. Changes in skill needs towards mechatronics (for physical and engineering technicians) and towards analytical and data handling skills (for chemical and biological sciences) were signalled. This situation is similar to that of New Zealand. There is also an ageing issue, exacerbated by recruitment difficulties in attracting young people into physical science and engineering technician roles. In biological sciences, those presenting for recruitment are more likely to hold a higher degree, again similar to the New Zealand situation. It was acknowledged that career and skill development is relatively *ad hoc*, and the value of a registration scheme was mooted.

As a response to these concerns, a number of initiatives have been instigated in the UK to promote and professionalise technicians' roles, including, for example, the establishment of the UK Institute of Science and Technology (www.technicians.org.uk) to promote 'vital' STEM technician roles. The UK Institute of Science and Technology promotes and develops *'the science and practice of laboratory science technology'*. This includes a scheme offered in partnership with the Science Council (www.sciencecouncil.org) that provides the opportunity to gain professional registration as a Chartered Scientist, Registered Scientist, or Registered Science Technician (Figure 7-3).

Figure 7-3: Professional registration offered through the UK's Institute of Science and Technology.

CSci Chartered Scientist

Chartered Scientist (CSci):
For staff in senior scientific and leadership roles – candidates will typically be qualified to at least QCF level 7 and applying their knowledge in their roles. CSci status is a well established benchmark across the professions

RSci Registered Scientist

Registered Scientist (RSci):
For staff in scientific and senior technical roles – candidates will typically (but not exclusively) be qualified to at least QCF level 5 and will be applying this knowledge to their roles. It provides recognition in its own right but can also be a springboard to CSci status

RSciTech Registered Science Technician

Registered Science Technician (RSciTech):
For staff in technical roles – candidates will typically (but not exclusively) be qualified to at least QCF level 3 and will be applying this knowledge to their roles. It provides recognition in its own right but can also be a springboard to RSci or CSci status

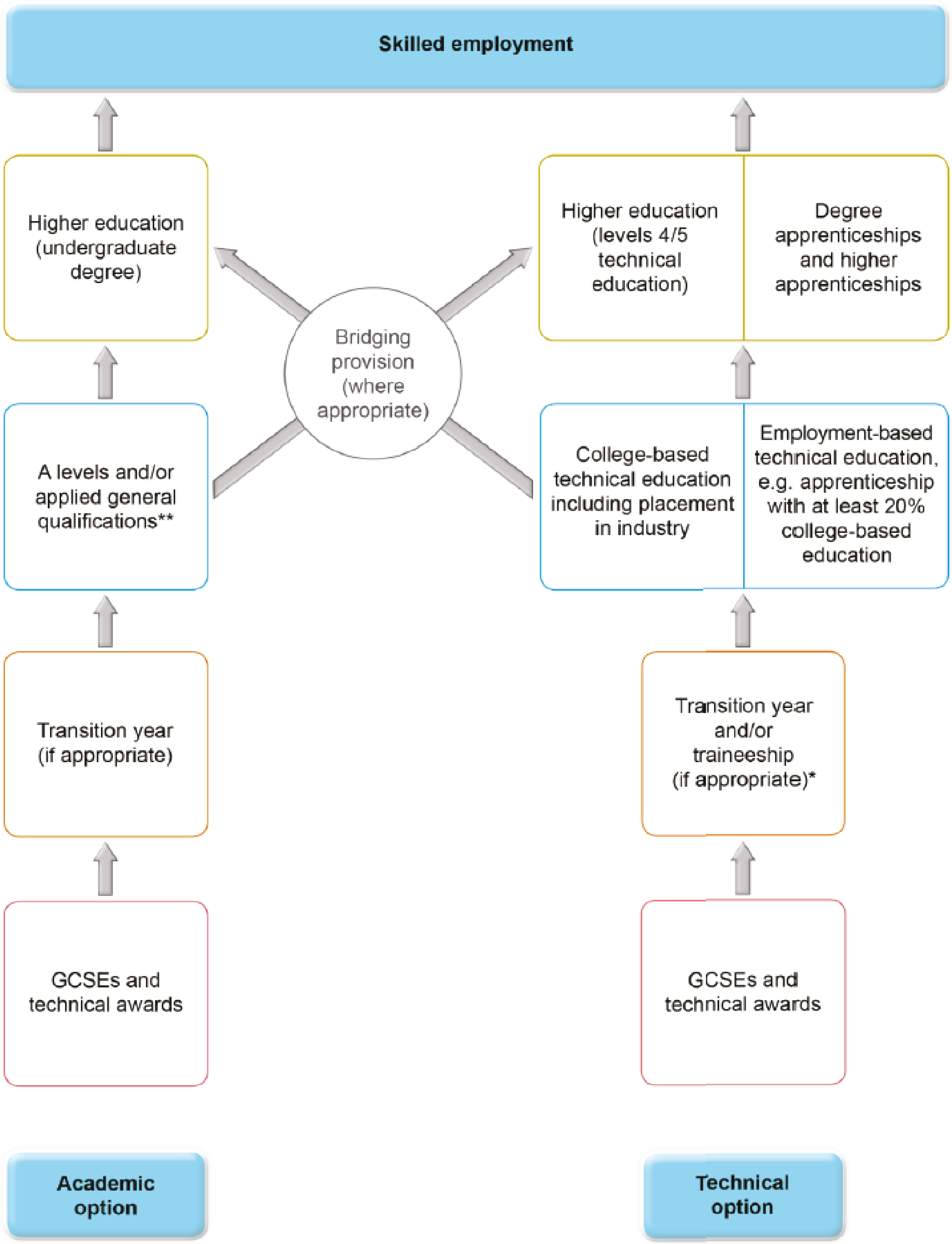
In addition to educational programmes that lead to a qualification, the UK government also supports science technician apprenticeships and websites such as 'www.notgoingtouni.co.uk' to promote apprenticeships offered by industry and other organisations. Many blue-chip companies offer such apprenticeships, such as Pfizer, Biocompatibles, GlaxoSmithKline, etc. A wide range of tertiary providers provide qualifications (e.g. Business and Technology Education Council, Higher National Diploma, etc.) that are available for study as part of these programmes. These examples demonstrate that frameworks can be adopted that: (i) create a professional identity for technicians; (ii) promote the role as a great career option; (iii) provide direct routes into employment; and (iv) are not reliant on a degree as an entry-level qualification. The Panel's view is that something similar could be adopted in New Zealand with appropriate industry support.

