

THE TRAINING AND EDUCATION OF CIVIL ENGINEERING STUDENTS AT NEW ZEALAND'S LARGEST TECHNICAL INSTITUTE

L. Tuleasca, W. Loo

UNITEC Institute of Technology (NEW ZEALAND)

Abstract

This paper attempts to highlight some interesting and unique aspects related to engineering education (mainly in the civil discipline) in New Zealand, a country where the typical student cohort is extremely diverse in terms of nationality, ethnicity, previous educational background, and age. The New Zealand education system follows a three-tier model made up of: kindergartens and childcare centers (Early Childhood Education), primary and secondary school (high schools), and tertiary education (higher and vocational education) – provided by the universities, institutes of technology, industry and private training providers, and Māori training organizations. As with many other countries in the English-speaking world, engineering education in New Zealand is delivered at three levels: at diploma level (Dublin accord qualification), a three-year bachelor degree (Sydney accord), and a four-year bachelor degree (Washington accord). The diplomas and three-year bachelor qualification are typically delivered at institutes of technology around the country, while the four-year degree is only delivered at the universities. The diversity of Dublin and Sydney accord civil engineering students in the structural specialization over the past five years is introduced. Their academic performance in terms of these various characteristics, nationality, age, educational background, among others is investigated, and commentary is provided on how this relates to the imperatives of the New Zealand government's long-term Tertiary Education Strategy.

Keywords: engineering education, bachelor's degree, practical teaching.

1 INTRODUCTION

Civil engineering education has over 40 years of history at Unitec New Zealand (formerly named Carrington Technical Institute until 1994, Unitec Institute of Technology until 2020, then Unitec New Zealand as part of Te Pūkenga). In 1976, Carrington Technical Institute was established at the present Mt Albert site. Within two years, delivery of the partly work-based New Zealand Certificate in Engineering (NZCE) in both the civil and mechanical disciplines had already started. While the NZCE was reputed to serve students and industry very well, in 1998 the government began to progressively disestablish the qualification. The replacement qualification, developed by a consortium of polytechnics, was the level 6 Diploma in Engineering (Civil) in 2000. This was quickly followed by the launch of the Bachelor of Engineering Technology (Civil) at Unitec in 2001. Both these qualifications were initially offered in the civil discipline only [2].

In 2010, both the diploma and the degree were brought under the auspices of national-wide governing bodies – the New Zealand Board of Engineering Diplomas (NZBDE) and Metro Group of Institute of Technology, respectively. This was done to bring greater consistency to graduate outcome, curricula, and course content right across the country. It is important to note that the New Zealand Diploma in Engineering (NZDE) and Bachelor of Engineering Technology (BEngTech) were governed by international accords: the Dublin Accord in case of the NZDE, and the Washington Accord in the case of the BEngTech. These accords anchor the programmes to the international best practice and help ensure their international recognition – at least throughout most of the English-speaking world [1].

In 2019 a new major restructuring process of Tertiary Education Institution (universities, institute of technology and polytechnics, and wānanga) has start and is supposed to be finished on 31 December 2022. Te Pūkenga – New Zealand Institute of Skills and Technology, as New Zealand's largest tertiary education provider, will ultimately have the national and regional reach to become a long-term skills training partner for firms and industry, enabling learners to move between workplaces and other educational offerings and locations as their needs change [3]. Process is not yet finalised therefore no details or information related to Te Pūkenga will be presented in this paper.

This paper is primarily concerned with demographic characteristic and education performance of civil engineering students who enrolled in the civil engineering diploma or degree programme at Unitec during period 2010 to 2019. This is a particularly interesting period, which during its first half enjoyed a

near doubling of enrolments and it was a period of rapid demographic change: if in 2010 international students represented just 11% of civil engineering cohort, by 2016 this had increased to 45%. By the end of the decade under study, 1,856 students representing a diverse cohort of 39 different nationalities and 29 ethnicities had enrolled at some point, in one or more courses of study in civil engineering. These facts alone make the matter of diversity and academic achievement in civil engineering at Unitec a topic well worth studying.

2 DEMOGRAPHIC CHARACTERISTICS AND EDUCATIONAL PERFORMANCE

In the decade period analyzed, Unitec’s Department of Civil Engineering educated 1,856 students, studying either on the BEngTech or the NZDE. These students represent 3,684 Equivalent Full-time Students (EFTS) of enrollment: a typical full-time student studies 8 x 15-credit courses in a year, representing 1 EFTS, and one 15-credits course corresponds to 0.125 EFTS. On average, each student thus enrolled in 2 EFTS (16 x 15-credit courses), the equivalent of two years of full-time study. In term of individual course enrollment, there were 15,154 in BEngTech and 14,665 in NZDE, refer Fig.1.

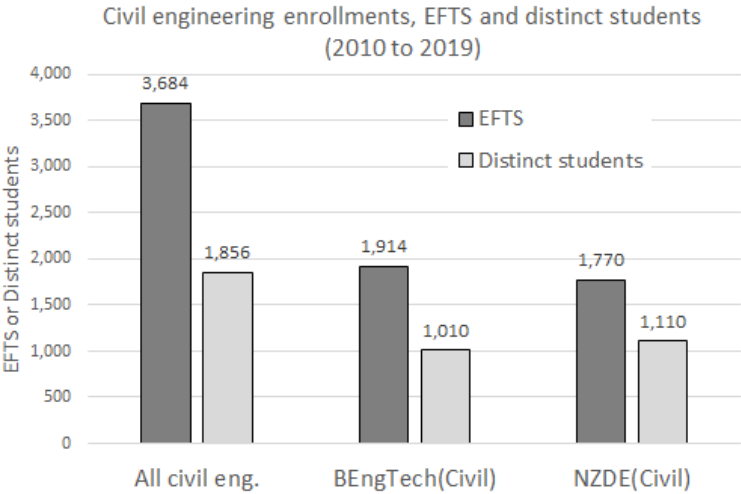


Figure 1. BEngTech degree and NZDE enrolments (EFTS).

