Academic performance and persistence of on- and off-campus engineering and technology students

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***Abstract**: A study of more than 9000 unit enrolments in an Australian engineering program found that: the off-campus withdrawal rate was close to twice that for on-campus students; whether a student withdrew or not was highly correlated to mode of study; the rate of withdrawal was significantly different between the two student groups; the grade distribution for completing students was significantly different between the two groups; the mean final grade was significantly higher for off-campus students; the failure rate for off-campus students was significantly lower; and the overall wastage rate (withdrawn rate plus fail rate) was significantly higher for off-campus students.*

***Keywords**: academic performance, student persistence, off-campus study*

Introduction

Flexible delivery of engineering and technology education is now an essential component of the engineering education scene, catering for significant numbers of students who cannot attend traditional, full-time, on-campus studies. In Australia, most engineering and technology undergraduates studying in the off-campus mode are mature age students. The literature suggests that:

- engineering students have one of the highest withdrawal rates of all disciplines;
- off-campus students have higher withdrawal rates than on-campus students; and
- mature age students have higher withdrawal rates than conventional entry students.

This suggests that off-campus mature age engineering students would have a relatively high rate of withdrawal from their studies prior to completion. The literature also suggests that for those students who persist (don't withdraw), off-campus students have a better academic performance than their on-campus counterparts.

The engineering and technology programs at Deakin University in Australia cater for both on-campus conventional entry students and mature age off-campus students. Anecdotal reports from academic staff tended to support the general withdrawal and performance characteristics reported in the literature. However, no formal research had previously been conducted, and a cursory inspection of student academic records provided some counter examples to the accepted wisdom. To gain an objective understanding of the withdrawal and performance characteristics of both on- and off-campus students in the engineering and

technology programs at Deakin University, a study was undertaken on more than 9000 unit enrolments over the period 1996 to 2000.

Student persistence and academic performance

A 1968 study in the United Kingdom found that engineering and technology students had one of the lowest rates of course completion in the normal course time (68 percent) and the highest rate of non-completion of studies (21.8 percent) (University Grants Committee, 1968). Seymour and Hewitt, in an investigation of why United States science, mathematics and engineering (SME) students swapped study majors, found that 38.1 percent of commencing engineering students swapped out of a SME study major (Seymour & Hewitt, 1997). In a major United States study Astin reported that only 43 percent of first-year engineering students successfully completed their studies (Astin, 1993). Dobson, reporting on first-year progression rates in Australian universities in 1995, found that 22 percent of commencing engineering students where not successful in completing the first year of their studies, one of the lowest rates of all disciplines (Dobson, 1999). Shah and Burke using Australian student data in 1996 concluded that, 'An Engineering student has the least chance of completing a course…' (Shah & Burke, 1996). Urban et al., in a 1997 review of Australian students who commenced their studies in 1992, found that particular fields of study, including engineering, contributed negatively, irrespective of student characteristics, to the probability of the student completing their studies (Urban et al., 1999).

High withdrawal rates (30-80 percent) are historically reported for distance education programs (Rekkedal, 1972). Glatter and Wedell in 1971 suggested, 'The purely quantitative data on wastage in correspondence courses indicates two things: that it is much higher than would be expected in full time oral courses; and that it is particularly heavy in the early stages of a course...At examinations, correspondence students seem to do as well or better than their counterparts taught the same subject orally.' (Glatter & Wedell, 1971) McIntosh and Morrison reported on two Australian studies in 1965 and 1967 that showed an average 33 percent withdrawal rate for first year correspondence students, with only 34 percent eventually graduating, and a withdrawal rate of 34 percent for correspondence students compared to 12 percent for full time students (McIntosh & Morrison, 1974). The same source reported on student demand, progress and withdrawal in the first four years of operation of the Open University of the United Kingdom (OUUK). In 1971, 19 percent of students provisionally registered for study did not complete their final registration and, of those who did, another 19 percent withdrew prior to their course examination (McIntosh & Morrison, 1974). Woodley and Parlett reporting on OUUK students in 1982 found that 28 percent of provisionally enrolled new students did not complete their final registration, for all students finally enrolled 24 percent withdrew prior to their course examination and that the failure rate for those who sat their final examination was 6 percent; giving an overall 'wastage' figure of 29 percent of all enrolled students (Woodley & Parlett, 1983). They also found that in 1981 'technology' courses at the OUUK had the highest wastage rates of all first and second years courses, that for all students the highest drop-out rate occurs in the first two levels of study and that student drop-out rates in comparable international distance education institutions varied from 20 to 71 percent (Woodley & Parlett, 1983). Urban et al. in the 1997 review of Australian students noted above found that full-time students had the highest completion rate (73 percent) while external students had the lowest completion rate (37 percent); the mode of study was significantly correlated to academic outcome (Urban et al., 1999).

