The IT Apprentice: An IT Degree Apprenticeship

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Abstract

This paper documents the results from phase one of an exploratory, descriptive study that builds on research first conducted in 2010, proposing the concept of an apprenticeship-based IT degree. It presents the results of a literature review into the approaches that have been taken by other countries with similar digital school curriculums to New Zealand (UK and Australia). The review also looks comparatively at the New Zealand context and initiatives to improve the quality of IT education and number of students engaging in it. The discussion outlines the changes in the external environment that has made the concept, first proposed in 2010, now a viable, and industry supported option. Further details on the UK degree apprenticeship standard in Digital and Technology Solutions are provided. The paper then proposes a model of NZ IT apprenticeship, based on the UK model, to IT academics within the NZ Polytechnic sector for discussion and refinement.

1 Introduction

This paper proposes a model of IT degree apprenticeship that has been developed based on a review of what has been implemented in the UK. The literature review was conducted to answer the following research questions:

- What models of Cadetship/Apprenticeship are in use in other countries with similar digital school curriculums to New Zealand (Australia, UK)?
- What entry criteria do students wishing to enter these programmes need?
- What will school leavers, and mature students, need to have as entry criteria if they have not taken Digital Technology curriculum while at High School?
- What has changed in the context of the NZ environment that makes an IT degree apprenticeship favourable?

2 Background

Since reforms, brought about by the Education Act 1989, allowed New Zealand Institutes of Technology and Polytechnics (ITPs) to confer degrees they have strived to deliver highly vocational Information Technology (IT) degrees that provide work ready graduates with the technical skills required by the IT industry (Clear, 2000; Tertiary Education Commission, 2018a). The vocational approach taken within polytechnics' IT degrees is seen as a point of difference to the Computer Science degrees on offer in the University sector (Clear, 2000; Vaughan & New Zealand Council for Educational Research, 2012). Vaughan and NZCER state "ITP courses are explicitly "vocational" in nature and aim to respond to labour market demand" (2012).

As a result, work-integrated learning (WIL) has always been a feature of the IT degrees offered by most ITPs through the inclusion of a final year, final semester, industry project often referred to as the 'Capstone' project (Bridgeman, 2008; Cleland et al., 2010; McLay & Skelton, 2007; Snell & Snell-Siddle, 2017). The importance and benefits of WIL in IT tertiary education has been well documented both here and abroad (Johns-Boast & Patch, 2010; Koppi et al., 2010; Lloyd & Chard, 2013). There has also been robust discussion around the value of the capstone projects, which may involve limited exposure to a client for whom the work is being completed, or alternatively consist of semester long internships where the student is onsite with the sponsor. The internship option leads to more interaction with IT professionals and building of networks which prove invaluable to not only the student staying engaged during the internship but also to the new graduate when looking for work (McLay & Skelton, 2007; Steele et al., 2013; Steele & Cleland, 2015).

In 2010, a concept paper was presented that proposed an apprenticeship-based ICT degree built around an existing bachelor's qualification but with additional WIL elements (Cleland et al., 2010). The proposed structure shared the same first year as the existing ICT degree, with significant industry placement components embedded into years two and three of the degree. The concept was then presented to a sample of IT employers (Steele et al., 2012), and IT students (Cleland et al., 2011), to gain their perceptions on this mode of learning. At the time, the sampled employers were hesitant; they were mostly looking to hire experienced workers and were concerned about the drain on their current employee's time to mentor an inexperienced apprentice (Steele et al., 2012). Reaction to the idea from the IT students was mixed. Those that were the high academic achievers were concerned about missing out on the diversity of learning provided in the degree courses they would progress through if some of those courses were replaced with work experience components; those who were less capable academically were very interested in the concept (Cleland et al., 2011). However, IT employers had made it clear they would only be interested in taking those with high grades as apprentices; this was due to the perception these students would be more capable and motivated and therefore require less mentoring from the employer (Steele et al., 2012). The hesitancy of the employers coupled with resource limitations for the researchers led to the decision to not pursue the concept any further.

In 2017, two of the researchers revived the idea of an IT cadetship, as a tool that could help combat the national IT labour shortage (Snell & Snell-Siddle, 2017). Though the paper was well received, at the time the national focus and funding was directed at the ICT Graduate School initiative, so no traction into the idea was gained.

3 Apprenticeship and/or Cadetship models in UK and Australia

To assist with creating an appropriate model of a NZ IT degree apprenticeship it is useful to investigate what is being done elsewhere. The countries with the education systems that align most closely to New Zealand are going to provide the most useful data. The UK and Australia were chosen as they have similar education systems and they are two of the few countries which, like New Zealand,

have mandatory computer science education built into their primary and secondary schooling curricula (Fowler, 2020).