Overall education performance is presented in Fig. 2. Note that course success is simply the aggregate number of courses passed, divided by the total number of courses enrolled less courses listed as continuing or deferred. GPA stands for Grade Point Average. Unitec adopts the 0 to 9 grade points system common to most New Zealand tertiary institutes [4].

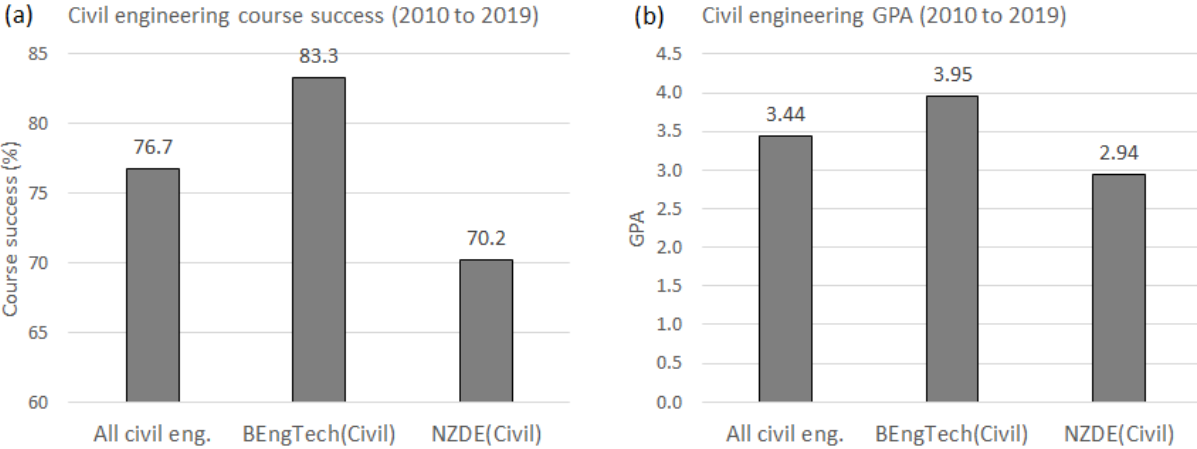


Figure 2. Civil engineering overall education performance in terms of (a) course success, and (b) GPA

2.1 Cohort Nationality

Over the period 2011-2019, students from 39 nationalities enrolled in civil engineering. Table 1 shows the EFTS enrolment by nationality. The nationalities and further categorised as domestic (New Zealand citizens, permanent resident, and Australian citizens), or from one of seven broad geographic regions – Asia, Middle Est, Pacific, Africa, North America, South America, or Europe.

Table 1. National origin of students (EFTS), 2011 to 2019.

<i>Residency</i>	<i>Region/Category</i>	<i>BEngTech</i>	<i>NZDE</i>	<i>Total</i>	<i>Percentage</i>
New Zealand	Domestic	1314	1119	2433	66.2%
China	Asia	241	334	575	15.7%
India	Asia	68	135	203	5.53
Saudi Arabia	Middle East	51	24	75	2.05%
Solomon Island	Pacific	49	3	52	1.42%
Sri Lanka	Asia	12	26	38	1.02%
Kenya	Africa	14	22	36	0.98%
Fiji	Pacific	17	19	36	0.98%
Tonga	Pacific	27	1	28	0.75%
Papa New Guinea	Pacific	17	6	23	0.64%
Kiribati	Pacific	15	3	18	0.49%
Russian Federation	Europe	6	9	15	0.40%
Vanuatu	Pacific	14	0	14	0.37%
Taiwan	Asia	9	3	12	0.32%
Viet Nam	Asia	3	7	10	0.27%
Australia	Domestic	8	2	10	0.27%
Korea Republic of	Asia	1	7	8	0.23%
Bangladesh	Asia	4	4	8	0.21%
Samoa	Pacific	7	1	8	0.20%
Philippines	Asia	3	4	8	0.20%
Nepal	Asia	0	7	7	0.18%
East Timor	Asia	5	2	7	0.18%
Iran	Middle East	2	4	6	0.16%
Chile	South America	3	2	5	0.13%
Brazil	South America	4	0	4	0.11%
Pakistan	Asia	1	3	4	0.11%
France	Europe	4	0	4	0.11%
Hong Kong	Asia	0	3	3	0.08%
Myanmar	Asia	3	0	3	0.08%
South Africa	Africa	1	2	3	0.08%
Thailand	Asia	0	3	3	0.08%
Tuvalu	Pacific	3	0	3	0.08%
Mauritius	Africa	3	0	3	0.08%
Cambodia	Asia	0	3	3	0.08%
Iraq	Middle East	2	1	3	0.08%
United States	North America	2	0	2	0.05%
Namibia	Africa	0	2	2	0.05%
Jordan/Oman	Middle East	2/0	0/1	2/1	0.04/0.02%
Total		1913	1761	3774	100%

As a proportion of overall EFTS enrolments, 67% of students are domestic, 24% from Asia, 5 from Pacific, and 2% from Middle Est, refer Fig.3. Just 2% are from other regions, namely North and South America, Africa, and Europe. It is emphasised that this refers to nationality, and not ethnicity. While ethnicity often closely correlates with nationality, they are different concepts.