7.2.3 The Sainsbury Report and POST- 16 Skills Plan

In late 2015, an independent panel (chaired by David Sainsbury) was set up to advise the UK Government on improving the quality of technical education [29]. The result was the government's Post-16 Skills Plan for qualification reform. Published in 2016, this policy paper describes a framework designed to increase productivity and ensure prosperity and security for individuals by better matching the training of individuals with the needs of business and industry [23]. The plan proposes to deliver a system where all students acquire excellent grounding in core academic subjects to age 16, after which they choose between an academic or technical pathway (Figure 7-4). By implementing appropriate bridging courses where students can move between pathways, the locking of students in to one path at an early age can be avoided. This is compared to the New Zealand situation where many students defer their career choice until sometime during or after their university education.

The academic pathway is already well regarded, and thus the reform mainly focuses on the technical option that includes post-secondary school Colleges of Further Education that provide technical and professional education and training from 'A' level through to postgraduate degrees in specialist areas, and employment-based education. The latter builds on the apprenticeship reforms already in place. It is anticipated that employers will play a crucial role in setting the standards which will be determined by considering what is needed to move to skilled employment and then working backwards [23]. The technical pathway will consist of 15 routes representing grouped occupations that have shared training requirements. Industry training in Colleges of Further Education as industry placement modules, as well as employment-based education through the apprenticeship scheme, are essential components in science technician training in the UK. These are largely lacking in New Zealand and the Panel's view is that this needs to be addressed accordingly. The Panel noted the important role of the employers play in this development, which is currently less prevalent in New Zealand.

Figure 7-4: The UK's proposed academic and technical options which include industry placement



* Where a student does both, the traineeship will follow the transition year. Students doing both the transition year and a traineeship may progress directly to employment.

** Some students will move directly from A levels and/or applied general qualifications to degree and higher apprenticeships.

Sourced from [23].

In April 2017 an independent statutory body, the Institute for Apprenticeships, is scheduled to be launched that will ensure the high quality of apprenticeships in England. Currently the UK Government funds apprenticeships by way of an employer's levy. This levy is required from all employers with an annual salary expenditure of over £3 million. In turn, employers can access the funding to pay for apprentice training. The scheme also assists employers in finding training providers to help develop and deliver the apprenticeship programme [30]. This is a model that New Zealand could consider to facilitate greater ownership and buy-in by employers of science technicians. As well as ensuring relevant work place experience, this would collectively benefit both the student and the employer.

7.2.4 Australian technician workforce

A major study of the STEM workforce was undertaken by Australia's Office of the Chief Scientist, and released in March 2016 [24]. The number of STEM qualified individuals in Australia in 2011 is shown in Table 4.

