A Flexible Approach towards Delivering Qualifications to address the Skills Shortage Gap in the Industry

Keywords: Engineering, Civil Engineering, Technological Design Context, Engineering Cadetship, Cadets, Skill Shortage, Mixed Mode Delivery Model.

Introduction

According to the Talent Shortage survey (2018) complied by the ManpowerGroup Talent shortage research group, it is clear that New Zealand will require more capable engineering graduates with special traits to meet industry demands. The talent shortage figure in New Zealand compares to a global average of 45% according to this report. 44% of employers in New Zealand find it difficult to hire talents and for large organisations (250+ employees) it is even higher with 81% reporting talent shortages in 2018 (Talent Shortage Survey, 2018). To counteract shortage of talent especially in the Engineering sector, The Ministry of Business and Innovation in New Zealand (n.d., para 1) is encouraging overseas engineers to migrate to fulfil these gaps.

According to the Talent Shortage Survey report (2018), Engineers can be viewed as a unique group of talent which ranks number three on the top ten skills in demand for New Zealand. It is also clear that in near future we will require more engineering graduates to meet industry demand, and these engineers will require specific traits in order to thrive in a rapidly changing and advancing economy (Talent Shortage Survey, 2018). Engineering attrition is a source of concern and several studies around the world have been conducted to understand why students transfer out of engineering (Savage et al., 2011). According to various research findings (Makina, 2010; Makgoba, 2010; Eloff, 2013), the academic environment needs to adapt to the changes experienced by the world where knowledge is contextual, holistic, converging and cross-disciplinary.

Many school students lose interest in science and mathematics at an early age, and thus make an early exit from the so-called “STEM pipeline” which is one factor in a workforce having low science and/or mathematics ability. Students often find it difficult to apply and integrate knowledge they have acquired in a classroom to real world problem (Sanders, 2008). These findings along with other studies carried out in education support the need for an integrated learning environment to develop interdisciplinary thinkers who can consciously apply methodology and language from more than one discipline to make connections in content that cuts across subjects. The challenge tertiary providers face is to align teaching and learning in a manner it could be achieved in real-life settings, and to develop instructional approaches reflecting situated learning (Brown, Collins, & Duguid, 1989; Collins, Brown, & Newman, 1989; McLellan, 1996; Cobb & Bowers, 1999).

Authentic learning is a pedagogical approach that situates learning contextually, giving meaning and purpose to students’ actions, providing motivation and has the potential to improve student learning (Reeves, Herrington and Oliver, 2005). The rationale to push for authentic learning is that students are more likely to be interested in what they are learning; more motivated to learn new concepts and skills, and more successful if what they are learning mirrors real-life situations (Strobel, Wang & Weber, 2013).

It can be argued that the most important quality in an engineer is the ability to think critically (Cooney, Alfrey & Owens, 2008). As tertiary educators, it is our responsibility to provide structured approach to learning so they could build critical thinking skills, or we will keep producing engineers who can pass courses without an ability to think holistically and cross-disciplinary. There is a need to engage with the Industry to identify the attributes an engineering graduate at various qualification levels should possess to be work ready. An early intervention at the school level and encouraging the Cadetship programs through industrial cooperation could be a potentially promising approaches to make science, mathematics, engineering and

technology more interesting and the engineering curriculum (at various levels) more realistic for learners to fulfil skill shortage gap.

A background to Cadetship Programs in New Zealand

Cadetship programs are aimed at school leavers and those already in the workforce with an advantage of earning while studying (engineeringe2e, n.d., para 6). The employer supports a 'cadet' to study towards a diploma or degree qualifications while the cadet is working full time on civil engineering projects. The scheme is also referred to as 'earn while you learn' by many employers (engineeringe2e,n.d., para 6) which includes full pay and time to study towards a diploma or degree.

In New Zealand, the first civil engineering cadet scheme was started by the Public Works Department in 1894. Following a few political changes in the late 1980s, the cadetship program eventually collapsed but started to gain momentum in early 2000 by Opus (now WSP-Opus) when companies were struggling to get people with engineering qualifications to fulfil technician and technologist level engineering roles. An engineering technician graduate is expected to work with 'well-defined' engineering problems as opposed to engineering technologist required to work with 'broadly-defined' engineering problems (Competency Assessment, 2017).