Many off-campus students are also mature age students; electing to study in the off-campus mode so as to be able to combine their work, study, family and/or other commitments. In a 1980 review of international literature on the academic performance of mature age students, Eaton reported that mature age students have comparable failure and withdrawal rates to conventional entrants, but achieve higher academic results than their younger counterparts (Eaton, 1980). In a 1980 review of Australian literature on the academic performance of mature age students, Eaton and West reported that mature age students perform better than conventional entrants do (fewer failures and higher average grade), but have a higher dropout rate (Eaton & West, 1980). Shah and Burke using Australian student data in 1996 concluded that the probability of course completion decreases with the age of the student and, in particular for engineering, 'A student who commences a course...in Engineering at an age of 24 years or more has a 50% or less chance of completing it.' (Shah & Burke, 1996)

The Deakin University engineering programs

The Deakin School of Engineering and Technology offers three year Bachelor of Technology (BTech), four year Bachelor of Engineering (BE), Masters and Doctoral engineering programs in flexible delivery mode. The undergraduate programs are delivered in both on-campus and off-campus modes. Conventional entry students would normally undertake these programs on-campus, full-time; with some of these students taking part or all of their studies part-time and/or off-campus in later years to better suit the employment or other personal circumstances. Mature age students may study the programs on-campus, full-time, but many elect to study off-campus and/or part-time because of employment or other commitments.

The flexible delivery and articulated entry characteristics of these engineering programs mean that students studying in off-campus mode form a significant proportion of the total student population at the Deakin School of Engineering and Technology. Hence it is important for the School to understand the characteristics and performance of this student group, along with those of the conventional entry student group studying on-campus. Previous research in the School identified that off-campus students are predominately mature aged at the commencement of their studies (Briggs, 1995), with a significantly different age distribution to their on-campus counterparts (on-campus mean = 18.5 years, standard deviation = 2.1; off-campus mean = 34.4 years, standard deviation = 7.2) (Palmer, 2001b). In the School there was anecdotal evidence that off-campus students had higher dropout rates, but those who persisted performed better academically than on-campus students. It was considered important to determine objectively the rates of persistence and academic performance of the two principal classes of students in the School. This was not intended to fuel any debate about which was the 'better' student group or the 'better' mode of study. Rather, it was intended to assist the academic staff of the School to understand the different characteristics of these two student groups so that teaching and learning strategies could be best adapted to their differing circumstances.

Methodology

This research study aimed to discover quantitative relationships between academic performance and mode of study via a longitudinal statistical analysis of student academic results in a representative cross section of study units from the undergraduate engineering programs at Deakin University. Ten units of study were selected from the first two years of the Deakin engineering programs. The units were chosen because they were core units common to all or most of the engineering disciplines on offer, hence capturing the full

diversity of the major study areas selected by students, as well as having relatively large enrolments to enhance the validity of statistical comparisons. Various units included significant laboratory work, computer programming, mathematical problem formulation and solution, case study investigation, essay/report writing, spatial visualization and CAD drafting. The list of units included in the study and their nominal year level are included in Table 1.