Table 4: The number of individuals in Australia with post-secondary qualifications

Level of education	Science	IT	Engineering	Mathematics	Agriculture & environmental science
Total Bachelors and above	206,818	160,911	257,384	25,669	53,080
Bachelors level	143,644	107,768	200,356	17,960	38,440
Advanced Diploma & Diploma	20,898	55,745	149,327	784	36,869
Ratio of Diploma to Bachelors	15%	52%	75%	4%	9%

Adapted from [24].

The distribution of qualifications in Australia is consistent with both the New Zealand and United Kingdom data. There is a well-developed technician workforce in ICT and engineering, but not in science. The report did not separately set out the employment of Bachelors' graduates from those with higher degrees so it was not possible to determine whether technician roles were a significant employer of such Bachelors' graduates.

The Technical and Further Education (TAFE) institutes in Australia operate in a similar way to the ITPs in New Zealand by offering a wide range of Certificate, Diploma, and Bachelor degree courses whereby:

- Bachelor degrees, Associate degrees, Graduate Certificates, and Graduate Diplomas provide advanced skills and a higher education qualification;
- Diplomas and Advanced Diplomas offer complex and technical skills to help progress career development;
- Certificates (at their levels) I to IV provide a range of introductory to advanced level skills to help a candidate to become job-ready or prepare for a promotion; and
- Statements of Attainment are part qualifications or short courses that can provide extra skills or preparation for further study.

The Panel considers that these provide a suitable education and training route for science technicians.

7.3 What can we learn from comparison with other New Zealand sectors?

Within New Zealand, other sectors such as engineering and ICT have taken concerted action to establish National (Level 6) qualifications.

7.3.1 The engineering sector and the National Engineering Education Plan

Facing a long-term shortage of qualified engineers and the low number of individuals entering into engineering programmes, in 2007 the Institution of Professional Engineers New Zealand (IPENZ) conducted a study to identify the drivers of the shortage. Following on from this research, the Tertiary Education Commission funded the National Engineering Education Plan (NEEP) to *'develop a coherent national plan for ensuring that the right numbers of the right types of graduates are produced to meet New Zealand's needs'* [31]. The process of development of the plan was a consensus one, involving ministries and Government departments, universities, ITPs, ITOs, Wānanga and industry representatives. The key issues identified, together with appropriate recommendations and desired outcomes relevant to the technician workforce were:

- There is a strong demand for a national, generic, but discipline-based engineering technician qualification (in addition to the specialised qualifications in particular industries);
- The present rates of production of 270 graduates per year need to rise to 500 per year on a business as normal approach and 750 per year on an '*innovation-led economy*' approach;
- There should be a 240 credit (2.0 FTE) theoretical Level 6 Diploma delivered by ITPs, and a 120 credit (1.0 FTE) 'practical' Diploma delivered by ITOs;
- There should be a national governance structure with moderation between delivering providers to ensure a nationally consistent standard (achieved through creation of a New Zealand Board for Engineering Diplomas http://www.nzbed.org.nz/);
- IPENZ would proceed to seek signatory status to the Dublin Accord (gained in 2014) thereby ensuring the NZDE (NZ Diploma of Engineering) was internationally benchmarked.

In practice, several engineering companies chose to reintroduce so-called cadetships whereby students could work and study part-time. In 2016, there are 15 providers delivering into this national framework. It should be noted here that students who were studying under the earlier NZCE and NZCS system were referred to as cadets and held cadetships.

A likely key success factor was that throughout the period after the demise of the NZCE there were considerable shortages of engineering graduates in Levels 6, 7 and 8 [31]. New Zealand was consistently producing engineering graduates at only half the OECD average, yet there was no evidence New Zealand needed fewer such persons. The NEEP report identifies the increasing need for engineers and technicians to support the highly mechanised agricultural sector, growing manufacturing sector and the complex infrastructural needs of New Zealand. There was little evidence of engineering graduates working out of field, which is an effective indicator of overall shortage.

As a follow on from the NEEP project, the Engineering Education-to-Employers E2E programme has been developed to respond to the anticipated shortage of engineers. This is aimed at increasing graduates with the Diploma of Engineering (Level 6) and Bachelor of Engineering (Level 7) qualifications. The action plan includes:

- Promotion - a national marketing and promotion campaign;
- Employer engagement - partnerships which provide opportunities for students to learn and up-skill;
- Educational delivery - ensuring multiple, coherent pathways for learners;
- Operational/policy parameters - developing more sustainable ways of funding engineering provision.