3.1 Australia

Australia has implemented a cadetship approach to combating their IT skills shortage and growing their digital talent. Cadetships have been available for many years in Australia, with companies often providing the service of linking students to employers and placing them in a cadet role (ACS Foundation, 2022). Most existing cadetships in Australia are targeted at graduates, though there are some that recruit students currently studying in degree programmes that have completed the first or second year of study. There are varying levels of participation in cadetships both by state and sector (Dawkins et al., 2020).

Currently, higher apprenticeships are being offered which "enable individuals to undertake a recognised vocational education and training qualification at Diploma or Advanced Diploma level" (Higher Apprenticeships - AAPathways, n.d.). The researchers found no evidence of these Higher Apprenticeships extending to degree level qualifications.

In response to an alarming increase in youth unemployment bought on by the arrival of the coronavirus pandemic and its subsequent lockdowns, along with the likelihood that a recession would follow that would further increase the number of youths not in employment, education, or training (NEET) Dawkins et al (2020) proposed a national job cadet program. The program proposes two streams: Stream 1 expands the current apprenticeship and training systems into new areas, including Information Technology at a possible degree level; Stream 2 focuses on supporting employers to hire employees who have qualifications or work experience already into semi-skilled and skilled jobs, but who would not be hired without a financial incentive or additional training (e.g., micro-credential course) (Dawkins et al., 2020). The researchers found no evidence of this moving beyond the proposal stage at time of writing.

3.2 UK

Between 2010 – 2015 the UK government introduced a series of reforms to improve the quality and number of apprenticeships being undertaken (Mirza-Davies, 2015). In 2012, a review commissioned by the UK government to critically investigate the apprenticeship system was conducted by independent business figure Doug Richard. The Richard Review (Richard, 2012) included the following key recommendations:

- Employers will design the standards that apprenticeships are based on
- Increase the quality of apprenticeships: Rigorous and wholistic assessment will allow apprentices to demonstrate their competence, especially at the end of an apprenticeship to ensure the learner is ready to progress.
- Simplify the system: The employer-designed standards will describe skills, knowledge and behaviour that would make an individual fully competent in their role. They should be concise and easy to understand.
- Government should help ensure quality delivery by making some off-site learning and a minimum duration for apprenticeships mandatory.

During this period the UK government allocated funding to creating higher, or degree, apprenticeships. Degree apprenticeships were introduced through 'Apprenticeship Trailblazers'; the first phase of Trailblazers consisted of eight employer networks in 2013 that published the first sets of apprenticeship standards in 2014 (Department for Business, Innovation and Skills, 2015). Entry into

most Level 6 IT degree apprenticeships requires three 'A' levels (equivalent to NCEA Level 3 in New Zealand), or pathway in from a lower-level British Computer Society IT diploma.

A Digital apprenticeship standard is developed by a Trailblazer group (employers) and comprises a list of core skills, core technical knowledge, and core behavioural skills expected of an IT professional; the standard then describes the specialist skills and specialist technical knowledge required for a particular role (e.g., Software Engineer) (Institute for Apprenticeships and Technical Education, 2022b).

There have been extensive resources created to support the Trailblazer groups with creation of the standards and the end point assessment plan (HM Government, 2015). Whilst employers are keenly aware of the skills required by their employees to be effective in the workplace, they are not academics with experience in authoring of criteria for assessment. Therefore, as part of the process, trailblazers are encouraged to consult with training providers and possible end point assessors during the development of the new occupational standard and the corresponding assessment plan (Institute for Apprenticeships and Technical Education, 2020)

In 2017, The Institute for Apprenticeships and Technical Education was established to evaluate and coordinate the apprenticeship standards created by employer trailblazer groups; funding for the institute is provided by the Department of Education (Institute for Apprenticeships and Technical Education, 2022d).

Also in 2017, an apprenticeship levy of 0.5% was introduced for companies with a payroll over £3M; the companies recoup their paid levies when they are used to cover an apprentices' tuition costs (Office for Students, 2018). Smaller organisations who do not pay the levy, cover 5% of the apprentice's tuition with the government paying the remainder (HM Government, 2022a). In a report commissioned by the Higher Education Funding Council for England, the authors stated the introduction of the levy was "a key driver in accelerating the development and offering of apprenticeships" (Association of Graduate Recruiters, 2017). It is the employer's choice as to the educational partner for the apprenticeship, with evidence that local provision is often preferred (Association of Graduate Recruiters, 2017).

There are currently five Digital apprenticeship standards at Level 6 on the UK Higher Education Qualifications Framework (Bachelor's equivalent) and three at Level 7 (Master's equivalent) (Institute for Apprenticeships and Technical Education, 2022b).

Apprenticeships are lauded by the government as a way employers can effectively grow talent and expand their workforce with training that can be adapted to individual business needs (HM Government, n.d.).

Surveying of employers showed high satisfaction with apprenticeships:

> "86% of employers said apprenticeships helped them develop skills relevant to their organisation
> 78% of employers said apprenticeships helped them improve productivity
> 74% of employers said apprenticeships helped them improve the quality of their product or service" (HM Government, n.d.)