Unit code	Unit name	Year level
SCC172	Basic programming concepts	1
SCM113	Discrete mathematics	1
SCM124	Introduction to mathematical modelling	1
SCM228	Engineering mathematics	2
SEB121	Fundamentals of technology management	1
SEB221	Managing industrial organizations	2
SED102	Engineering graphics and CAD	1
SEM111	Materials 1	1
SEM212	Materials 2	2
SEP101	Physics 1A	1

Table 1: Units included in the research study

From the university student information database, enrolment and results data were downloaded for each of the units identified in Table 1 for the years 1996 to 2000 inclusive, and the following statistics were compiled for each unit in each year:

- number of students enrolled - all/on-campus/off-campus;
- percentage of enrolled students withdrawn - all/on-campus/off-campus;
- chi-square test of independence of study mode and withdrawn status;
- large sample inference test of the proportions of withdrawn students in the on- and off-campus groups;
- excluding withdrawns, chi-square test of homogeneity for the distribution of final grades (fail/pass/credit/distinction/high distinction) between on- and off-campus students;
- excluding withdrawns, mean final score - all/on-campus/off-campus;
- excluding withdrawns, one-way analysis of variance (ANOVA) test of mean final score for on- and off-campus groups;
- excluding withdrawns, percentage of students who failed to pass - all/on-campus/off-campus;
- excluding withdrawns, large sample inference test of the proportions of failed students in the on- and off-campus groups;
- percentage of enrolled students ‘wasted’, that is, the percentage of withdrawn and failed students combined; and
- large sample inference test of the proportions of wastage in the on- and off-campus groups.

For each unit the data for the five years 1996 - 2000 was combined and the above statistics were re-compiled to provide an overview of each unit. Finally, all data collected was combined and the above statistics were re-compiled to provide an overview of student performance in the engineering programs at Deakin University. For this research project, a statistical significance level of 0.01 was used.

Results

The data collected represents 9245 student enrolments in individual units of study (subjects). 5922 (64.1 percent) of these enrolments were on-campus students and 3323 (35.9 percent) were off-campus students. Table 2 presents the results compiled for each unit from the combined summary unit data over the period 1996 to 2000. Any significant deviation in the data for particular years compared to the combined summary results is noted in the Discussion below. Table 2 also presents the overall results compiled from all of the collected data combined. Where there is a statistically significant difference between on- and off-campus results ($p \leq 0.01$) the data pair are shaded. Figure 1 presents the distribution of final grades for on- and off-campus students based on all data combined.

Unit	Study mode	Enrolment (no.s)	Enrolment (%)	With-drawn	Mean score	Failed	Wastage
SCC172	On-c	641	62.9 %	24.5 %	57.2 %	22.3 %	41.3 %
	Off-c	378	37.1 %	48.7 %	60.1 %	23.3 %	60.6 %
	All	1019	100.0 %	33.5 %	58.0 %	22.6 %	48.5 %
SCM113	On-c	615	71.9 %	20.5 %	60.4 %	20.9 %	37.1 %
	Off-c	241	28.1 %	36.5 %	60.3 %	24.2 %	51.9 %
	All	856	100.0 %	25.0 %	60.4 %	21.7 %	41.2 %
SCM124	On-c	672	66.5 %	32.6 %	51.3 %	33.6 %	55.2 %
	Off-c	339	33.5 %	59.9 %	54.1 %	29.4 %	71.7 %
	All	1011	100.0 %	41.7 %	51.9 %	32.6 %	60.7 %
SCM228	On-c	387	56.8 %	23.0 %	58.4 %	16.8 %	35.9 %
	Off-c	294	43.2 %	32.0 %	63.1 %	13.5 %	41.2 %
	All	681	100.0 %	26.9 %	60.3 %	15.5 %	38.2 %
SEB121	On-c	697	75.3 %	26.7 %	61.0 %	17.2 %	39.3 %
	Off-c	229	24.7 %	52.4 %	65.3 %	14.7 %	59.4 %
	All	926	100.0 %	33.1 %	61.7 %	16.8 %	44.3 %
SEB221	On-c	515	49.8 %	26.2 %	63.7 %	12.4 %	35.3 %
	Off-c	520	50.2 %	40.0 %	65.8 %	12.2 %	47.3 %
	All	1035	100.0 %	33.1 %	64.7 %	12.3 %	41.4 %
SED102	On-c	782	69.6 %	38.0 %	55.3 %	26.4 %	54.4 %
	Off-c	341	30.4 %	57.5 %	63.5 %	17.9 %	65.1 %
	All	1123	100.0 %	43.9 %	57.2 %	24.4 %	57.6 %
SEM111	On-c	611	58.3 %	36.2 %	64.6 %	15.1 %	45.8 %
	Off-c	438	41.7 %	58.9 %	65.5 %	20.6 %	67.4 %
	All	1049	100.0 %	45.7 %	64.8 %	16.8 %	54.8 %
SEM212	On-c	190	50.7 %	16.8 %	61.3 %	14.6 %	29.0 %
	Off-c	185	49.3 %	26.0 %	66.5 %	9.5 %	33.0 %
	All	375	100.0 %	21.3 %	63.7 %	12.2 %	30.9 %
SEP101	On-c	812	69.4 %	20.9 %	57.7 %	25.9 %	41.4 %
	Off-c	358	30.6 %	47.5 %	67.1 %	20.2 %	58.1 %
	All	1170	100.0 %	29.1 %	59.8 %	24.6 %	46.5 %
All units combined	On-c	5922	64.1 %	27.6 %	58.7 %	21.5 %	43.1 %
	Off-c	3323	35.9 %	47.2 %	63.4 %	18.1 %	56.8 %
	All	9245	100.0 %	34.6 %	60.1 %	20.5 %	48.0 %