In terms of lessons for the present science technician study, the Panel recognises that science is different to engineering in that there is a substitute workforce (surfeit of Bachelors and higher degree graduates) that could be adapted into the technician role. However, as discussed earlier, there are significant disadvantages from such substitution including:

- Low employee satisfaction with impact on retention in the role;
- Need for extra training compared to Level 6 graduates, which is a cost to employers.

The Panel is of the view that it is in the national interest to have in place educational pathways well suited to maintaining and growing the science technician workforce in the future. The Panel notes the recent findings of the Productivity Commission [10] that the framing of University Entrance (often interpreted as a signal that a student should attempt university study) may be sending the wrong signals to students who might be better studying in Levels 5-7 programmes in ITPs. However, the New Zealand Qualifications Authority is recommending not to change University Entrance [32]. Hence the Panel suggests that an approach for raising the awareness of the career and qualification pathway for science technicians, similar to that of the E2E programme (Section 9.2), would be appropriate and beneficial.

7.3.2 The Information and Communications Technology sector and its Targeted Review of Qualifications process

In Computer Science and Information Systems, degrees (Level 7 and above) had existed in universities from the 1980s or even earlier (often delivered as majors or components in more generically titled degrees). These degree courses gradually evolved into specialised Bachelor and higher degrees in information and computer science in many instances. There has since been the further development and offering of degrees in software engineering and related areas. The ITP sector also commenced offering Level 7 degrees in Information and Communication Technology (ICT) over the last two decades. The Institute of IT Professionals has achieved provisional status (a stepping-stone to signatory status) in the Seoul Accord, which benchmarks Level 7 ICT qualifications. There is no equivalent Accord yet for ICT Level 6 qualifications. Specialised ICT qualifications for technicians before about 2000 were often developed by commercial suppliers to support their own soft/hardware. Throughout the 2000s a range of qualifications at different levels up to Level 6 were created piecemeal by ITPs and ITOs. The Electro Technology Industry Training Organisation had attempted to ensure a national framework, but this had not been successful.

The Institute of IT Professionals worked with the New Zealand Qualifications Authority in the TRoQ review in the period 2013-2015. The Institute of IT Professionals was able to bring to the table key players so that outcomes could best meet overall national needs. The partnership meant that, as was the case in engineering, the solution would be likely to have longevity.

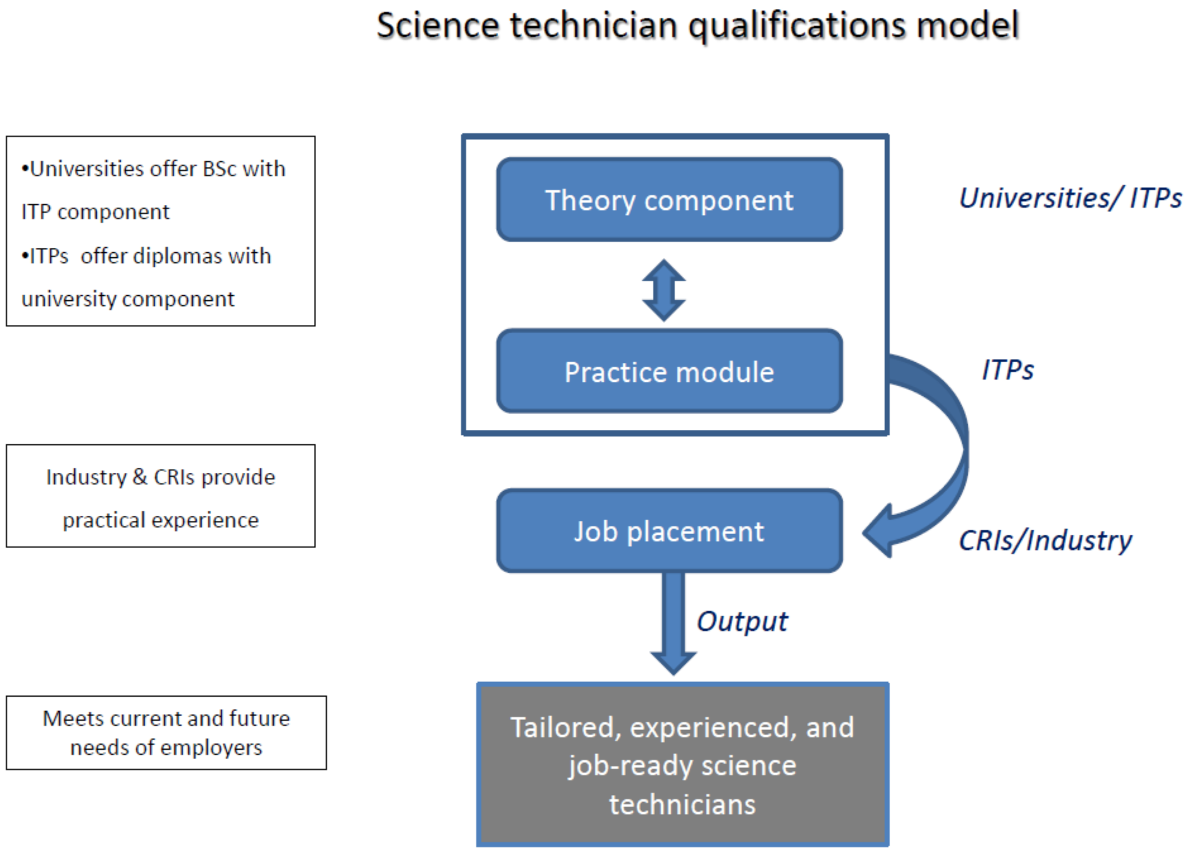
Outcomes of the TRoQ process concerning the ICT sector are Level 6 Diplomas placed on three broad pathways: information technology/IT support, information systems, and software development. The continuation of a national steering group with a composition that parallels that of the New Zealand Board for Engineering Diplomas is envisaged.