Educational performance in terms of geographical region is presented in Fig. 4. Note that only four board grouping are shown – Domestic, Asia, Pacific and Middle Est. These four grouping make up 98% of enrolments in term of EFTS.

From Fig. 4 it is seen that for the BEngTech degree, students from Pacific perform the best, followed by students from Asia and then domestic students. Students from the Middle East lag significantly behind students of other groups. For that NZDE, students from Asia perform the best, followed by students from the Pacific, then domestic students, while again, students from Middle East are found to be struggling compared with students from other groups.

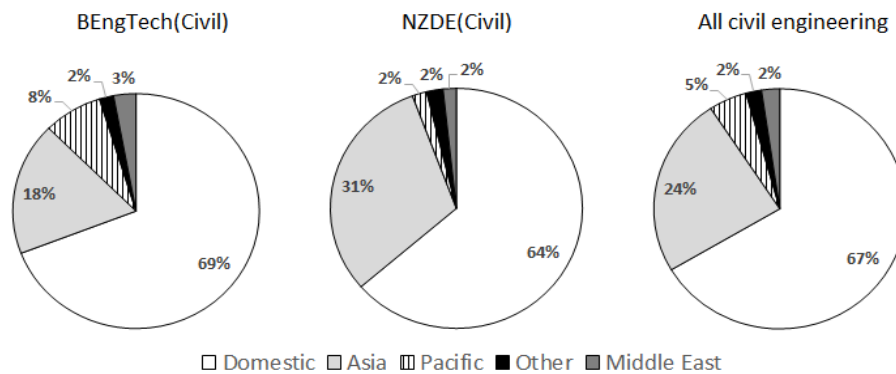


Figure 3. Students by broad geographical region, in percentages.

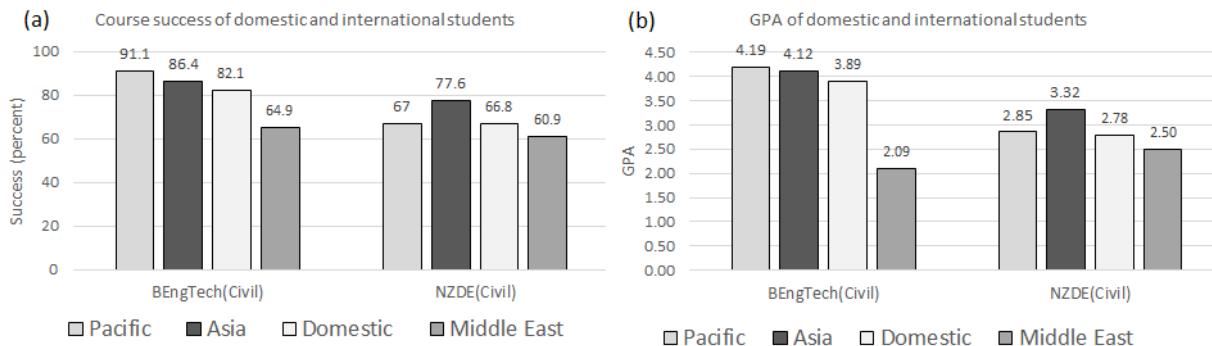


Figure 4. Educational performance by geographic region, in terms of (a) course success, and (b) GPA.

2.2 Ethnicity of Domestic Students

Domestic students make up 67% of EFTS of the civil engineering cohort, refer Fig. 3. These domestic students are from at least 28 ethnic groups (two of groups are ‘other’ or ‘no response’). The ethnicities are grouped as African, Asia, Europe, Latin American, Māori, Middle Eastern, and Pasifika. These classifications are adopted in the New Zealand census [5]. In the case of students who belong to two or more ethnicities, the ethnicity adopted by Unitec for reporting is assumed to be in line with the ethnic priority ranking used by New Zealand’s Ministry of Education [6].

Fig. 5 shows the proportional break-down of the major ethnic groups. From Fig. 5 the largest group are of Asian ethnicity (37.4%), followed by European (24.4%), Pasifika (12.8%), Māori (5.8%), Middle Eastern (6.1%), African (4.6%), and Latin American (2.1%).

Pasifika and Māori are both priority groups in terms of encouraging participation and enhancing educational performance [7]. The other priority group is under-25s – see Section 2.5. The main ‘catchment’ for domestic students is the West Auckland area. Around 12% of the population in this area identify as Māori, and 14% as Pasifika (Huakau, 2016).

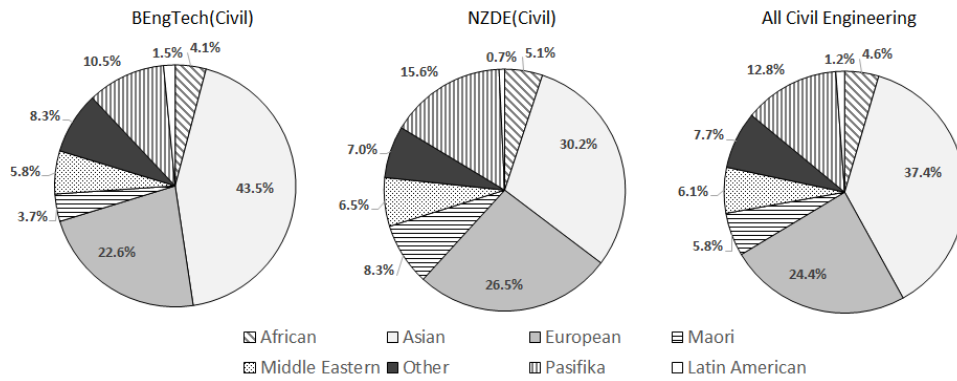


Figure 5. Ethnic background of domestic students as proportion of all civil engineering students.