Table 2: Summary results for individual units and all units combined

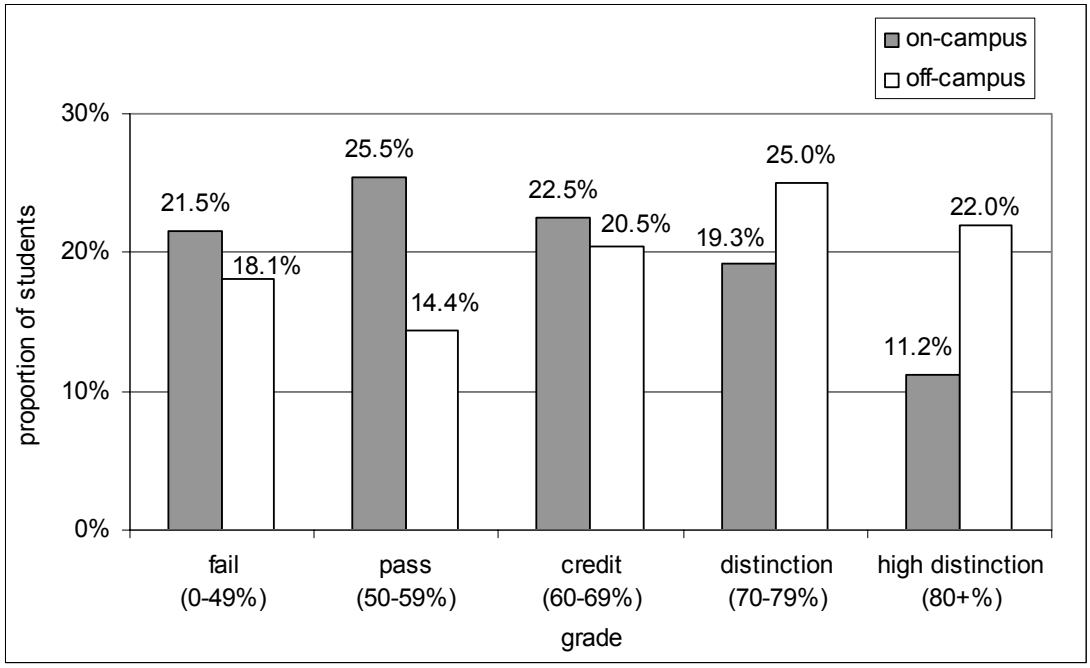

Figure 1: Distribution of final grades based on all data combined

Discussion

Overall

Combining all collected data, the following observations were made. Overall, the off-campus withdrawal rate was close to twice that for on-campus students, whether a student withdrew or not was highly correlated to mode of study ($\chi^2_5 = 541.528$, $p < 1 \times 10^{-114}$) and the rate of withdrawal was significantly different between the two student groups ($Z = -19.062$, $p = 0.000$). The grade distribution for completing students was significantly different between the two groups ($\chi^2_4 = 199.109$, $p < 1 \times 10^{-41}$) (see Figure 1) and the mean final grade was significantly higher for off-campus students ($F_1=66.684$, $p < 1 \times 10^{-15}$). The failure rate for off-campus students was significantly lower ($Z = -3.008$, $p < 0.003$), and the overall wastage rate was significantly higher for off-campus students ($Z = -12.570$, $p = 0.000$).