8 Conceptual career and qualification models

The science technician career model, developed by the Panel and tested by consultation with relevant stakeholders, was introduced earlier in Figure 6-1. This model correlates the level of achievement, according to the greater depth of knowledge (vertical axis component) gained by the student within the NZQF level structure, with the type of science technician role a graduate could expect to enter a science technician career at. The horizontal axis component illustrates possible career development pathways and progressions for different NZQF entry-level qualifications. It shows how a science technician can progress to a career pathway that requires a higher level of knowledge and demonstrated achievement by successfully embarking and completing higher degree qualifications. It also identifies the potential for underutilisation of skills and experience and the possible mismatch of the qualification and training for the particular role. Overall, the model provides a flexible and versatile system for qualifications, employment pathways and career opportunities for science technicians.

In addressing the question of a national qualification structure for science technician education that would support the career model, the Panel developed the model shown diagrammatically in Figure 8-1 to supplement that in Figure 6-1. This model recognises that the Bachelor’s degree qualification is now a frequently used pathway for entry into a science technician career, but equally recognises that this degree often fails to develop the technical aptitude and transferable practical skills required for a science technician role. In the model, entry via a diploma qualification is a preferred pathway.

Figure 8-1: The Royal Society Te Apārangi science technician education pathway model in support of the proposed career model in Figure 6.1.



9 Findings

9.1 Panel conclusions and observations

The Panel makes the following observations and reached the following conclusions:

- The science technician workforce is an important component of New Zealand's innovation capability, yet it has suffered from unintended neglect in the last two decades.
- The actual size of the workforce performing science technician work appears to be significantly larger than the Census data (3771 individuals) indicate, with many people in such roles holding different job titles, and others performing their own technician work as a part of their role (e.g. postgraduate students working on their research programmes in the natural or physical sciences).
- New Zealand can expect to have a science technician workforce of significant size, but undertaking increasingly diverse roles within the foreseeable future. This workforce includes:
    - Research and specialised instrument technicians in universities, CRIs, and other research organisations and, to a smaller extent, in industry;
    - Technicians supporting the introduction of new leading edge technologies;
    - Measurement, quality control and assurance, and analytical technicians (in a laboratory environment, particularly in service provider organisations);
    - Field technicians (setting up and operating field equipment, and collecting field data);
    - Education technicians (includes schools and tertiary teaching laboratories); and
    - Niche role technicians (those specific to a very narrow specialist role e.g. hydrology).
- Up until about 1997, the NZCS was the dominant qualification for science technicians. This ended in the early 2000s and now the Bachelor of Science is the most frequently held qualification of entrants to technician roles, with some technicians holding Masters and PhD degree level qualifications. These qualifications are generally gained before employment and often do not develop the essential technical aptitude and transferable practical skills. There are some NZCS graduates still in the workforce today, along with a few technicians who are not formally educated but have learnt on the job. Their numbers are now diminishing through retirement.
- The science technician workforce is united by the need for all technicians to have technical aptitude and competence in transferable laboratory practice skills together with skills in computation, written and oral communication, a knowledge of risks and their management, and health and safety procedures.
- There is wide agreement amongst employers that present entrants (primarily degree holders) are generally lacking sufficient technical aptitude and transferable laboratory practice skills except in specific cases where highly customised qualifications have been developed. Consequently, employers have responded by greatly extending their on-the-job training beyond industry-specific requirements. People with relevant practical skills are preferentially employed when they are available.
- A significant number of recent entrants to the technician workforce, particularly those in roles not related to research, unfortunately do not see it as a worthy career, but have accepted a

role below their qualification level in the hope of using it as a stepping-stone, resulting in over-education and qualification mismatch.

