Longitudinal study of the success rates of a cohort of New Zealand Diploma in Engineering (Civil) domestic students

Edward Chai[a], Jonathan Leaver[b]
Unitec Institute of Technology[a], Unitec Institute of Technology[b]
Corresponding Author E mail: echai@unitec.ac.nz

Structured Abstract

BACKGROUND
Low success rates in the New Zealand Diploma in Engineering - Civil (NZDE) in 2011 were a cause for concern. The average success rate of the eight compulsory courses in the first year of study in the NZDE was low at 44%. From the records of student applications, about 30% of the domestic students had not met the entry criteria of NCEA Level 2. This study examines the performance of those students along with domestic students who met the academic entry criteria and special admission students aged 20 and above with prior study or relevant work experience.

PURPOSE
The purpose of this study is firstly to find out if the admission of students who did not meet the entry criteria significantly affected the success rate of certain courses in NZDE. Secondly, to determine if the present National Certificate of Education Achievement (NCEA) Level 2 entry requirement an adequate entry criterion for NZDE programme to produce quality graduates as Engineering Technicians. Finally, to evaluate if prior study and work experience have effect on the students' success rate.

DESIGN/METHODOLOGY
Three categories of domestic students were identified and their success rates in courses through the NZDE analysed. They are: (A) students meeting entry criteria, (B) students not meeting entry criteria, and (C) special admission students aged 20 and above with prior study or relevant work experience. These three categories of students were analysed over three years to establish their average semester success rates and first attempt success rates for eight Year One compulsory courses.

RESULTS
The study found that the success rate of Category A and C students consistently higher than the success rate of Category B students. Both Category A and B students showed a similar increase in success rate with time but the success rate of Category C students was hovering within a narrow range although they have the highest success rate among the three categories of students in the beginning.

CONCLUSIONS
The findings confirm the effect of students' high school academic results on their first year university academic performance. However, the longitudinal study found that the students who stayed on the course continued to improve academically irrespective of their academic performances at the beginning of their study. The study also showed that prior study and work experience have a positive impact on the students' performance in general.

Key words

Success rates, entry criteria, mature students.

Introduction

The New Zealand government invests significantly in tertiary education every year. In 2011/2012, the total government expenditure on tertiary education was $5.3 billion, a decrease of about 3% than the previous year due to the global financial crisis (MoE, 2012). In the national Budget of 2013, despite the tight fiscal policy, the government increased the funding for tertiary subsidies for engineering and science by 2 percent or $27.2 million over four years in recognition of the importance of engineering in supporting innovation and economic growth in New Zealand (MoE).

According to the Department of Labour (2008), New Zealand produced around 1500 engineering graduates per year. However, the Institution of Professional Engineers of New Zealand (IPENZ) estimates that New Zealand will need 2000 to 2750 of new engineer graduates every year in order to meet its future labour demands (IPENZ, 2010).

The current government has increased the focus on performance in terms of output, efficiency, student achievement. Funding to the tertiary education organisations (TEOs) is closely tied to their ability to produce the outcomes sought by the government (MoE, 2014). This new shift of funding has led TEOs to prioritize raising academic performance of their students.

A significant body of research has been done on the cognitive and non-cognitive factors that affect tertiary student performances. Among the cognitive factors, many researchers found strong correlation between the success in high school mathematics and science subjects and the students' achievement especially in their first year of engineering or science programmes (Zhang, Anderson, Ohland & Thorndyke, 2004; French, Immekus & Oakes, 2005; Jin, 2013; Martin, Wilson, Liem & Ginns 2013, Anderson, 2014). In addition, Min, Zhang, Long, , Anderson and Ohland (2011) found high school mathematics scores a strong predictor of the dropout rate of engineering students. They asserted that the lower the high school mathematics score, the more likely the students are to drop out from the engineering course.

Leaver and Fernando (2013) analysed success rates in the three year civil engineering degree and two year civil engineering diploma at Unitec Institute of Technology. They found no significant dependency of success rate on either class size, mathematical content of the course, or the percentage mix of degree and diploma students in combined classes. Students' ability to make the transition from a directed learning environment at high school to a self-directed learning environment at Unitec was considered to be the most significant factor. McKensie & Gow (2004) found that the correlation between high school results and first year university academic performance is stronger for the school leaver than for mature-age students. For the mature students, the long gap of time between the two study periods diminishes the effect and they considered their first semester academic performance a better predictor on their subsequent performance. Martin et.al. (2014) also cited a number of researchers in support of the claim that preceding academic performance in university will strongly influence subsequent academic results.