In the 2021/2022 academic year, the UK had 288,800 apprenticeship starts with Degree level apprenticeships making up 13.1% (37,800) of those; this was a 10.3% increase on the previous year (HM Government, 2022c).

3.3 The New Zealand Context

Investigations into the New Zealand context were undertaken to identify changes that have taken place since the initial research (2010-12) that are likely to influence stakeholders' views of an IT apprenticeship degree, whether positive or negative

3.3.1. NZQA review of ICT qualifications

In 2013, the New Zealand Qualifications Authority (NZQA) began a review of sub-degree ICT qualifications (up to Level 6) (NZQA, 2013b). The steering group for the review included representation from: the polytechnic sector, Te Wānanga, private training establishments, and industry. The steering group was jointly chaired by NZQA and IT Professionals NZ (ITPNZ) (NZQA, 2013a). The aim of the review was to rationalise and nationalise the suite of IT qualifications available. The review, which included significant consultation with all parties, led to the listing of eleven "IT as a Profession" qualifications from Levels 4 -6, covering the job roles of: Computing technician, Helpdesk and Technical support, Network Administrator, Systems Administrator, Implementation and Application Support and Software Development (NZQA, 2013a). In 2018, two additional Level 6 diplomas were added: Cyber security and Software Testing (NZQA, 2022). These qualifications were reviewed again in 2019 resulting in the merger of two diplomas (Networking and System Administration became Infrastructure), the retiring of a Database Administration diploma, and updates to learning outcomes on the qualifications to keep abreast with current industry practice (NZQA, 2022).

The importance of these reviews to this research is twofold; firstly, industry has been involved in the creation and updating of these qualifications ensuring they are meeting the needs of employers; secondly, during development the qualification outcomes and skills were examined against the Skills Framework for the Information Age (SFIA) and NZ Qualification Framework (NZQF) levels were mapped to SFIA levels (NZQA, 2013a). "SFIA has become the globally accepted common language for the skills and competencies for the digital world" (SFIA, 2022, para. 1). This gives the researchers confidence that an initial degree apprenticeship model proposed by the academic sector will be based on Industry requirements if it takes into consideration the current suite of IT qualification's graduate outcomes

3.3.2. ICT Graduate Schools Fund

The ICT Graduate School was a 2014 initiative targeted at increasing participation in higher-level IT education for graduates from other disciplines (Tertiary Education Commission, 2018b). Funding of $28.6m was provided over four years for development and running of three regional ICT graduate schools in Auckland, Wellington, and Christchurch; though the graduate schools were successfully setup, they failed to deliver the number of graduates that were projected (Tertiary Education Commission, 2018b). The funding has now ceased for the graduate schools and the collaboration between providers to deliver the programmes offered has come to an end in Christchurch and Wellington. Victoria University in Wellington has rebranded the ICT graduate schools to 'Industry Alliance Programme'(Victoria University of Wellington, 2022). The collaboration between Waikato University and Auckland University is still operating as the Auckland ICT Graduate School (University of Auckland, 2022).

3.3.3. TEC research into degree apprenticeships

In 2015, TEC commissioned research into the viability of apprenticeship models to educate degree level engineers (Goodyer & Frater, 2015). In 2016, this was followed by a report into the first year of delivery of the BSc(Hons) Digital and Technology Solutions degree apprenticeship at the Manchester Metropolitan University(MMU); MMU saw an intake of 60 apprentices from 11 employers for the inaugural delivery in the 2015/2016 academic year (Goodyer, 2016). Points of interest from the review were:

- MMU commented that an apprenticeship standard created with minimal educational input (not in the digital technology area) was confusing for stakeholders as the standard could be met by

studying several qualifications at different levels. This highlights the importance of educational input into the creation of standards led by employer groups.

- Additional resource is required by the educational providers to allow them to effectively recruit both students and employers for their degree apprenticeships.
- Building relationships with schools is critical in the initial stages when degree apprenticeships are still likely to be perceived as "below the standard of a full-time degree" - a problem particularly in high decile schools.
- Degree apprentices were generally performing better academically than full-time students, this is believed to be partly due to wanting to prove to their employers they are worth the investment.
- Employers must be able to provide a mentor for the apprentice, some small companies are keen to use apprentices to fill gaps in their workforce with a cheaper employee, with no mentor available these companies are declined (Goodyer, 2016).

The recommendation from this report was to pilot a degree apprenticeship in an Engineering discipline that was suffering a skills shortage. Infrastructure Asset Management was selected as the area and the first phase of the project saw the development of a Degree Apprenticeship Standard in Infrastructure Asset Management (Goodyer et al., 2017). Otago Polytechnic now offer this qualification as the Bachelor of Engineering Technology – Infrastructure Asset Management Apprenticeship, with the pilot intake beginning in 2018 (New Zealand Ministry of Education, 2018).