Persistence

In all except one (SEM212 in 1996) of the fifty cases investigated the off-campus withdrawal rate was found to be greater than the corresponding on-campus rate, and in a majority of cases the difference was statistically significant. After combining the five sets of data for each unit, only one unit (SEM212) out of ten had a withdrawal rate that wasn't significantly different between the two student groups – the enrolment in SEM212 was significantly less than other units, leading to less robust statistical inferences.

When withdrawal and failure rates were combined to yield wastage, there were only two units (SCM228 and SEM212) out of ten where the wastage rate wasn't significantly greater for off-campus students. It is interesting to note that SCM228 is a second year mathematics unit that follows on from SCM113 and SCM124, and SEM212 is a second year materials unit that follows on from SEM111. It could be suggested that students experiencing difficulty in these subject areas may have already withdrawn or failed at the first year level, leading to lower wastage rates at the second year level. The high wastage rate at the commencement of studies for off-campus students is noted in the literature (Glatter & Wedell, 1971). It is

further noted that the only other second year level unit included in the study is SEB221, a second year engineering management unit that follows on from SEB121. Unlike SCM228 and SEM212, SEB221 did have a significantly higher wastage rate for off-campus students. But, many off-campus students are routinely exempted from SEB121 because of recognition of prior learning (RPL). So, for many off-campus students SEB221 will be the first unit in the engineering management studies stream that they encounter, and hence it may also have a higher wastage rate similar to many first year level units.

The overall wastage rate obtained by combining data from all units, for all years and both modes of study was 48.0 percent; this implies a persistence rate of 52.0 percent. This result is likely to be influenced both by the significant proportion of off-campus/mature age students in the survey group (who have high wastage rates) and the fact that the data is drawn from first and second year level units (which have high wastage rates). However, it is not markedly lower than the value of 55.8 percent reported in 1997 for all Australian engineering and surveying students who commenced their studies in 1992 (Urban et al., 1999).

Academic performance

After combining the five sets of data for each unit, the grade distributions of the two student groups were equally split; five were significantly different and five were not. While for the mean final grade four units were significantly different and six were not. As noted previously, when all data was combined, the overall grade distribution and mean final grade were significantly different, with off-campus students showing a mean final grade approximately 4.7 percent higher than on-campus students. In only two of the fifty cases investigated was the off-campus failure rate significantly different to the on-campus rate. Additionally, in both cases the off-campus failure rates were not markedly different from other years; the difference was that the corresponding on-campus failure rates were dramatically lower than other years.

General

Off-campus student success is affected by both internal and external factors. While some of these external factors are beyond the control of the university, there is much that the university can do to address internal factors within its control and reduce student wastage. University educational and administration systems are often designed around an idealized model of student preparation and circumstances. While a vision of an ‘average’ student may be a workable approximation for conventional entry on-campus students, the diversity of off-campus/mature age students requires more flexible university systems (Palmer, 2001a); there is a need to recognize the ‘complex personal equations operating with individuals’ (Woodley & Parlett, 1983) and design systems to accommodate them.

Conclusions

Based on a longitudinal study of 9245 unit enrolments in first and second year level units in the undergraduate engineering programs at the Deakin University School of Engineering and Technology, the conventional wisdom regarding the persistence and academic performance of off-campus students was confirmed. It was found that overall:

- the off-campus withdrawal rate was close to twice that for on-campus students;
- whether a student withdrew or not was highly correlated to mode of study;
- the rate of withdrawal was significantly different between the two student groups;
- the grade distribution for completing students was significantly different between the two groups;

- the mean final grade was significantly higher for off-campus students;
- the failure rate for off-campus students was significantly lower; and
- the overall wastage rate (withdrawn rate plus fail rate) was significantly higher for off-campus students.

Additionally, it was found that the year level of the unit influenced the off-campus wastage rate. Where the unit was the first in a study stream sequence to be encountered by off-campus students, the wastage rate was significantly higher than for on-campus students enrolled in the same unit. Where the unit was the second in a study stream sequence, there was no significant difference between on- and off-campus wastage rates.

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