Balduf (2009) and Honken & Ralston (2013) found that non-cognitive factors, in particular self-discipline and motivation, can have even stronger correlation with students' performance in tertiary education than high school academic results (11&12). Hence, some researchers viewed a combination of both cognitive and non-cognitive variables to be more effective in predicting students' success in tertiary education (Ting, 2001; French et al., 2005).

There are mixed views on the effect of age and work experience upon academic performance. Martin et. al. (2013) argued that while maturity and life experience might

enhance the self-directed learning required at university, the extended length of time away from formal education and other commitments in life could have negative impact upon their academic performance. Smith (2012) reported that though mature students show more enthusiasm towards study than the younger students, they were absent from classes more often due to their responsibilities and commitments in other aspects of life.

Purpose

The purpose of this study is firstly to find out if the admission of students who did not meet the entry criteria significantly affected the success rate in New Zealand Diploma in Engineering (NZDE). Secondly, to determine if the present National Certificate of Education Achievement (NCEA) Level 2 entry requirement is an adequate entry criterion for NZDE programmes to produce quality graduates as Engineering Technicians. Thirdly, to evaluate if prior study and work experience have effect on the success rate of students in the NZDE.

Background

Unitec offers both the two-year New Zealand Diploma in Engineering (NZDE) (Civil) and the three-year Bachelor of Engineering Technology (Civil). The NZDE programme offers Level 4 to Level 6 courses. It is accredited by New Zealand Board for Engineering Diplomas (NZBED) and falls under the internationally recognised Dublin Accord for engineering technician diplomas. The NZDE programme can be completed in a minimum of two years (four semesters) but part time students can take up to a maximum of 10 years to finish the course.

Students will be admitted into NZDE programme if they have the minimum total of 48 credits in the National Certificate of Education Achievement (NCEA) at level 2 in four subjects, with at least 12 credits in mathematics (Algebra, Calculus and Trigonometry). However, high school physics is not a prerequisite for this programme. There are two types of entry criteria in Unitec: the general admission for the post high school students and the special or discretionary admission for those above 20 years old and with relevant life or work experience. Alternatively, students not meeting the entry requirements can enter the one-semester Certificate in Foundation Studies prior to the NZDE programme.

All assessment in Unitec NZDE programmes is achievement based using an 11 point grading system with course grades range from A+ to E. A student needs to achieve at least a C- with the mark range of 50 to 54 to get a pass. Hence, the success rate of the NZDE courses in this study is defined as the percentage of students meeting at least the course grade of C-. Students who complete the NZDE can gain up to 50% credit in the Bachelor of Engineering Technology (Civil) (BEngTech).The BEngTech can then be completed in a further one and a half to two years. From 2010 to 2013, an average of 14% of Unitec NZDE students continued to the BEngTech.

In 2011, the low success rates in the New Zealand Diploma in Engineering - Civil (NZDE) were a cause for concern. Table 1 shows the average success rate of the eight compulsory courses in the first year of the study in 2011 as compared to the other years. The low success rate reflected negatively on the teaching staff and indirectly affected the quality of teaching for the programme. In addition government funding of the NZDE would be at risk if the success rate of the programme fell below 80%.

Table 1: Average success rate of the eight compulsory courses in the first year of study in the NZDE for 2009-2011

Year	2009	2010	2011	2012
Average				

success rate	56%	53%	44%	55%

The 2011 semester 1 new cohort of students in the NZDE programme were made up of 68 domestic and 12 international students. Of these, 67 are male and 13 are female students. About 30% of the domestic students who had not met the entry criteria of NCEA Level 2 were accepted into the programme. Although teaching staff were faced with a daunting task of raising the academic performance of the students, the case presents an opportunity to examine the performance over a period of three years of this group of students along with domestic students who met the academic entry criteria and special admission students aged 20 and above with prior study or relevant work experience.

Design/Methodology

In this longitudinal study, three categories of domestic students were identified and their success and retention rates in the NZDE courses analysed. They are: (A) students meeting entry criteria, (B) students not meeting entry criteria, and (C) special admission students aged 20 and above with prior study or relevant work experience. Table 2 shows the composition of the three categories of students. All the three categories of students are made up of students from different ethnicities.