3.3.4. Industry call for degree apprenticeships

The 2021 Digital Skills Report (New Zealand Digital Skills Forum, 2021) and the Digital Tech Skills and Talent Plan (IT Professionals NZ & NZTech, 2021) both highlight the need for IT apprenticeships. This shows that industry perceptions of the apprenticeship model have changed significantly as the IT labour shortage and lack of migrant workers during covid lockdowns to fill these positions has directed employers' focus to growing domestic talent

4 The UK IT degree apprenticeship model

This section will provide more detail on the UK model of IT degree apprenticeship which will be used as a basis for the suggested NZ model that follows in section 5.

4.1 Mandated conditions of apprenticeships

The UK government has mandated some conditions of apprenticeships to help ensure that the experience is beneficial for not only the apprentice but also the employer.

4.1.1. On and off the job training

Apprentices are guaranteed to receive both on-the-job and off-the-job training. Employers must agree to provide training and supervision in the workplace in a job role that allows the apprentice to meet the apprenticeship standard for the duration of the apprenticeship (HM Government, 2022b). The mentoring that occurs on-the-job allows the apprentice to learn the processes, procedures, and tools specific to the employer's business and helps build their soft skills and confidence.

Off-the-job training must comprise 20% of an apprentice's working hours. The training should be designed to cover knowledge, skills and behaviours required by the apprenticeship standard; the

delivery can be flexible (online, at the training provider, in the workplace) and the frequency of training can vary (e.g., one day a week, block course, two afternoons) but should equate to one working day per week for a standard work week (HM Government, 2022b). The flexibility and training approaches required by an employer influence their choice of provider; providers must negotiate the training delivery and content with the employer before signing of an agreement (HM Government, 2022b).

4.1.2. Working hours and pay

An employer must provide enough paid hours of work per week that the apprentice has sufficient on-the-job training time to achieve the apprenticeship; a minimum of thirty hours a week is prescribed which is inclusive of the 20% off-the-job training (HM Government, 2022b). The apprentice must be paid the minimum wage for an apprentice if under 19 or in the first year of their apprenticeship (the apprenticeship rate is equivalent to a 'youth' rate); once they have completed the first year of their apprenticeship, they are entitled to come off this rate and get paid the minimum wage for their age (HM Government, 2022b). Interestingly, MMU had a bad experience with an employer who was paying only the minimum wage to their apprentice, and they now refuse to engage with employers who are not paying at least double the minimum stating that larger employers are paying their degree apprentices three to four times the minimum wage (J. Goodyer, 2016).

4.2 Digital apprenticeship Standard

An apprenticeship occupational standard is made up of knowledge, skills, and behaviour that an employee should be competent in for the role it is describing. The standard must: be short, concise, and clear; be based on a clear occupational profile that lists an employee's duties and the knowledge, skills and behaviours required to perform them; fully define the competence of an occupation, allowing those that qualify with it to perform the role in any size of organisation; align with any regulatory requirements and professional recognition criteria (Institute for Apprenticeships and Technical Education, 2021).

The Institute for Apprentices and Technical Education have two professional occupational areas at degree level listed on the Digital Business Services Pathway: Business Information Professional, which has a Data Scientist Level 6 degree; and Digital Solutions Professional, which contains two masters (Level 7) qualifications (AI and Digital & Technology Solution Specialist) and a Level 6 Digital & Technology Solutions Professional with six specialisation strands (Institute for Apprenticeships and Technical Education, 2022c). As previously stated, the UK Level 6 is equivalent to Level 7 on the NZ qualification framework. The description of what constitutes occupational competence at this level is shown in Table 1.

	Level Descriptors – Guidance for Qualifications		**Level Descriptors – Occupational Competence**	
Level	**Knowledge descriptor**	**Skills descriptor**	**Occupational competence**	**Autonomy and accountability**
6	Advanced practical, conceptual, or technological knowledge and understanding of the subject or field of work to create ways forward in contexts where there are many interacting factors Understand different perspectives, approaches or schools of thought and the theories that underpin them Critically analyse, interpret, and evaluate complex information, concepts, and ideas	Determine, refine, adapt, and use appropriate methods and advanced cognitive and practical skills to complete work activities and address problems that have a limited definition and involve many interacting factors Use and where appropriate design relevant research and development to inform actions Evaluate actions, methods and results and their implications	Occupational competence which involves the application of advanced theoretical and/or technological knowledge, understanding, skills and methods across a wide and often unpredictable variety of contexts Address problems that have limited definition and involve many interacting factors	Take responsibility for planning and developing courses of action that are capable of underpinning substantial changes or development. Initiate and lead tasks and processes, taking responsibility where relevant, for the work and roles of others and the allocation of substantial resources. Exercise broad autonomy and judgement

Table 1: Level 6 definition from the Apprenticeship Standard Occupational Level Guide (Institute for Apprenticeships and Technical Education, 2022a)

The professional occupational competence descriptors in Table 1 have been mapped to SFIA level 4 – Enable (SFIA Foundation, 2021). During the review of NZ ICT qualifications, the NZQF was mapped to SFIA levels with Degree level qualifications also being mapped to SFIA level 4 (see Figure 1) (NZQA, 2013a).