- Except for the more specialised research technician role, there is little evidence that science is different to engineering and ICT in needing technicians educated above Level 6 on the New Zealand Qualifications Framework for many role types. Whereas these other two fields still have viable sub-degree systems of education and training in place, for science, these systems have been significantly eroded.
- The essential core elements of education for a competent science technician that will better meet the future needs of the New Zealand economy are:
  - Transferable laboratory practice skills (including topics such as risk and hazard analysis, health and safety, hygiene and cleanliness, quality assurance, measurement, calibration and standardisation, regulatory systems, facility management, and inventory management);
  - Data collection, computation, processing, and management systems;
  - Basic elements of experimental design for ensuring repeatability and reliability of measured data;
  - Identification and implementation of suitable measurement systems (i.e. more than following a recipe), including aspects such as method and equipment selection;
  - Oral and written communication skills;
  - Unsupervised operational laboratory practice – developed via monitored practical experience in a working laboratory, rather than as a student in a teaching laboratory.
- The Level 6 Diploma programmes offered by a small number of ITPs for educating science technicians are demonstrably fit-for-purpose for many technician roles. Monitored practical work in industry is key to the success of these programmes and can currently be offered by ITPs with much greater ease than by a university. In the ITPs, smart arrangements that link the technician programme with one or more science-informed vocational programmes, appeared to be financially viable. This method seems a better approach than linking the technician programme with the engineering or ICT technician education system. The partner laboratory component offered by one PTE is also appropriate.
- Compared to the apparent demand by industry, the ITP qualifications for science technicians are not strongly sought after by school leavers and hence these qualifications suffer from low student numbers and are available in limited locations. In addition, because of the scarcity of graduates, employers are often unaware of such programmes or how to access their graduates.
- Research technicians may be suitably prepared through an appropriately modified Bachelor of Science programme.
- There would be a distinct benefit for both the Bachelor of Science graduates themselves, and for New Zealand's industrial and research communities, if all science education in the experimental natural and physical sciences at Level 7 were to include the core competences set out above.
- Some universities are concerned that erosion of practical skills in their programmes has occurred and that employers are reporting a lack of technical aptitude and practical skills in

Bachelor of Science graduates. These universities have shown a willingness to rethink their graduate profile for the Bachelor of Science degree.

9.2 Suggested pathway forward

The Panel considers the following delivery options to best meet New Zealand's future needs in the education and training of science technicians:

- A national network of provision in the ITP sector of a Level 6 science technician programme that includes formally monitored and assessed practical experience in a working laboratory. The network should be supported by clear information available through the careers advice system comparable to that of the E2E (Engineering Education-to-Employment) programme (delivered through the Tertiary Education Commission to support ITP engineering qualifications). Without this central support, it is unlikely that this qualification would attract sufficient students, both to be viable and to meet the demand for science technicians in industry. Further, it would create a more visible career option, provide direct routes to employment and a professional identity for science technicians:
    - This network of provision should also co-offer a standalone 60 credit Graduate Certificate in Laboratory Practice or similar (e.g. this could be the existing 60-credit Level 6 New Zealand Certificate in Laboratory Management Systems) which a science technician already in employment could take to upgrade his/her practical skills. This Graduate Certificate would need to be flexible in its delivery (e.g. block courses).
    - Also co-offered by the network of provision should be block courses (e.g. one week) without formal assessment – employers could opt to send their new technicians on the next available block course.
    - PTEs may also be able to contribute alongside ITPs.
- In a similar manner, for students wishing to pursue a Bachelor's degree with a science technician role as a possible career option, the Panel recommends that in the national interest, the Universities adopt a consistent approach to offering additional laboratory practice courses appropriate to science technician education and employment requirements in their Level 7 Bachelor of Science degree programmes. These could include:
    - The inclusion of a core (compulsory) paper of 15 credits (points) on the basics of laboratory practice. Taking a wider view, the Panel also saw this as a useful requirement for all natural and physical science majors to include in their undergraduate science degree programme. This approach could also be taken up by ITPs in their Level 6 Diploma programmes.
    - The creation of an optional 'minor' in laboratory practice in the particular science discipline e.g. 40-60 credits (points) which students could include in their science degree, would similarly be very useful. This should include the development and assessment of a portfolio of evidence showing the practical proficiencies developed during the degree programme and through relevant work experience that could be undertaken in vacation periods.
- The Panel considers that it is reasonable that universities and ITPs offering science degrees all voluntarily agree to implement the above core paper and optional minor within their Bachelor

of Science programmes so employers can expect consistency in this respect. This would partly address the widespread concern employers have that students with Bachelor degrees who are presenting themselves for a science technician career, do not possess sufficient technical aptitude and the transferable practical skills required for the role. It would also lessen the extent of job training that is often required and hence the employee would be more valuable to the employing organisation at the outset. The employer would once again focus on more highly specific training needed for the particular science technician role.