Table 2: Composition of the three categories of domestic students

Categories of students	Number of Students			Age range (years)
	Male	Female	Total	
A. Students meeting entry criteria	21	4	25	17 - 21
B. Students not meeting entry criteria	17	3	20	17 -23
C. Students on special admission	14	3	17	23 - 49
Total	62			

These three categories of students were analysed over three years (six semesters) from 2011 to 2013 to establish their average semester success rates and first attempt success rates for eight Year One compulsory courses. As the international students only made up 15% of the new students and their overseas secondary school qualifications were vastly different, they were not included in the study group. The success rates of the four Year Two compulsory courses and eight elective courses were also not considered because of the small class sizes or underrepresented by one or more of the categories.

Results

Table 3 shows the first attempt success rate of the three categories of students for the eight compulsory papers in their first year of study. The figures shown below the percentages are the number of students taking the paper from each category. The number varies because not all students enrolled in the compulsory papers in their first year. Category B students normally enrolled in fewer papers in a semester than Category A students. Category C students also take fewer papers because most of them study part-time.

In 2011, this cohort of 80 students achieved an average of 44% success rate for the eight compulsory Year One courses. As can be seen from Table 4, the average success rates for Category A and Category C students were 6% and 17% better than the class average respectively. On the other hand, the average success rate of Category B students was 20% worse than the class average.

Table 3: Comparison of the first attempt success rate for the eight compulsory courses for the three categories of students in their first year of study

Category	DE4101	DE4102	DE4103	DE4201	DE4202	DE5201	DE5202	DE5207
A	46%	35%	54%	33%	41%	44%	56%	47%
No. of students	24	21	24	24	18	18	19	18
B	24%	20%	20%	20%	17%	44%	20%	31%
No. of students	17	10	14	15	12	10	10	13
C	62%	80%	60%	60%	67%	60%	67%	40%
No. of students	13	5	10	10	9	10	9	10
Class average	52%	39%	58%	35%	36%	48%	42%	40%
No. of students	90	70	79	80	77	73	74	86

Table 4: The success rate for the three categories of students for the eight compulsory NZDE Year 1 courses in 2011

Categories of students	Class average success rate	Group average success rate	Group average as compared to the class average success rate
A	44%	50%	+ 6%
B		24%	- 20%
C		61%	+ 17%

Figure 1: Comparison of average semester success rate for the three categories of students from NZDE 2011 cohort