NZQF Level	Target Roles	SFIA Levels
Level 1	-	N/A
Level 2 (Certificate)	4.2 Basic use of IT	L1: Follow
Levels 3-4 (Certificate)	4.1 Preparation for further study 4.3 Power user	L2: Assist
Levels 5-6 (Certificate)	5.1 Preparation for further study; + potentially a subset of below	L2: Assist L3: Apply
Levels 5-6 (Diploma)	5.2 Computer Technician 5.3 Helpdesk and Tech Support 5.4 Network/Systems Admin 5.5 Implementation/App Support 5.6 Associate Developer	L3: Apply
Level 7 (Degree) *Out of scope of this review*	Software Developer, Engineer, Business Analyst, etc	L4: Enable

Figure 1: NZQF levels mapped to SFIA levels with target roles (NZQA, 2013a, pg.11)

The Digital & Technology Solutions Professional standard defines a core set of skills that are required by all graduates that cover all areas of IT and would help ensure a well-rounded graduate that had the ability to change career paths (see table 2) (Institute for Apprenticeships and Technical Education, 2019).

Information Systems	Is able to critically analyse a business domain in order to identify the role of information systems, highlight issues and identify opportunities for improvement through evaluating information systems in relation to their intended purpose and effectiveness
Systems Development	Analyses business and technical requirements to select and specify appropriate technology solutions. Designs, implements, tests, and debugs software to meet requirements using contemporary methods including agile development. Manages the development and assurance of software artefacts applying secure development practises to ensure system resilience. Configures and deploys solutions to end users.
Data	Identifies organisational information requirements and can model data solutions using conceptual data modelling techniques. Is able to implement a database solution using an industry standard database management system (DBMS). Can perform database administration tasks and is cognisant of the key concepts of data quality and data security. Is able to manage data effectively and undertake data analysis
Cyber Security	Can undertake a security risk assessment for a simple IT system and propose resolution advice. Can identify, analyse and evaluate security threats and hazards to planned and installed information systems or services (e.g. Cloud services)
Business Organisation	Can apply organisational theory, change management, marketing, strategic practice, human resource management and IT service management to technology solutions development. Develops well- reasoned investment proposals and provides business insights
IT Project Management	Follows a systematic methodology for initiating, planning, executing, controlling, and closing technology solutions projects. Applies industry standard processes, methods, techniques and tools to execute projects. Is able to manage a project (typically less than six months, no inter-dependency with other projects and no strategic impact) including identifying and resolving deviations and the management of problems and escalation processes.

Computer and Network Infrastructure	Can plan, design, and manage computer networks with an overall focus on the services and capabilities that network infrastructure solutions enable in an organisational context. Identifies network security risks and their resolution.

Table 2: Digital & Technology Solutions Professional Core Skills for all graduates (Institute for Apprenticeships and Technical Education, 2019)

Along with these core skills, core technical knowledge and behaviours required of all graduates are specified (see table 3).

<table>
<tr><th colspan="2">Core Technical Knowledge and Behavioural skills</th></tr>
<tr><td colspan="2">Knows and understands:
How business exploits technology solutions for competitive advantage.
The value of technology investments and how to formulate a business case for a new technology solution, including estimation of both costs and benefits.
Contemporary techniques for design, developing, testing, correcting, deploying and documenting software systems from specifications, using agreed standards and tools.
How teams work effectively to produce technology solutions.
The role of data management systems in managing organisational data and information.
Common vulnerabilities in computer networks including unsecure coding and unprotected networks.
The various roles, functions and activities related to technology solutions within an organisation.
How strategic decisions are made concerning acquiring technology solutions resources and capabilities including the ability to evaluate the different sourcing options.
How to deliver a technology solutions project accurately consistent with business needs.
The issues of quality, cost and time for projects, including contractual obligations and resource constraints.</td></tr>
<tr><th>Professional, interpersonal, and business skills</th><th>Attributes and behaviours</th></tr>
<tr><td>Fluent in written communications and able to articulate complex issues.
Makes concise, engaging and well-structured verbal presentations, arguments and explanations.
Able to deal with different, competing interests within and outside the organisation with excellent negotiation skills.
Able to identify the preferences, motivations, strengths and limitations of other people and apply these insights to work more effectively with and to motivate others.
Competent in active listening and in leading, influencing and persuading others.
Able to give and receive feedback constructively and incorporate it into his/her own development and life-long learning.
Applies analytical and critical thinking skills to Technology Solutions development and to systematically analyse and apply structured problem-solving techniques to complex systems and situations.
Able to put forward, demonstrate value and gain commitment to a moderately complex technology-oriented solution, demonstrating understanding of business need, using open questions and summarising skills and basic negotiating skills.
Able to conduct effective research, using literature and other media, into IT and business related topics.</td><td>Have demonstrated that they have mastered basic business disciplines, ethics and courtesies, demonstrating timeliness and focus when faced with distractions and the ability to complete tasks to a deadline with high quality.
Flexible attitude.
Ability to perform under pressure.
A thorough approach to work.
Logical thinking and creative approach to problem solving</td></tr>
</table>