The proportion of Pasifika in civil engineering (12.8%) appears to be quite close to their representation in the community (14%). However, Māori at just 5.8% of the overall cohort are significantly underrepresented – given that 12% of the local population is Māori.

Educational performance by ethnicity is presented in Fig. 6. Overall domestic success is also included (black column).

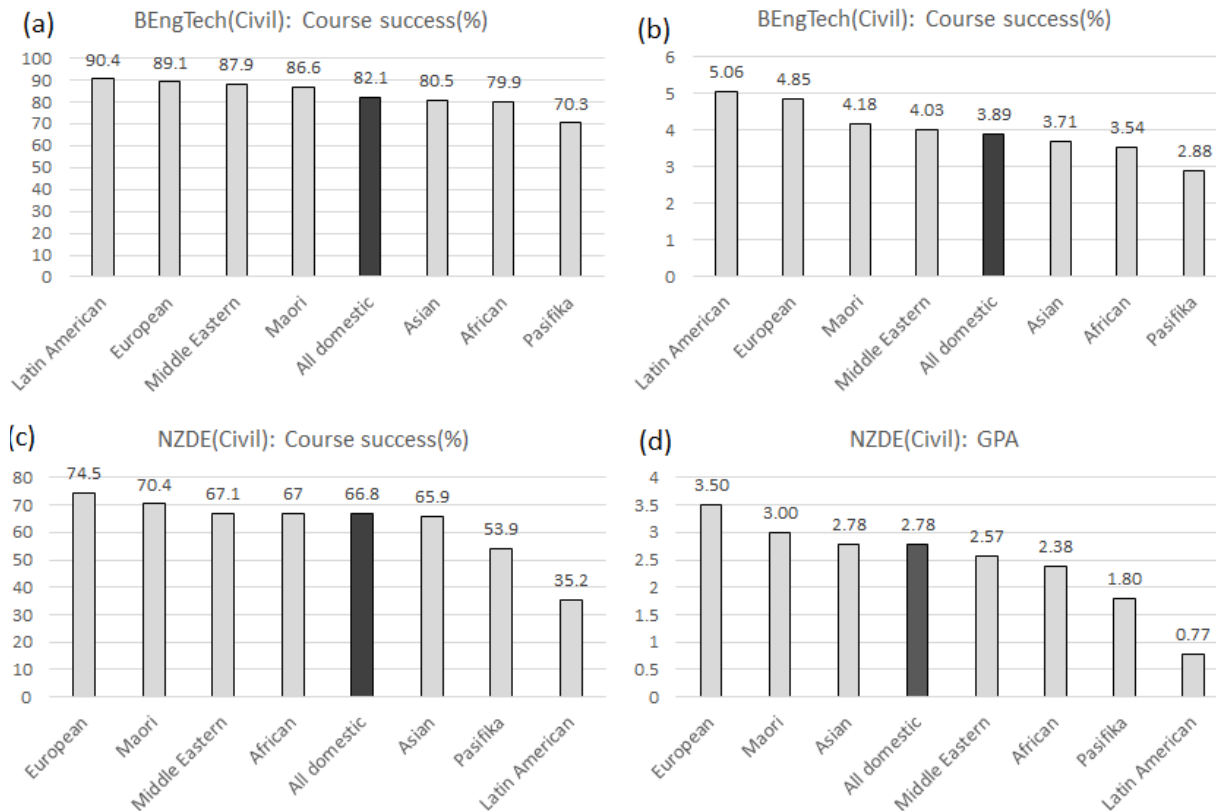


Figure 6. Educational performance by ethnic background for the BEngTech(Civil) in terms of (a) course success, (b) GPA, and for the NZDE(Civil) in terms of (c) course success, and (d) GPA.

If we disregard the very small number of Latin American enrolments, domestic students of European ethnicity perform the best in both programmes, whether in terms of course success or GPA. Māori also perform well in both programmes, exceeding the overall domestic performance in terms of both success and GPA. However, Pasifika course success and GPA in both programmes lags significantly behind the overall averages. For the BEngTech(Civil) the overall success rate is 82.1%, which is 11.8 percentage points above the 70.3% of Pasifika. For the NZDE the overall success rate is 66.8%, while Pasifika success is just 53.9% (12.9 percentage point gap).

2.3 Student's Gender

From Fig. 7, civil engineering clearly has difficulty in attracting female students. In the BEngTech(Civil) only 12.7% of students are female, while for the NZDE(Civil) just 11.9% of students are female. For domestic students the rate of female participation is 16.5% and 14.1% for the BEngTech(Civil) and NZDE(Civil) respectively, while for internationals the corresponding rates are 12.7% and 12.3%.

