International Education Journal, 2006, 7(3), 371-378.
ISSN 1443-1475 © 2006 *Shannon Research Press*.
http://iej.com.au

Relationship between entry qualifications and performance in graduate education

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It is generally accepted that the undergraduate cumulative point average (UCPA) is associated with graduate performance of the same discipline. Less known, however, is how good the UCPA at predicting graduate performance in a different discipline. This paper discusses a study on the relationship between UCPA, undergraduate program of study, and graduate performance – operationalised as graduate CPA (GCPA) – in a Master in Technical and Vocational Education program (MTVE). Data were gathered on UCPA, their undergraduate program of study, gender and previous university of 612 MTVE students using their application forms and academic records. The large number of programs of study was reduced to five groups of disciplines namely, Civil Engineering, Electrical Engineering, Mechanical Engineering, Business and Management, and Others. Descriptive statistics and linear regression were used to analyse the data. The results showed that both undergraduate program of study and UCPA are predictors of GCPA and the extent to which UCPA contributes towards GCPA varies across programs of study.

Graduate studies, undergraduate performance, teacher training, technical education, correlation

INTRODUCTION

One quality indicator of undergraduate students that has been consistently used for entry selection into graduate programs is the undergraduate Cumulative Grade Point Average (CPA) which in this paper refers to the average of credit points obtained at the end of a program study as opposed to the Grade Point Average, which refers to the credit points obtained for a specific semester of study. The CPA has also been generally accepted as the indicator of graduating quality graduate education. The question is how good really is the undergraduate CPA (UCPA) at predicting graduate CPA (GCPA)?

This paper discusses the findings of a preliminary study on one of the graduate programs in the University (i.e., the Master in Technical and Vocational Education (MTVE) program). The study came into being as a result of a mixture of professional curiosity and the need to review the current entry requirements into the university graduate programs. It was felt that the findings may be relevant to policy decision-making in the University as well as other universities that offer similar kind of programs.

MTVE program

The MTVE program is a program for training teaching staff in post-secondary technical institutions under the Malaysian Ministry of Higher Education, namely, polytechnics and community colleges. It is a pre-service teacher training program. As such, the students who are enrolled into this program are fresh graduates who have had no formal professional training in teaching although a limited few (less than 1% going by their application form records) may have had some teaching experience as part-time teachers. This university is one of two universities that provide trained technical teachers for technical institutions under the Ministry of Higher Education. The program is a special one as it is only offered to those under the sponsorships of the Ministry of Higher Education.

The MTVE program is a 3-semester program, designed with two major components, a professional training component and an academic component, which is atypical of master of education programs in Malaysia. Typical master of education programs are without the professional training component as these programs are normally offered to in-service teachers. To fulfil the professional training component requirement, students undergo two teaching practicums for a specified duration, which are implemented during the semester break. Teaching practicum is given a pass or a fail grade and the grade obtained does not count towards GCPA. Similar to other master's programs, MTVE students are also required to do a master's project spread out over a period of two semesters in addition to other education courses (such as, measurement and evaluation, psychology, statistics in education and pedagogy). As a consequence, the MTVE program is quite a demanding one when compared to other master of education programs.

Another unique aspect of the MTVE program is its students, whose undergraduate qualifications vary from Engineering to Hospitality. The varied disciplines reflect the human resource needs of the technical institutions that these graduates are supposed to serve.

Admission policy

Admission into the MTVE program is undertaken through a two-phase process. The first phase is conducted by the Ministry of Higher Education prior to the first degree of the candidates. The second phase is by the university based solely on the UCPA. Current University policy states that a minimum UCPA of 2.5 from an accredited university is the necessary requirement for entry into its master's program including the MTVE program. Under rare circumstances, considerations for admission with lower UCPA are given where applicants have had several years of experience in the related field. The single entry criterion was found to be adequate initially as the number of places offered by the University was sufficient to meet the demand of the Ministry of Higher Education. However, recently the number of candidates that the University received has increased beyond what can be easily accommodated by the University. Furthermore, certain trends in the incoming candidates that may impact success in graduate education were also observed. For example, casual observations indicated that candidates of certain disciplines tend to come from a certain university, and certain disciplines tend to have candidates of higher UCPA compared to other disciplines. As the university is a major producer of trained technical teachers for post secondary technical institutions, it is of utmost importance that the university produce not only the right quantity but also the right quality of the human resource needs of the country, which can be achieved through the appropriate choice and training of candidates. Therefore, there is the need to review the current entry requirement to ensure a fairer selection procedure and a more balanced mix of graduate students in the MTVE program.

PREDICTOR VARIABLES FOR GRADUATE SUCCESS

The literature provides a wide array of studies that attempts to identify the one best predictor variable for success in graduate studies. Variables studied include Graduate Record Examination

(GRE) scores, Graduate Management Aptitude Test (GMAT), class of undergraduate degree (first/second-upper), academic ability as rated by academic advisors, as well as scores on non-cognitive measures. The indicators for graduate performance also vary from one study to another, which may include first year grades, mid-program grades, subjects' grades at advanced levels and GCPA.