Table 3: Digital & Technology Solutions Professional Core technical knowledge and behaviours (Institute for Apprenticeships and Technical Education, 2019)

The Digital & Technology Solutions Professional has six strands of specialisation: Business Analyst, Cyber Security Specialist, Data Analyst, IT Consultant, Network Engineer, and Software Engineer; the employer selects one (and only one) of the specialisms for the apprentice, specific to the role the apprentice will be performing in the organisation. An example of a specialism is provided in Figure 2.

Specialism title	Software Engineer
Role Details The primary role of a software engineer is to be able to design, build and test high-quality software solutions. The software engineer role is broader and with higher levels of responsibility than a software developer as they need to apply engineering principles to all stages of the software development process, from requirements, analysis and design, development and data requirements whilst ensuring security robustness is built in. They will typically be working as part of a larger collaborative team and will have responsibility for significant elements of software projects.	
Skills Be able to: • Create effective and secure software solutions using contemporary software development languages to deliver the full range of functional and non-functional requirements using relevant development methodologies. • Undertake analysis and design to create artefacts, such as use cases to produce robust software designs. • Produce high quality code with sound syntax in at least one language following best practices and standards. • Perform code reviews, debugging and refactoring to improve code quality and efficiency. • Test code to ensure that the functional and non-functional requirements have been met. • Deliver software solutions using industry standard build processes, and tools for configuration management, version control and software build, release and deployment into enterprise environments.	**Technical Knowledge** Knows and understands: • How to operate at all stages of the software development lifecycle. • How teams work effectively to develop software solutions embracing agile and other development approaches. • How to apply software analysis and design approaches. • How to interpret and implement a design, compliant with functional, non-functional and security requirements. • How to perform functional and unit testing. • How to use and apply the range of software tools used in Software engineering.

Figure 2: Digital & Technology Solutions Professional - Software Engineer (J. Goodyer, 2016, p. 53)

The degree that is awarded on completion of the apprenticeship is a BSc (Hons) in Digital & Technology Solutions, generally the specialism is defined as the major e.g., BSc (Hons) in Digital & Technology Solutions (Software Engineer) (Institute for Apprenticeships and Technical Education, 2019).

Each apprenticeship standard also has an assessment plan that is created by the trailblazer group. For the digital degree apprenticeship, assessment is integrated into the degree and achievement of the degree ensures the standards have been met (Institute for Apprenticeships and Technical Education, 2015).

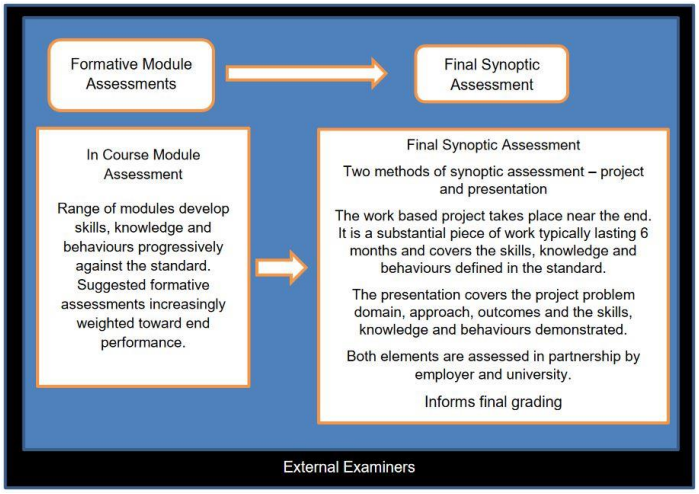

Figure 3: Overview of assessment (Institute for Apprenticeships and Technical Education, 2015, p.2)

As shown in figure 3, knowledge, skills and behaviours are progressively assessed through the training provider's coursework. The assessment plan provides an overview of the typical types of assessment and their criteria that can be used to assess each of the skills, knowledge, and behaviour

requirements; the plan also covers in detail the synoptic project assessment, a capstone project completed over six months that broadly represents the skills, knowledge and behaviours of the specialism being undertaken (Institute for Apprenticeships and Technical Education, 2015). Key to a successful synoptic assessment is an agreement prior between Employer, Apprentice, and Training Provider as to what will be completed for the synoptic project; the apprentice needs to undertake something that is achievable, within the constraints of the business, and can be undertaken during their normal work.