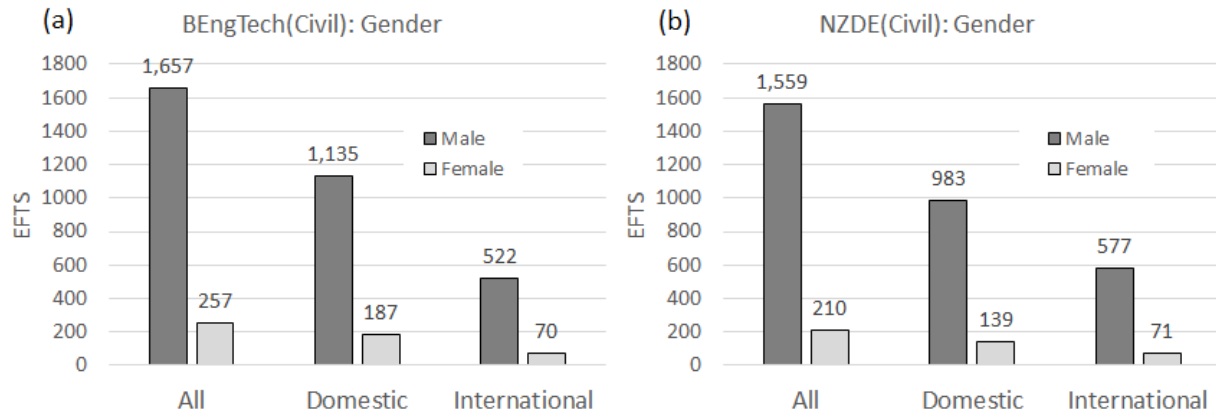


Figure 7. Female and male students for the (a) BEngTech(Civil), and (b) NZDE(Civil).

Despite female students being significantly under-represented, they perform well academically, refer Fig. 8. In terms of course success, female internationals outperform male internationals, who in turn outperform female domestics who outperform male domestics, refer Fig. 8(a).

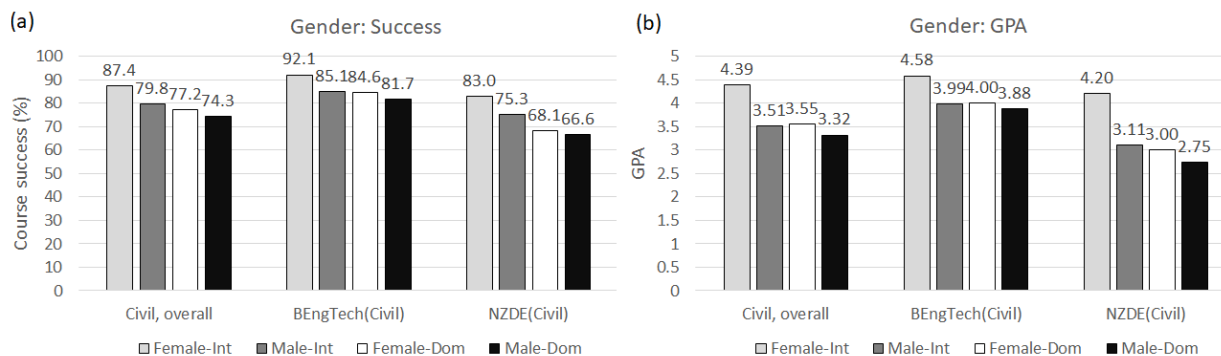
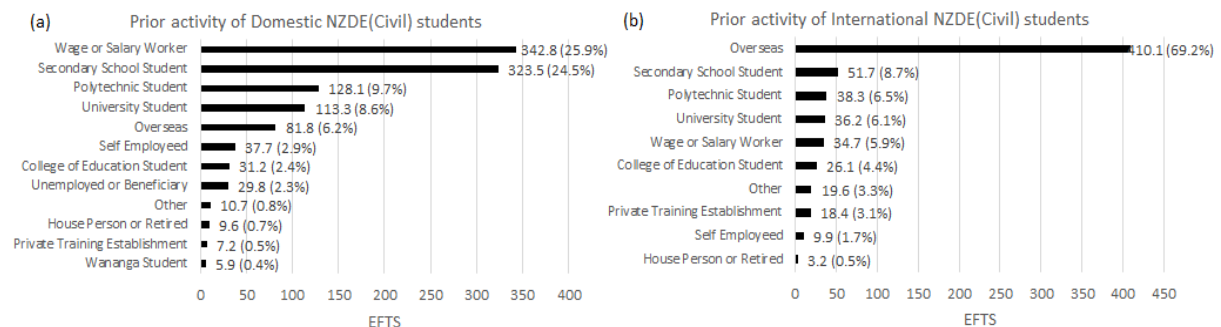


Figure 8. Educational performance by gender, in terms of (a) course success rates, and (b) GPA.

2.4 Student's Prior Activity

The term prior activity refers to the activity the student was involved in immediately before his or her *first* semester of study at Unitec, regardless of programme. The prior activities of students enrolled on the BEngTech(Civil) and NZDE(Civil) during 2010 to 2019, are shown in Fig. 9.



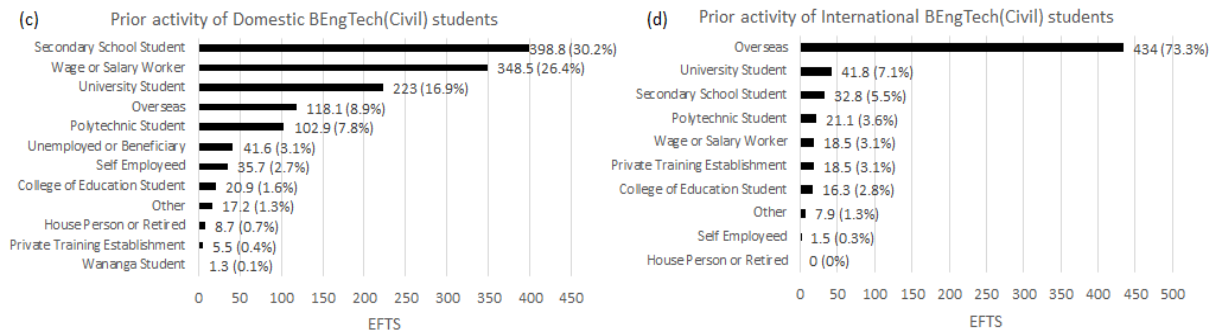


Figure 9. Prior activities of (a) domestic NZDE(Civil) students, (b) international NZDE(Civil) students, (c) domestic BEngTech(Civil) students, and (d) international BEngTech(Civil) students.