- A core element of the offerings proposed for the ITP sector is monitored practical work to develop the competence for undertaking laboratory practice without supervision – students could work as interns in an industrial, service or research laboratory, or this could be part of their formal employment.
- To establish a culture of providing practical experience in working laboratories, the Panel suggests that Crown Research Institutes and Callaghan Innovation take the lead with the goal of building a collaborative approach with large service laboratory companies as a second stage. A goal would be to demonstrate to industry that supporting practical work is a better option for employers than needing to provide extensive in-house training to overcome the mismatch of the skills of new employees to their role.
- Students (and their key influencers such as parents and career advisors at secondary schools) studying science should be made aware that technician roles are a major employment pathway for Bachelor of Science graduates, so they should set their employment horizons appropriately – the career models need to be widely promulgated, accepted and understood. Careers New Zealand needs to take the lead, but all universities and ITPs need to acknowledge that a Bachelor of Science degree has a potential outcome of science technician employment in all their promotional literature and campaigns.
- Consideration should be given to include more specific assessment of the qualifications and skills of the science technician workforce in the accreditation system for laboratories (by IANZ), as well as the particular processes and procedures being carried out. This would make it explicit that having appropriately skilled technicians is a vital part of the requirements for retaining such accreditation, and hence enhance the promotion and career opportunities for science technicians. At the same time, it is recognised that a registration system for technicians, as is used in the United Kingdom, is unlikely to prove cost effective in a small nation like New Zealand.

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Appendix A

The report was produced by a Royal Society Te Apārangi Expert Panel, with support and advice from an Expert Reference Group. The work of the Panel has been informed by consultation with Chief Executives of the Crown Research Institutes, Independent Research Associations of New Zealand, and Institutes of Technology and Polytechnics, as well as with key individuals and organisations from industry, government, and the tertiary education sector. It has also undergone international peer review.

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Staff from the Ministry of Business Innovation and Employment, Ministry of Education, Ministry of Health, New Zealand Qualifications Authority and the Tertiary Education Commission were also consulted in developing this report.

Appendix B

Summary of NZQF qualification definitions and level descriptors

Table 5: Summary of NZQF qualification definitions.

	Certificate 1	Certificate 2	Certificate 3	Certificate 4	Certificate 5	Diploma 5	Certificate 6	Diploma 6
Purpose	To qualify individuals with basic knowledge and skills for work, further learning and/ or community involvement	To qualify individuals with introductory knowledge and skills for a field(s)/areas of work or study	To qualify individuals with knowledge and skills for a specific role(s) within fields/ areas of work and/ or preparation for further study	To qualify individuals to work or study in broad or specialised field(s) / areas	To qualify individuals with theoretical and/or technical knowledge and skills within an aspect(s) of a specific field of work or study	To qualify individuals with theoretical and/or technical knowledge and skills within a specific field of work or study	To qualify individuals with theoretical and/or technical knowledge and skills within an aspect(s) of a specialised / strategic context	To qualify individuals with theoretical and/or technical knowledge and skills in specialised / strategic contexts
Credits	A minimum of 40 credits at level 1 or above	A minimum of 40 credits at level 2 or above	A minimum of 40 credits at level 3 or above	A minimum of 40 credits at level 4 or above	A minimum of 40 credits at level 5 or above	A minimum of 120 credits from level 4 or above, including at least 72 credits at level 5 or above	A minimum of 40 credits at level 6 or above	A minimum of 120 credits from level 5 or above, including at least 72 credits at level 6 or above