Engineering New Zealand's Competency Based Assessment guidance document (2017; p.24) defines 'well-defined' engineering problems that include some or all of the following:

- Several issues, but only a few that result in conflicting constraints,
- Can be solved using a systematic approach,
- Resolved with limited theory but extensive practical knowledge,
- Frequently experienced and so familiar to most practitioners in the practice area,
- Covered by standards and/or documented codes of practice,
- Limited range of stakeholders with differing needs,
- Consequences that are important locally but aren't far-reaching,
- Discrete components of engineering systems

Eventually more engineering companies throughout New Zealand have now set up cadetship schemes over the last 20 years to address the skill shortage experienced by the Industry at an engineering technician level who can work with 'well-defined' engineering problems.

Cadetship Programs as Authentic Integrated Learning

The cadetship programs offered by the Industry are great platforms for engineering skills to be implemented and honed. In New Zealand, the cadetship are suitable for those who have achieved a National Certificate of Education Achievement (NCEA) Level 2, and with strong ability in Maths and Science and have a desire to gain an engineering qualification whilst gaining practical experiences working on a range of projects (Opus Cadetship Program, 2014). There have been studies which have highlighted that students are most successful when they are keen to learn, motivated to work, ask lots of questions, are willing to do independent research (Cameron & Devitt, 2016). Engineering has a strong connection with authentic problems and context (Strobel, Wang & Weber, 2013). Students need to be shown the connection which exists amongst the courses/papers they undertake with the real-world significance of the information gathered in classrooms/workshops. Authentic learning encourages students to be motivated and to attend classes and develop greater opportunity to communicate and develop higher order thinking and problem-solving skills (Fouts, 2000). There have been studies carried out by Treacy and O'Donoghue (2014) which have reported positive attitudes when an authentic learning approach is followed. Herrington et al. (2014) believes that authentic learning is the pedagogical orientation of education of the future. On

job training of staff through cadetship schemes leading to formal qualifications could fulfil societal and industrial needs to translate skills into engineering innovations. Ensuring authentic learning environments mirror real life situations, a training cadet can attach meaning to his/her practical knowledge and skills with the classroom engineering theoretical concepts.

There are concerns expressed by researchers with authentic learning environments. A concern expressed by Petraglia (1998) and supported by various researchers (Barab et al., 2000; Gulikers et al., 2005; Herrington, Oliver & Reeves, 2002) is the challenge with presenting students with authentic learning environments and tasks predetermined to correspond to activities in real-life. The issue identified has been the perception of the student if they consider the task being authentic or not. Students need to be made aware that the learning is meaningful or the purpose of designing an authentic learning environment is lost (Herrington, Oliver & Reeves, 2002). Ensuring ownership of their learning which leads to the generation of multiple perspective within a learning task could attain meaningfulness in learning (Petraglia, 1998). Cadetship programs has a huge potential to eliminate above mentioned concern as undertaking a qualification while working in the Industry presents a curriculum which is both relevant and situates learning.

This paper outlines pedagogical practices and program delivery model as referred to as the 'mixed mode delivery model' which has assisted the Industry to upskill their existing workforce to take up higher cognitive roles within their organisation. This model also implies a shift from traditional face to face full time delivery models with a focus on a blend of both face to face and distance learning to make the qualification delivery flexible.

The Qualification

The New Zealand Diploma in Engineering (NZDE) is a 2-year full time (16 courses 240 credit) programme at level 6 on the New Zealand Qualifications Framework. Students can choose to major in Civil, Electrical or Mechanical engineering. The New Zealand Diploma in Engineering (NZDE) is a national qualification which has been designed and implemented to meet the demands of the Industry. The NZDE has been a response to the Industry's call for technician level qualifications that recognise practical skills in combination with quality academic study to national standards (NZDE, n.d., para 1). Gaining practical skills through the NZDE has been at the heart of the qualification. The New Zealand Board of Diplomas (NZBED) is the current body which oversees the NZDE qualification to ensure the qualification continuous to meet the requirements of the Industry. The NZDE technician level qualification is seen as central to the future of New Zealand and the challenge of offering the qualification to working students was overcome through the mixed mode delivery model which will be discussed in the next section.

The Mixed Mode Delivery Model

This teaching model is a distant learning approach for the delivery of the NZDE where each course is covered through the study block format. The academic year is divided into two semesters of approximately 18-20 weeks each. All courses are offered as semester courses. Each course is offered in two study blocks of 2.5-3 days each arranged in a delivery permutation that best suits the requirements of the specific course. Students enrol all over the country who are unable to attend a conventional full-time program. There is a gap of 4-5 weeks between the first and second study block to allow for study time. The course content is disseminated to be presented to ensure smooth transition topic by topic for the student. All course materials and resources are made available to the students before the first study block. All open book assignments are completed by the students outside the block teaching hours. Closed book assessments are fit in the second or the final study block. The tutors evaluate, mark and provide feedback for all coursework through an online platform which the students can access. There is a final examination at the end of semester through venues spread across New Zealand.