The researchers have undertaken initial work on mapping the technical knowledge and skills in the Digital & Technology Solutions Professional (Level 6) to the learning outcomes of the courses in the suggested model (see following section), and some likely courses from which specialisation electives will be chosen and believe there is a strong match. This along with the reassurance that both the NZ IT qualifications and the UK digital apprenticeship standard have been mapped to SFIA should allow NZ employers to use with confidence the UK degree apprenticeship standard as a starting template when producing the NZ apprenticeship standard. When Goodyer et al. (2017) undertook the pilot study to create the occupational standard for the Bachelor of Engineering Technology – Infrastructure Asset Management Apprenticeship, they too used a UK apprenticeship standard as the starting point.

5 Proposed NZ model

As previously discussed, the researchers are using the employer-consulted and reviewed NZ qualifications as the starting point for the NZ delivery model. These qualifications were updated in 2020, so this gives confidence that the graduate profile outcomes for these programmes are current and relevant to industry. The three NZ diplomas that were chosen as the basis for the model are ones, that combined, are offered by all the polytechnics in NZ except Otago Polytechnic who have opted to not offer any of the NZ Level 5 or Level 6 diplomas. The model is presented in Figure 5.

It is important to note that the degree apprenticeship is not being designed to replace existing IT degrees, it is simply being suggested as an additional pathway to obtaining an IT degree. This will hopefully address some of the barriers that stop people engaging in traditional full-time education (particularly financial barriers).

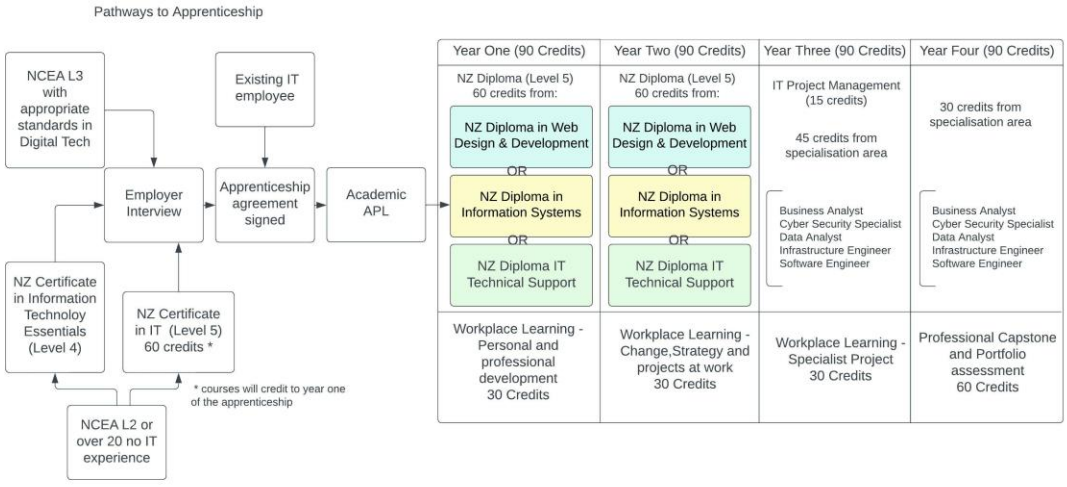

Figure 4: Proposed model for NZ IT Degree Apprenticeship

5.1 Entry pathways, the apprenticeship agreement and APL

Similar to current entry criteria for Level 5 information technology programmes, apprenticeship candidates can interview with employers for IT apprenticeship roles having gained NCEA Level 3 with appropriate Digital Technology credits. Alternative forms of entry are provided for: students with NCEA Level 2; mature students (over 20) with no IT experience; and existing employees of an IT organisation looking to qualify or upskill. NCEA Level 2 graduates and mature students can staircase in through the NZ Certificate in Information Technology Essentials (Level 4), or for some providers the NZ Certificate in IT (Level 5). Ultimately, the employer interview process will decide the candidate's suitability to work as an apprentice in their organisation. Existing employees will not have to interview and enter the process at the apprenticeship agreement point.

Once a candidate has been selected through the interview process, or an existing employee has been selected for upskilling, an apprenticeship agreement is signed. This agreement is between employer, apprentice, and training provider. It is at this point that the employers will negotiate the training pathway for their apprentice and necessary release time with the training provider. The collaborative nature of educational delivery that is now occurring within the polytechnic sector could see the training being delivered at various campus locations suitable to the employer as block courses, or day release, as well as some content being offered fully online. The key to the agreement is flexibility from the training provider around delivery and content and commitment from the employer to support an apprentice through consistent and pre-planned release time.