The results on GRE studies appear to vary from one discipline to another. Within the same discipline, the correlation also varies from one subject to another. For example, House and Johnson (2002) found that the correlation coefficients between GRE scores and subject grades in advanced psychology range from 0.24 – 0.58. Studies on GMAT show that the correlation between GMAT scores and mid-program grades is about 0.48 (Graduate Management Admission council (GMAC), 2005). A validity range of 0.30 to 0.40 is generally considered good for standardised admissions tests, making the GMAT an outstanding predictor.

Correlations between class of undergraduate and graduate performance is also weak as shown by Lane et al., (2003) who did a study on hospitality students and found that the correlation between class of undergraduate degree and GCPA is about r=0.24, p<0.01. They also found that students with first class honours down to upper second class do consistently well in graduate studies while those below vary in their performance. Their study covers all the classes of the undergraduate degree, from the third class to first class degree.

Kuncel, Hezlett, and Ones (2001) and Braunstein (2002) found similar strength of relationships (i.e., a correlation of 0.3 between UCPA and GCPA). Kuncel, Hezlett, and Ones (2001) uses the first year GCPA rather than the graduating CPA. Using a different undergraduate performance indicator, Wardlow, (1989) who did a study on success in Agricultural education for international students studying in the USA found that the correlation between undergraduate academic ability as rated by academic advisors and GCPA to be 0.38. However, Micceri (2002) did not find support for the relationship between UCPA and graduate success when "graduate" and "do not graduate" is used as the operationalisation for graduate success. Absence of association between UCPA and CGPA is also supported by Truitt (2002) whose study was on MBA.

Overall, the literature shows that the relationship between entry qualifications and graduate performance has not been consistent depending on the specific indicators used for success in graduate education as well as varying across graduate program of study. In cases where statistically significant correlations are found, the correlations between undergraduate performance and graduate performance are weak (i.e., between 0.24-0.38 with standardised admission test giving the highest correlations to graduate performance). The purpose of the current study therefore, was to determine to what extent graduating UCPA contributes towards success in the MTVE program, operationalised as graduating GCPA. Also of interest was to determine if the contribution of UCPA towards GCPA varies across undergraduate program of study.

METHODS

Sources of data were students' application forms and academic records from the June 2001 intake to the June 2003 intake. These records furnished complete data on UCPA, undergraduate program of study, previous university attended and GCPA. A limited number of records provided additional information on previous experience and co-curricular activities. However, these data were too limited to be useful and therefore were not included in any of the analyses. Descriptive statistics were used to analyse data on demography and multiple regressions were used to determine the contribution of two factors of interest, namely, UCPA and undergraduate program of study on GCPA.

Due to the large number of undergraduate programs of study found, they were regrouped into five categories of disciplines based on their contents (judged qualitatively by the authors), namely Civil Engineering, Electrical Engineering, Mechanical Engineering, Business and Management, Building and Planning, and Others. The "Others" category is created to incorporate other undergraduate programs that cannot be grouped with any of the four categories. Programs identified as "Others" include Textile Design, Town Planning and Geoinformatics. Six hundred and twelve complete records of students from the Master in Technical and Vocational Education program were analysed.

RESULTS

Description of sample

Of the 612 students, 214 (35%) and 398 (65%) are males and females respectively. Females make the larger proportion of every cohort (Male:Female [M:F] ~30:70) except in cohort five where male students constitute a larger proportion (M=56% and F=44%). The larger proportion of males in this particular cohort is due to a larger proportion of males obtaining scholarships from the Ministry of Higher Education. Table 1 shows the distribution of students according to gender and cohort.

Table 1. Distribution of students according to gender and cohort

Cohort		June 2001	Nov. 2001	June 2002	Nov. 2002	June 2003	Total
Gender	M	40	36	53	21	64	204
	F	112	81	101	54	50	398
Students (*N*)		152	117	154	75	114	612

The distribution of students according to program of study varies as follows: Electrical Engineering (25.5%), Civil Engineering (23.0%), Business and Management (29.6%), Mechanical Engineering (14.4%), and Others (7.5%). The specific undergraduate programs that feed into each cohort is determined by the Ministry of Higher Education based on projected needs of the recipient technical institutions. The top five universities that feed into the program are the Tun Hussein Onn University College of Technology (47.2%), the University of Utara Malaysia (19.8%), the University of Technology Malaysia, (11.4%), and the MARA University of Technology (9.6%). The percentage of students that did not finish their studies within the minimum three semesters duration is given in Table 2. Data on these students are excluded from our analyses.

Table 2. Percentage of students who fail to complete within three semesters

Cohort	June 2001	Nov. 2001	June 2002	Nov. 2002
Percentage who failed to complete within three semester	2%	14%	2%	5%

The higher percentage of incompletion rate in the second cohort is mainly due to students failing to complete their master's projects on time. The effect of the higher incompletion rate on the overall study is uncertain. However, a localised effect is suggested as seen by the absence of association between UCPA and GCPA for the second cohort, which is inconsistent with the correlation coefficients of the other cohorts (Table 3).