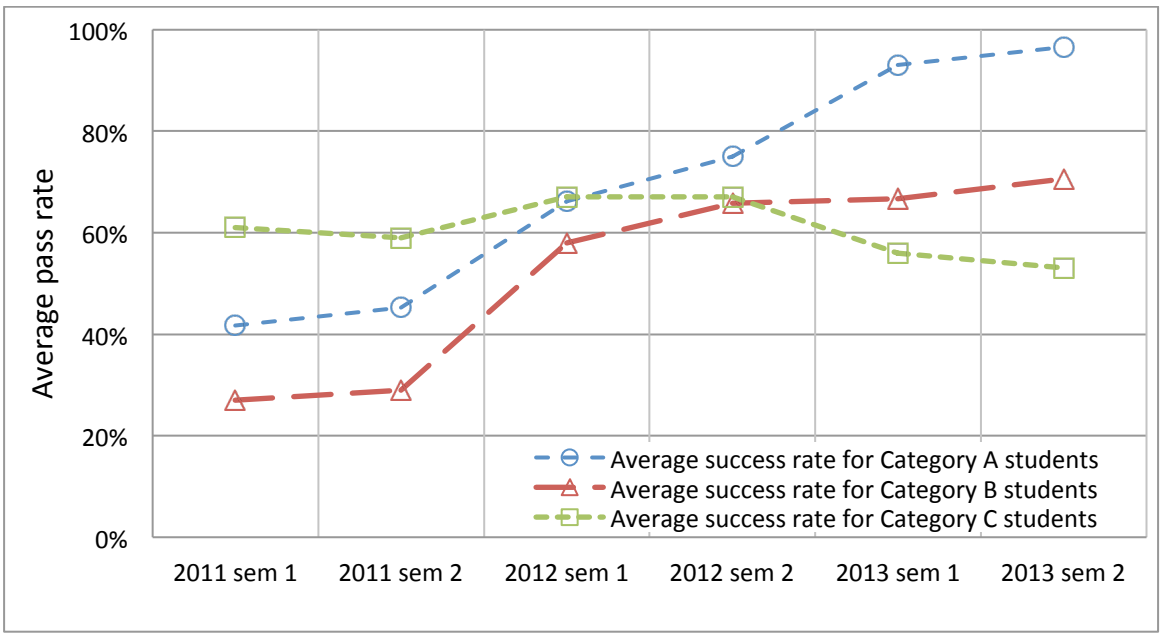

Figure 1 shows the semester average success rates of students for the three year period of this study. The average success rate for each category of students for each semester was calculated by taking the number of students passing the courses in relation to the total number of courses taken for that semester. Both Category A and B showed a similar increase in success rate with time, but the success rates of Category A were consistently 8% to 26% higher than Category B. Category C generally showed a flat success rate throughout the three years study period, hovering between 53% and 67%.

Discussion

As shown in Table 3, the Category A students, who satisfied the NCEA Level 2 requirement is consistently similar to the class average for the eight Year One courses . The significantly higher pass rate for Category A students over Category B students confirms the strong correlation between high school performance and tertiary academic performance as previously noted in many studies. At the same time, the performance of the Category A students and their continual outperforming the other groups as shown in Figure 1 also indicates the capability of the students with NCEA Level 2 in meeting the academic demands of tertiary education. It can be deduced that the present NCEA Level 2 requirement is an adequate entry criterion for Diploma in Engineering (Civil) study.

In comparison to Category A and B students; the performance of Category C students is the most consistent. At 61% as illustrated in Figure 1, this group has the highest success rate at the beginning of the course. This shows that they are better prepared to adapt to the self-directed learning environment than the other two groups of students. In addition, their prior study and relevant work experience would probably have helped them to understand the subject matter of their study better as well as providing the necessary motivation for them to excel. In addition, some of the students from this category were transferred from other tertiary organisations and already have the prior knowledge of tertiary study.

However, the performance of Category C students in Year Three falls behind the other two groups of students. This result is consistent with the view of Smith (2012) and Martin et.al. (2013) that the commitments and responsibilities outside of study for mature-age students can hinder their academic performance. On the other hand, the ongoing improvement in academic performance for Category A and B students defied the notion that academic results of preceding semesters are strong predictors of subsequent performance as claimed by McKensie & Gow (2004) and Martin et.al.(2014). Other factors for Category A and B students are relevant such as the adaption to a self- directed learning environment (Leaver and Fernando , 2013).

The overall low success rate of this cohort of students was not entirely caused by the poor academic performance of Category B students. Category B students only accounted for about 15% of the total number of students who were taking the eight compulsory courses. If they were excluded in the calculation for the class average success rate, the resulting change in the average success rate for the eight Year One compulsory courses is about 4%. For the low-success-rate courses such as Engineering Mathematics, Material (Civil), Land Surveying, and Geotechnical Engineering 1, the increase in success rates were only 3%, 3%, 2%, 1% respectively if the Category B students were excluded in study.

While the inclusion of the Category B students resulted in about a 4% drop in success rate for this cohort of students, we do not recommend that students who do not meet the current entry criteria be accepted into the NZDE programme. Other data not included in this study, show that Category B students have the highest dropout rate during their study. If more stayed in the programme the success rate in Year One would be even lower.

Given the small contribution of Category B students to the low pass rates of the 2011 cohort a further study should be undertaken to assess the influence of other factors on pass rate such as on the impact a new NZDE course syllabi in 2011.

Conclusion

From this longitudinal study of the three student categories over three years from semester One of 2011the results reveal firstly, that the students who met the entry criteria in Category A performed 6% better than the class average in Year One, and achieved the highest pass rates in Years Two and Three. This indicates that the present entry criterion for Category A is sufficient to meet the envisaged success rate of 80% set out by the government.

Secondly that the students who stayed on the course continued to improve academically irrespective of their academic performance at the beginning of their study. Thirdly the study shows that the students with prior study and work experience (Category C) performed much better than the rest of the class in Year One.

However, from Year 2 onwards, they were caught up by the rest of the class indicating that commitments and responsibilities outside their study could have affected their performance. Finally students who did not meet the entry criterion (Category B) did not have a significant adverse effect on the low success rates of eight Year One NZDE(civil) compulsory courses in 2011 at Unitec. If this category of students is excluded, the average success rate only increases by about 4% from 44% to 48%, which is still low when compared to Year 2009, 2010, and 2012 values.

We suggest a further study be undertaken to assess the influence of other factors on pass rate such as on the impact a new NZDE course syllabi in 2011.

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