A similar format is followed to present courses around four venues geographically spread around the country so students can enrol and attend these courses at their nearest venue.

Using this format, it is possible to complete a full time NZDE qualification effectively in 5-6-year part time. The mixed mode delivery model is of particular interest to the industry as it keeps their employees away from work for a minimal time, typically 5 days in a semester if they do one course. It is expected that the self-directed study component is undertaken by the student in his/her own time (outside the tutor directed study blocks) and is supported by a set of course materials specially designed for the purpose.

This paper seeks to highlight the success of the mixed mode delivery model for the delivery of the NZDE qualifications through the perspective of Graduates from the program.

Methodology

The findings from this paper will be aligned with the elements of both an interpretive and critical theory paradigm. The interpretive paradigm according to Sarantakos (2005) is "concerned with views, opinions, and perceptions of people as they are experienced and expressed by everyday life" (p.40). Thus, in interpretive research, participants articulate their "subjective world of human experience" (Cohen et al., 2007, p.21); and the researcher depends on the "participants" views of the situation being studied, that is their experience with the mixed mode delivery model. This paper would provide an opportunity to critique the current practices with an aim to highlight the teaching model and to share the success of the model with other tertiary educators.

The paper has a component of being interpretive, relying on human interactions and the interpretations of their experiences. This paper will analyse data from graduate surveys collected from students online once they have fulfilled the requirements of the program to graduate from the provider. The survey questionnaires were not developed specifically for this paper. The survey data between the period 2016-2019 will be presented in this paper. There are a standard set of questions multiple choice type with an option of adding further comments to justify their choice. These questionnaires are mailed out to the students in March before their Graduation in May of each year. The quantitative and quantitative data were coded to formulate charts in order to help visualise the principal themes and responses. The Semantic themes analysis will be utilised to identify the explicit and surface meanings of the data. The researcher does not look beyond what the participant wrote. Initial codes were generated by coding features in a systematic manner across the entire data corpus of the survey and collecting relevant data to highlight the significance of the delivery model. The author identifies data only from one research instrument to be a limitation to this paper but seeks to highlight the flexibility of model towards qualification completions.

Open-ended questions were also integrated to the survey. This served a means of capturing unanticipated results and to gauging attitudes/opinions which was useful for this paper. A qualitative data analysis method was adopted to analyse text, language, opinions expressed while acknowledging any sensitive data. Based on further recommendations by Brown & Edmunds (2011), open-ended questions were analysed after careful reading and any emerging themes were coded.

Findings from the Surveys

There were 48 students who graduated in 2016 with the provider and the survey was send out to all students out of which only 9 graduates responded. An initial analysis of the 2016 survey completed by 9 students indicate that all students were employed in an engineering occupation. This was seen to be a common theme from the 2017 to 2018 survey with an exception in the 2019 survey where two students out of eighteen indicated that they were not employed. From the 2016 survey data, 77.78 % of the students indicated that the undertaking the NZDE qualification part time enhanced their performance in the 'present role' with 22.22 % pointing that the qualification 'advanced' their role further in the company. Nearly 66.67 % students felt that the NZDE prepared them well for work/employment. 88.89% of students indicated that they would recommend studying NZDE to their colleagues/friends/employers,

however one student mentioned they would not recommend the qualification. This question had an option of explaining/justifying their choice and we received four comments from 9 students. On investigating further through the 'explain why' section, there was a comment which mentioned that the student would have preferred to complete a Washington Accord degree from the beginning instead of taking the longer NZDE pathway. The other responses were focused on good tutors, good educational supplies, flexibility of studying part time while working full time and one response identified the qualification as good but found it challenging to study while working full time.