A plurality of domestic NZDE(Civil) students (25.9%) come from a wage or salary background. Former secondary school students also make up a significant percentage of the domestic NZDE cohort (24.5%). For the BEngTech(Civil), 30.2% are from a secondary school background, followed by wage or salary background (26.4%). Most international students arrived at Unitec straight from overseas (69.2% for the NZDE and 73.3% for the BEngTech).

To simplify the investigation of prior-activity and educational performance, the following broad groupings of activities are adopted: (1) Tertiary education (College of Education, Polytechnic, Private Training Establishment, University, Wananga), (2) Secondary school, (3) Workforce (house persons or retired), Unemployed (unemployed or beneficiary), (4) Overseas.

Course success and GPA associated with prior-activity group, for degree and diploma, and international and domestic students are shown in Fig. 10.

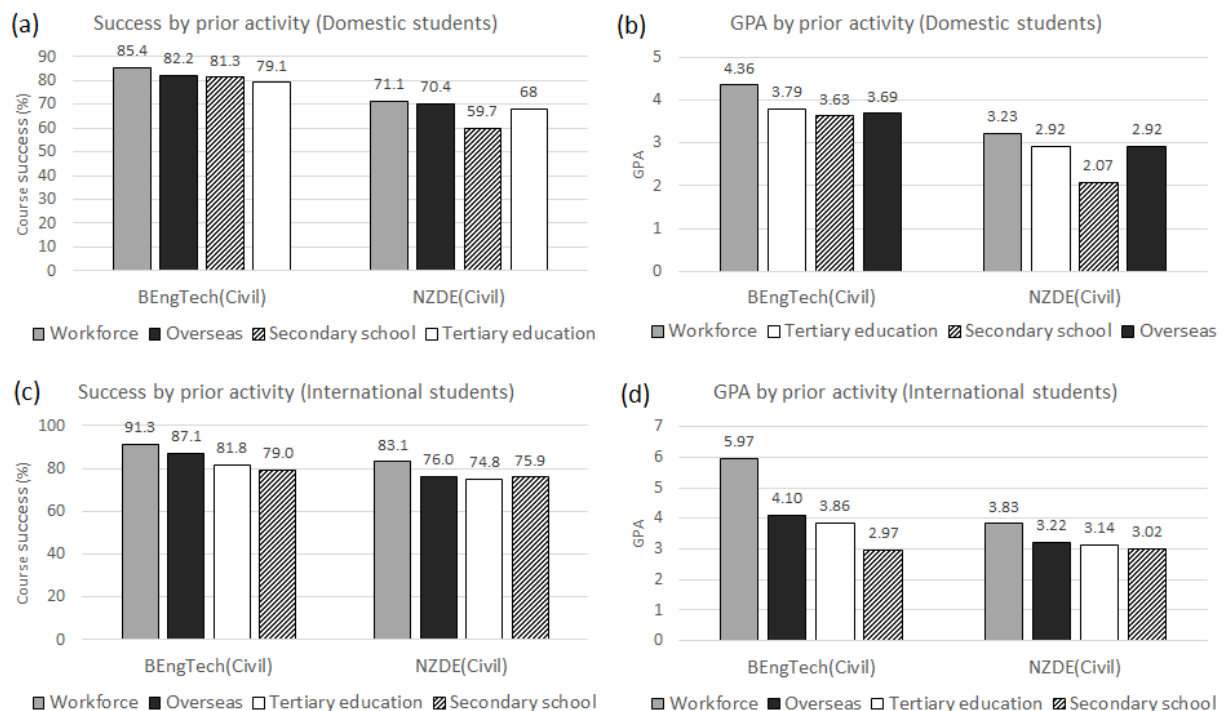


Figure 10. Prior activities of (a) domestic NZDE(Civil) students, (b) international NZDE(Civil) students, (c) domestic BEngTech(Civil) students, and (d) international BEngTech(Civil) students.

From Fig. 10, students who arrive from the workforce, regardless of whether they are domestic or international, have the highest rates of course success on both programmes. Students from the workforce also significantly outperform other students when it comes to GPA. Students arriving directly from overseas, whether domestic or international, also have high rates of success on both programmes.

2.5 Student's Age

The age of civil engineering students (based on enrolments between 2010 to 2019) are shown in Fig. 11.

Note that the age is the age at the beginning of the semester for the relevant course studied. The distributions are weighted by EFTS. As would be expected, the mean age and median age of BEngTech students is higher than that of NZDE students. The spread (standard deviation) of the age distributions, are similar for both groups.