	Diploma 7	Bachelor's Degree 7	Graduate Certificate 7	Graduate Diploma 7	Bachelor Honours 8	Postgraduate Certificate 8	Postgraduate Diploma 8	Master's Degree 9	Doctoral/ Degree 10
Purpose	To qualify individuals with specialised and technical knowledge and skills within a professional context	To provide individuals with a systematic and coherent introduction to a body of knowledge of a recognised major subject (or subjects, in the case of a double degree or a double major) as well as to problem-solving and associated basic techniques of self-directed work and learning	To act primarily as a vehicle for degree graduates to pursue further study at an advanced undergraduate level	To act as a vehicle for degree graduates to pursue a significant body of study at an advanced undergraduate level	To recognise distinguished study at level 8	To extend and deepen an individual's knowledge and skills	To extend and deepen an individual's knowledge and skills by building on attainment in the principal subject(s) of the qualifying degree	To qualify individuals who apply an advanced body of knowledge in a range of contexts for research, a pathway for further learning, professional practice and/or scholarship	To become an increasingly independent scholar who makes a substantial and original contribution to knowledge
Credits	A minimum of 120 credits from level 5 or above, including at least 72 credits at level 7 or above	A minimum of 360 credits from levels 5 to 7, including at least 72 credits at level 7	A minimum of 60 credits, including at least 40 credits at level 7 or above	A minimum of 120 credits, including at least 72 credits at level 7 or above	A minimum of 120 credits at level 8, with a research component that represents at least 30 credits at that level	A minimum of 60 credits at level 8	A minimum of 120 credits from levels 7 and above, including at least 72 credits at level 8	A Master's Degree by thesis is includes 120 credits, of which at least 90 credits (at level 9) consist of a research project. A Master's Degree by coursework and thesis includes 240 credits, of which at least 90 credits at level 9 are in the form of a thesis, dissertation, substantial research paper or scholarly creative work, and of which up to 150 credits are from coursework. A Master's Degree by coursework is at least 120 to 240 credits. The Masters Degree must comprise a minimum of 40 credits at level 9 with the remainder at level 8	At least 360 credits

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Table 6: NZQF level descriptors.

Dimension	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10
Knowledge	Basic general and/or foundation knowledge	Basic factual and/ or operational knowledge of a field of work or study	Some operational and theoretical knowledge in a field of work or study	Broad operational and theoretical knowledge in a field of work or study	Broad operational or technical and theoretical knowledge within a specific field of work or study	Specialised technical or theoretical knowledge with depth in a field of work or study	Specialised technical or theoretical knowledge with depth in one or more fields of work or study	Advanced technical and/or theoretical knowledge in a discipline or practice, involving a critical understanding of the underpinning key principles	Highly specialised knowledge, some of which is at the forefront of knowledge, and a critical awareness of issues in a field of study or practice	Knowledge at the most advanced frontier of a field of study or professional practice
Skills	Apply basic solutions to simple problems	Apply known solutions to familiar problems	Select and apply from a range of known solutions to familiar problems	Select and apply solutions to familiar and sometimes unfamiliar problems	Select and apply a range of solutions to familiar and sometimes unfamiliar problems	Analyse and generate solutions to familiar and unfamiliar problems	Analyse, generate solutions to unfamiliar and sometimes complex problems	Analyse, generate solutions to complex and sometimes unpredictable problems	Develop and apply new skills and techniques to existing or emerging problems	Critical reflection on existing knowledge or practice and the creation of new knowledge
	Apply basic skills required to carry out simple tasks	Apply standard processes relevant to the field of work or study	Apply a range of standard processes relevant to the field of work or study	Select and apply a range of standard and non-standard processes relevant to the field of work or study	Select and apply a range of standard and non-standard processes relevant to the field of work or study	Select and apply a range of standard and non-standard processes relevant to the field of work or study	Select, adapt and apply a range of processes relevant to the field of work or study	Evaluate and apply a range of processes relevant to the field of work or study	Mastery of the field of study or practice to an advanced level	
Application [of knowledge and skills]	Highly structured contexts	General supervision	Limited supervision	Self-management of learning and performance under broad guidance	Complete self-management of learning and performance within defined contexts	Complete self-management of learning and performance within dynamic contexts	Advanced generic skills and/or specialist knowledge and skills in a professional context or field of study	Developing identification with a profession and/ or discipline through application of advanced generic skills and/or specialist knowledge and skills	Independent application of highly specialised knowledge and skills within a discipline or professional practice	Sustained commitment to the professional integrity and to the development of new ideas or practices at the forefront of discipline or professional practice
	Requiring some responsibility for own learning	Requiring some responsibility for own learning and performance	Requiring major responsibility for own learning and performance	Some responsibility for performance of others	Some responsibility for the management of learning and performance of others	Responsibility for leadership within dynamic contexts		Some responsibility for integrity of profession or discipline	Some responsibility for leadership within the profession or discipline	
	Interacting with others	Collaborating with others	Adapting own behaviour when interacting with others							
			Contributing to group performance							

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