The 2017 Graduate survey had a low turnover as only three students responded out of 45 students who graduated in the same year. All the three respondents from the 2017 survey indicated that they would recommend their colleagues/friends/employers to study NZDE and their justifications were around the benefit and teaching staff involved to deliver the qualification. A few excerpts from the 2017 survey are as follows:

> *Very good and not extremely hard for the benefit it can give you in the workforce (Graduate Survey, 2017)*
>
> *Helpful teachers and staff members make studying easier beside work (Graduate Survey, 2017)*

The 2018 Graduate survey had a comparatively better turnover than the past two years. There were 21 (out of 30 graduates) respondents who were employed in an engineering occupation. 81.81% of the respondents indicated that the qualification either enabled them to advance or enhanced performance in their current roles in the Industry. One graduate pointed out that it helped him/her secure an employment. 63.64% graduates responded that the qualification prepared them either 'well' or 'very well' for employment in the sector with 100 % responding that they would recommend the qualification to their colleagues. Their explanations included reasons around strong encouragement from the employer to complete qualification, renumeration, promotions, the applicability of taught in class material to the field, broad engineering knowledge and the part time delivery model. An abstract from the 2018 survey is as follows:

> *Though I completed much of the course while not employed in the industry, I expect that being involved while studying would greatly enhance the NZDE's value to students. (Graduate Survey, 2018)*

There is a clear reference being made by this student to the significance of practical/field experience and knowledge with the formal class lectures. The qualification could be more meaningful to the students if they could make a connection between field knowledge/experience with in-class learning. A few abstracts from the 2018 survey preferring the block format are as follows:

> *Block courses - I prefer that format to full time study. This also allows the compartmentalisation of the work which makes to easier to learn. (Graduate Survey, 2018)*
>
> *The best way in my opinion of getting a qualification. The block courses are really practical and easy to relate too, and most of the staff are there to help. (Graduate Survey, 2018)*

Students have clearly identified the format to be a suitable mode of delivery to enhance their educational pathway. The compartmentalisation or structuring of the block format is a crucial aspect of the model to engage learners for effective participation in studies while they work full time. The practical nature of the NZDE qualification along with the contextual method of delivery has been complimented by the students.

The 2019 Graduate survey was completed by 18 out of 36 graduates. 14 respondents indicated they were working full time and 2 part time. 66.67 % of students responded that the program design/delivery matched their needs as leaners. There was a 50:50 split between the two options of 'yes' and 'somewhat' on a question where they were asked if the teaching and learning met their expectations with 0% response on 'no'. Graduates provided written response to a question which required them to identify two key drivers that helped to successfully complete the qualification. The common theme which emerged out of the responses were the

relevance of learning, block format, requirement by the employers to undertake the qualification, support from the employers, developing new skills, promotion, increase in salary, and finally good tutors. The data from the survey is presented in Appendix A. Responses which referred to the name of the Institution and person has been omitted to maintain anonymity.

Cadetship programmes offered by the Industry are a good way to secure quality workers, so once cadets have finished their qualification, they are likely to be offered a higher level, full-time position within the company (Engineering NZ, n.d., para 13). The next section will discuss the findings to make reasonable judgement based on the available data.

Discussion

The mixed mode delivery model was developed to engage cadets from the Industry who could study part time while undertaking full time employment. The data from the graduate surveys claim most of the students were in full time employment and the delivery model was a structured approach towards learning to relate their field experience with classroom lectures. Cadetship schemes could be viewed as authentic structured learning experience which could lead to qualification completions as students find the learning experience relevant to their work. Engineering cadets usually have years of experience working on workplace and work on authentic engineering projects considered to be ill-structured and complex (Petroski, 1996). The learning environments are multidisciplinary in the current workforce. According to Reeves, Herrington and Oliver (2005) authentic learning is a pedagogical approach that situates learning tasks in the context of the future, giving meaning and purpose to students' endeavours, providing motivation and it has the potential to improve student learning. Previous studies have concluded that students are more likely to be interested in what they are learning; more motivated to learn new concepts and skills, and more successful if what they are learning mirrors real-life situations (Reddy & Bruyns, 2016). Qualifications and teaching aimed at cadets should be structured in a way which aims at producing work ready graduates and focuses on linking what students are taught in relation to real world problems and their applications.

Another common theme which emerged from the surveys are the employers motivating employees to complete qualification. Training and development assists in building a knowledge base which improves individual's performance in terms of personal and organisational level (Tahir, Yousafzai, Jan, Hashim, 2014). Motivation helps an organization reach its goals faster because cadets are encouraged to complete their qualification to upskill and to move higher up the ranks within the organisation.