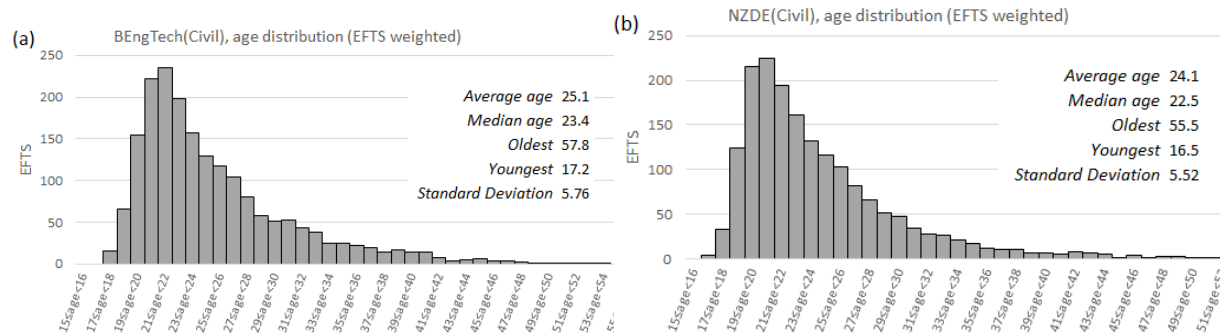


Figure 11. EFTS-weighted age distribution (at start of course) for (a) BEngTech(Civil) students, and (b) NZDE(Civil) students./

Success and GPA are plotted against age (excluding those age ranges with fewer than 30 enrolments) and presented in Fig. 12. Age and educational performance are seen to be highly correlated.

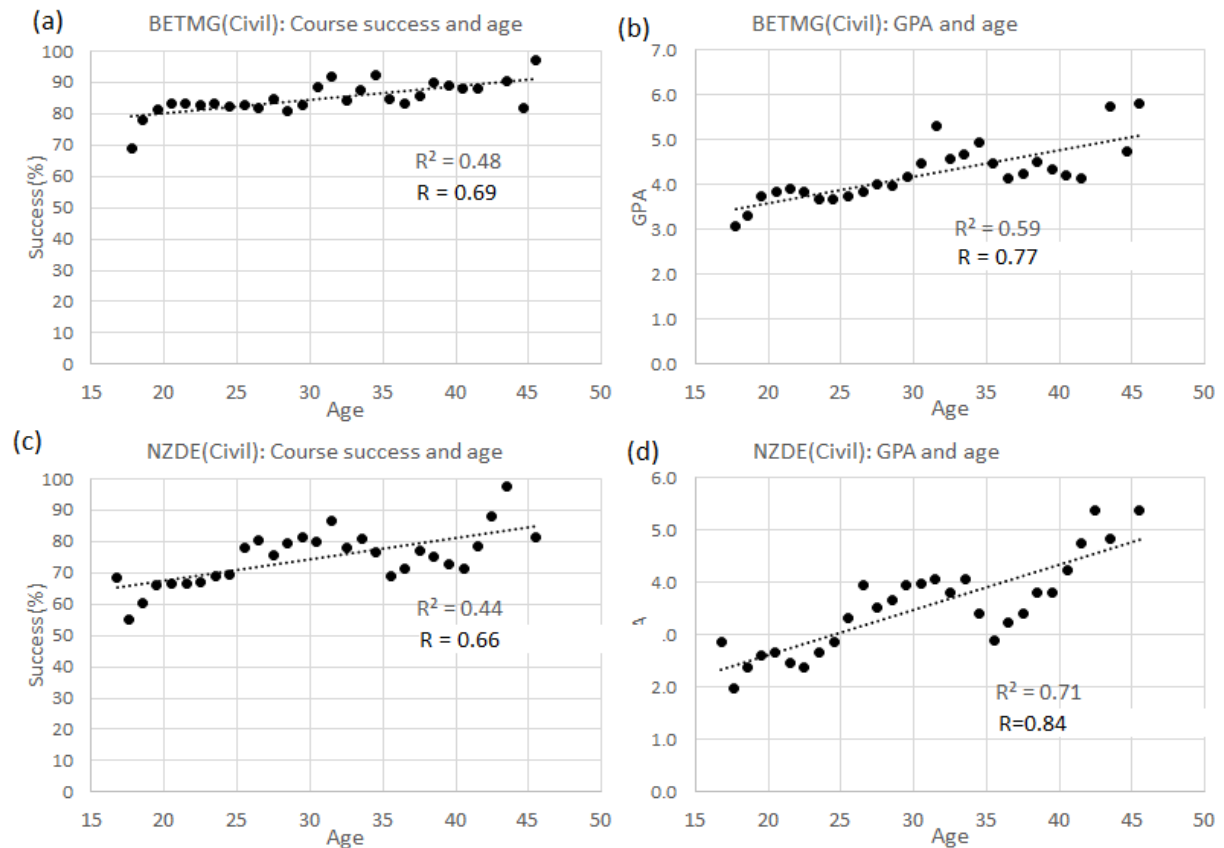


Figure 12. Educational performance and age for the BEngTech(Civil) in terms of (a) course success, and (b) GPA, and NZDE(Civil) (c) success, and (d) GPA.

Domestic under-25 students are a priority group when it comes to improving educational performance [7]. There are significantly more students in this age range than older than this group. As expected from the strong correlation of age with educational performance, under-25s underperform compared with their older counterparts

2.6 Part-time and Full-time Study

Part-time students are those students who enroll in three or fewer 15-credit courses a semester. Full-time students are enrolled in four or more 15-credit courses a semester. The enrolments from 2010 to 2019 associated with part-time and full-time study are presented in Fig. 13.