The final step before commencement of the apprenticeship is accreditation (or recognition) of the apprentices prior learning. It is possible at this point that a student who has completed NCEA Level 3 with Digital Technology credits is given credit towards a Level 5 course in the NZ Diploma in Web Design and Development (e.g., Programming Fundamentals). The APL process may be significant for those already in IT employment and employers should be made aware of the time required by the employee to gather evidence for large APL applications. It may be more succinct to offer a series of challenge assessments to the employee to prove competence in knowledge and skills required by an academic course. The APL process should be flexible in this regard.

5.2 The apprenticeship years

It is recommended that five specialisations are offered in the NZ degree apprenticeship covering the roles of: Business Analyst, Cyber Security Specialist, Data Analyst, Infrastructure Engineer, and Software Engineer. It is acknowledged that these five job roles will not cover all majors currently on offer in the polytechnic IT bachelor's degrees. With a degree apprenticeship it will not be possible to have a double-major. The researchers believe that these five broad specialisations cover most of the majors. In example, a Software Engineer apprentice may be working in desktop, or mobile, or web environments, or all three. The course work should be chosen to complement the skills being developed in the workplace.

Year one covers 60 credits of core IT learning, for most providers this will be the credits covered in the NZ Certificate in IT. Some workplace learning occurs in year one, this is focused on personal and professional development for the apprentice and is likely to be the start of the portfolio assessment. Year two covers the 60 remaining credits from the NZ diploma and has 30 workplace learning credits on change, strategy and projects at work that will be captured in the apprentice's portfolio. As per the graduate profiles of the NZ diploma programmes, the core courses in year one and two should cover fundamentals in: information systems; business concepts; programming; web, UI design; computer networks; hardware and operating systems; technical communication (written and training); data and modelling, testing; securing software applications; and cyber security. The coursework should assist an apprentice in building their problem-solving, communication, and critical analysis skills; coursework

should also make the apprentice aware of industry best practice, ethical and sustainable practice, and codes of conduct that IT professionals should adhere to.

Year three has two core courses: IT project management and a workplace project of 30 credits. The remaining 45 credits come from courses in the apprentice's specialisation area. Generally, these specialisation paths are already mapped in IT degrees with majors. An attempt to specify individual courses here would not be of much use, particularly due to the unification of the IT degree in the polytechnic sector imminent. Specialisms already listed for the UK models can be used as a guide.

Year four has the remaining 30 credits of specialist courses. The final professional capstone project occupies the last six months of the apprenticeship with its presentation and the final assessment of the portfolio attributing the final 60 credits to the degree.

5.3 Recommendations for supporting degree apprentices

Training providers will need to implement additional resource to create a positive experience for the apprentices. In most institutions in the UK that were examined by the researchers there was a dedicated apprenticeship team that takes care of the marketing, applications, employer liaison, and accreditation of prior learning (with assistance from IT academic staff). Within the IT programme staff there needs to be provision for academic supervision of the apprentices. This should not be added to an existing academic's workload. It should be a dedicated apprenticeship supervisor to ensure positive and consistent relationships with apprentices and employers. The supervisor will visit an apprentice in the workplace and assist the apprentice and the employer with selection of work projects that assist in meeting the skills and knowledge in the occupational standard.

There must be a mandatory amount of release hours from the workplace to allow the apprentice to complete the academic component of their studies. The way in which the training takes place can be negotiated between providers and the employer but should equate to 20% of the apprentice's work hours. The employee who will mentor the apprentice should receive formal training on coaching and mentoring (including active listening) prior to the start of the apprenticeship. Goodyer (2016) states MMU found that employers were often not prepared for the time it takes to mentor and were unsure how to supervise the apprentice; they now offer a half day training course to employers at the beginning of the apprenticeship and are considering expanding it to a full day.

The ability to provide a mentor is a key part of the apprenticeship / employer relationship. Without a master (mentor) there can be no apprentice. Smaller businesses without the internal expertise to mentor should be guided to discuss the possibility of a full-time degree student completing some work for them as part of a traditional capstone project or internship, where guidance and mentoring can be provided by academic staff.

6 Summary and next steps

This paper has proposed a model of IT degree apprenticeship based on those that have been successfully implemented in the UK, which is now six years into the IT degree apprenticeship journey. Existing NZ qualifications have been used as the basis of the model to help ensure it will likely meet the needs of employers, prior to there being an occupational skills standard developed for the apprenticeship. The next phase of this project is to review the feedback received on this proposed model from academics and refine it. Feedback on the refined model will then be sought from IT employers at this stage it will become clearer to the researchers as to what work needs to be done to have an employer created occupational skills standard to accompany the apprenticeship degree programme. The final stage of feedback will ask students currently engaged in IT programmes for their opinions on the degree apprenticeship model. The researchers are hopeful that an IT degree apprenticeship can be fast tracked and resourced by government to assist with the critical skills shortage that the NZ IT industry faces.

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