Tutors in this model need to be engaging and the significance of tutors/lecturers with practical field experience cannot be undermined. A tutor's role should not be underestimated in terms of the success of the block delivery, assessment preparation, student motivation, progression and development. Institutions could recruit candidates who demonstrate a clear passion for engineering and teaching. Engineering is an area in which the theories and concepts being taught has to be contextual and this could be achieved by employing tutors with field experience. Vansteenkiste, et al. (2004a) believe the way in which a teacher frames work has the greatest influences on student motivation. Hands on learning and engineering is a major aspect of the NZDE qualification (NZDE, n.d. para 2) and to achieve authentic learning, practising engineers/consultants/contractors should be actively employed to engage students to aid their learning. In the study conducted by Done & Willmot (2015), out of majority of the students surveyed, interviewed etc. all wish to apply their learning prior to graduating and working in industry as a way of keeping them motivated and to improve their understanding. Cadets have extended opportunities to gather practical hands on experience at work while they study part time through qualified engineers who share real life industry experience with the students which relates to their course. Fallows & Ahmet (1999) claim most teaching is out of context, without the use of "focused practical" or other "direct involvement" of the students. The mixed mode delivery model allows students to engage with current practitioners.

The survey results demonstrate a collective support for the mixed mode delivery model. It is the role of the qualification provider to ensure that practical, varied support and feedback

channels are provided to each student's needs during their time of study. Results from the survey show that the graduates appreciated the level of support and feedback, not restricted to course materials, but extends to accommodate administrative staff, competent tutors and most importantly the Employers. According to Tinto (1975), the level of academic integration is one factor which predicts a student's persistence or withdrawal from academic study. It is crucial to maintain academic integration for learners throughout the delivery model as the interaction between the student and academic support entailed within the institutional culture would increase the likelihood of a student to complete the qualification. In addition, Thomas (2012) postulates that the creation of a sense of belongingness and engagement are critical to promoting retention. The commitment of faculty and administrators become critical in the mixed mode delivery model.

Conclusions and Recommendations

Based on the findings of the Graduate survey, it can be reasonably concluded that the flexibility offered by the mixed mode delivery model allows the student to spend less time off their full-time employment and complete the qualification in their own pace and time. The model also allows for an authentic learning approach where students could interrelate theory to practice which leads to better learning and understanding. Learning is hugely influenced by factors such as student engagement, participation, relevance of the qualification and authentic contexts.

A recommendation from this paper would be to utilise existing staff from the Industry for the upskilling process to address short skill problem through cadetship schemes and to actively support the needs of part time learners. A structured approach to deliver qualification to part-time learners should be taken into account along with the motivational factors as perceived by the learners including their integration into the academic life through active learning and enriching educational experiences. Cadetship schemes could be an effective transition from school to tertiary education if they are all managed by schools, tertiary education and the Industry in tandem. Engaging learners from the Industry at an early age could inspire them to work through hands on learning approach with frequent opportunities to put engineering theory to practice. While their cadets are learning the knowledge and skills taught by the course provider, companies could complement this with training them in specific skills or processes required in their business.

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Appendix A

Q12 What are two key drivers that have helped focus you to successfully pass your studies?

Answered: 16 Skipped: 2

#	RESPONSES	DATE
1	Great support and guidance of the teachers, as well as entire team support, when was necessary.	6/7/2019 6:24 AM
2	Desire to continue to learn and develop new skills The learnings were relevant to the knowledge I need in my work.	5/24/2019 4:03 PM
3	Love of learning Further my education	5/23/2019 12:27 PM
4	Employer requirement Enjoyed the learning	5/23/2019 12:24 PM
5	Enjoy the learning module of courses Structure courses	5/23/2019 12:23 PM
6	Block courses Relevance	5/23/2019 12:22 PM
7	Employee requirements	5/23/2019 12:20 PM
8	Enjoyment Finishing what I started	5/22/2019 4:13 PM
9	Job promotion Kids	5/22/2019 3:55 PM
10	1. Post-nominals 2. Completion to succeed as a mature student, help fellow students that need help and make some great friends.	5/22/2019 11:31 AM
11	hard work	5/22/2019 8:30 AM
12	Being able to do block courses, work allowing for study leave before exams.	5/22/2019 8:12 AM
13	Striving for constant personal growth and improvement. Salary improvement	5/22/2019 7:33 AM
14	That the completion of the NZDE would give me a qualification to take the next step in becoming a civil engineer and grant me a new job title in my current role.	5/21/2019 4:50 PM
15	Employer paid Desire to finish	5/21/2019 4:36 PM
16	The prospect of having to pay to redo courses The potential increase in salary at the end	5/21/2019 4:34 PM