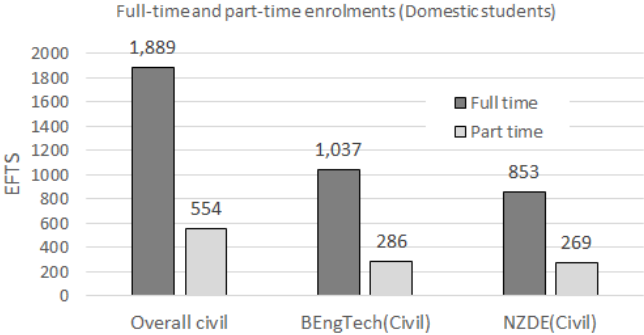


Figure 13. Domestic students in full-time and part-time study

Note that as international students are rarely involved in part-time study (just 125 of 1240 EFTS), only the figures relating to domestic students are displayed. Around 23% of domestic enrolments are of students studying part time.

Fig. 14 compares the educational performance of full-time with part-time students. Clearly, full-time students tend to perform better than part-time students, particularly those enrolled in the NZDE(Civil).

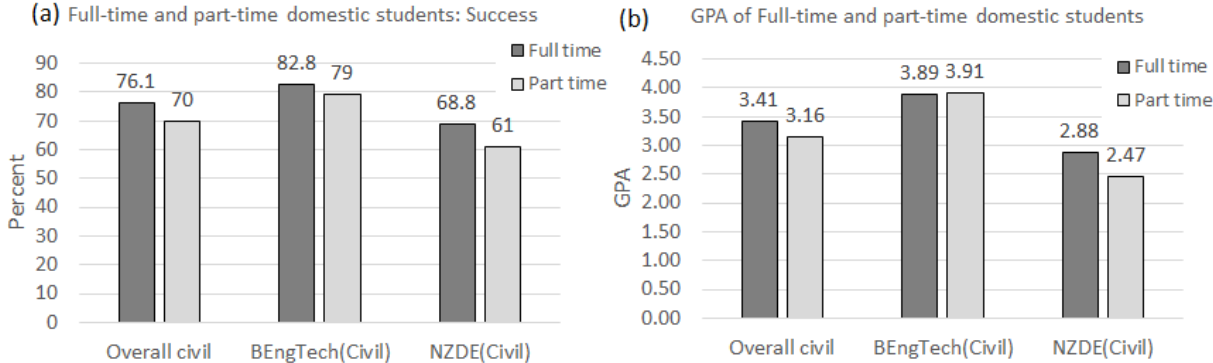


Figure 14. Domestic students in full-time and part-time study; (a) course success, and (b) GPA.

3 CONCLUSIONS AND RECOMMENDATIONS

Key findings on demographic characteristics and how they relate to education performance are presented below.

3.1 Conclusions

Based on the present and past research done by authors, for both domestic and international students can be concluded that educational performance correlates strongly with age of students. Older students tend to perform better than young students: for example, on NZDE, 25 and older students have a course success rate of 77.1%, when for under 25 course success rates is 60.7%.

Also, full-time students on both programmes tend to perform better than part-time students. The gap in performance for NZDE is significant – 68.8% course success for full-times compared to 61% for part-time students.

Female students at Unitec are significantly underrepresented in civil engineering, at around just 12% of overall EFTS. However, female students outperform their male colleagues academically, particularly international female students who have a course success rate of 87.4%.

3.1.1 Domestic Students

Of domestic students, students of Asian ethnicity are a plurality (37.4%), followed by NZ European (24.45%), Pasifika (12.84%), Other (6.63%), Middle Eastern (6.1%) Māori (5.82%), African (4.6%), Latin American (1.18%) and no response (1.04%).

The highest-performing group among domestic students are Europeans, and Māori students, despite the underrepresentation in the domestic cohort, consistently perform close to Europeans in terms of course success.

One quarter of domestic BEngTech and 24.5% of domestic NZDE students come directly from New Zealand secondary school, and around 30% of enrolments for both programmes arrived straight from the workplace. Students arriving directly from the workplace perform well academically compared with other students. This applies in the case of both domestic and international students, and across both programmes.

3.1.2 International Students

International students typically outperform domestic students academically. International Pasifika perform the best among international students, while students from Middle East struggle when compare with students from other nationalities. It is interesting to note that of the 86 Middle Eastern EFTS enrolled over the period of interest, 2010 to 2019, 75 EFTS (i.e. 87.2%) came from one country, Saudi Arabia, under a particular exchange scheme. The overall success rate of the Saudi students was 61.5% over the period of interest, whereas for the non-Saudi Middle Eastern students it was far higher (84.1%). Therefore, the apparent low performance of the Middle Eastern students can possibly be attributed to insufficient oversight of entry criteria for a particular group of Saudi students who entered the programmes under a particular exchange scheme. Tightening up the entry criteria for the Saudi students could well have resulted in much higher course success for the Middle Eastern group as a whole.

Most international students (around 70%) come directly from overseas prior to studying civil engineering at Unitec, while 30% have worked or studies in New Zealand prior to their engineering studies.

3.2 Recommendations

Authors consider that future research will be benefited to focus on those students who drop out after one or two semesters of study is a possible “low-hanging fruit” when it comes to improving overall education performance of the two civil engineering programmes. Funding to comprehensively explore the background of these students before they start their studies, the reasons they leave their studies, and their destinations after leaving their studies, could allow improvements to be made to selection criteria, and support of at-risk students during the early period of study.

As mentioned above from author analysis, the female students are significantly underrepresented in civil engineering. Therefore, future research could focus on how Unitec fares in this regard compare with other New Zealand and international technical institutes and universities, and whether the number of female teaching staff is a factor when it comes to increasing female enrolments.

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