Table 4 shows the descriptive statistics for UCPA and GCPA for each cohort. The UCPA diminishes over time and the mean difference between cohort 1 and cohort 5 is statistically significant, t=4.765, p<0.001(two-tailed, n_1=152, n_5=114, df=264). However, the lowest mean ($\bar{x}$=2.66) is still above the minimum UCPA stipulated by the university which is a UCPA of 2.5. The reason for the diminishing UCPA was mainly due to selected students taking up employment instead of enrolling into the program.

Table 3. Correlations coefficients between UCPA and CGPA according to cohort

Cohort	June 2001	Nov. 2001	June 2002	Nov. 2002	June 2003
Correlation between UCPA and GCPA	r=0.31*	r=0.03	r=0.40*	r=0.39*	r=0.44*
n	152	117	154	75	114

*Statistically significant, p<0.01 (two tailed)

Table 4. Descriptive statistics for UCPA and GCPA according to cohort

	UCPA		GCPA	
Cohort	$\bar{x}$	s	$\bar{x}$	s
June 2001	2.85	0.31	3.56	0.12
Nov. 2001	2.83	0.29	3.60	0.11
June 2002	2.79	0.32	3.46	0.14
Nov. 2002	2.72	0.27	3.54	0.11
June 2003	2.66	0.32	3.44	0.14

Relationship between UCPA, graduate program of study, and GCPA

Regression analysis was used to determine the extent to which UCPA and graduate program of study contributes towards GCPA. Prior university was not included as the undergraduate program of study was closely associated with university attended. There were no outliers according to Cook's D and the studentised deleted residual. Descriptive statistic for UCPA and GCPA for n = 612 gives an r=0.353 which is statistically significant at alpha =0.05 (two-tailed). Linear regression for UCPA and GCPA shows that UCPA is a predictor of GCPA, $F(1,610) = 86.85$, $MSE = 0.018$, $p<0.001$, $Adj.\ R^2$=0.123.

Multiple regressions were used to determine if program of study contributes towards GCPA. To facilitate the analysis, the five categories of program of study were first transformed into four dummy variables F1 (Civil Engineering), F2 (Electrical Engineering), F3 (Mechanical Engineering), and F4 (Others), with Business and Management chosen as the reference variable because it has the largest number of cases. Multiple regressions show that program of study as a group was a predicator of GCPA when controlling for UCPA, $F(5,606) = 21.83$, $MSE = 0.018$, $p<0.001$, $Adj.\ R^2$=0.146 (with $F_{change} = 5.003$, $R^2_{change} = 0.028$, p *for* $F_{change}= 0.001$). UCPA was also found to be a predictor for GCPA when controlling for program of study, $t = 8.25$, $p<0.001$.

To determine if UCPA and program of study interact in their prediction of GCPA, an interaction term "F*UCPA" was introduced by multiplying field of study and UCPA. Program of study was found to interact with UCPA when predicting GCPA, $F\ (9,602) =14.628$, $MSE = 0.018$, $p<0.0001$, $Adj.\ R^2$=0.167 (R^2_{change}=0.027, F_{change}=4.919, p for $F_{change} = 0.001$). The descriptive statistics are shown in Table 5. An alpha of 0.05 was used for each test unless otherwise stated and the regression model is shown in Table 6. As a consequence of the interaction result, regression models predicting graduate CPA using UCPA were reported for each program of study (Table 7). UCPA was found to be a significant predictor of GCPA for Civil Engineering, Electrical Engineering, Mechanical Engineering, and Business and Management, but not for programs grouped under the 'Others' category.

DISCUSSION

The purpose of this study was to determine the extent to which UCPA and undergraduate program of study contribute towards GCPA in a master in an MTVE program. The first objective was to determine how much UCPA on its own contributes towards GCPA. Bivariate correlations indicate that the relationship between UCPA and GCPA for the MTVE program is weak but statistically significant ($r = 0.353$, $p<0.01$). The positive correlation indicates that as UCPA increases, GCPA also tends to increase. The correlation found in this study is consistent with the those found in

similar studies such by Kuncel et al., (2001); Braunstein (2002); Lane et al., (2003), Wardlow, (1989) and GMAC, (2005) keeping in mind that these studies did not necessarily use UCPA or GCPA as the operationalisations of undergraduate and graduate performance. In fact none of these studies use graduating UCPA and graduating GCPA for their bivariate correlation analysis. Therefore, the finding in the present study is important because it provides empirical evidence for the relationship between UCPA at graduation – the most often used criterion for graduate admission – and CGPA at graduation. However, it is also important to note here that the variance in GCPA at graduation accounted for by UCPA is only 12.3 per cent leaving a large amount of variance still unexplained.

Table 5. Descriptive statistics for all variables

Program of study	Variable	$\bar{x}$	*s*	*r*
Civil Engineering (*N*=141)	UCPA	2.72	0.27	.418*
	GCPA	3.48	0.14	
Electrical Engineering (*N*=156)	UCPA	2.64	0.29	.198*
	GCPA	3.52	0.14	
Mechanical engineering (*N*=88)	UCPA	2.67	0.36	.535*
	GCPA	3.48	0.16	
Business and Management (*N*=181)	UCPA	2.92	0.25	.315*
	GCPA	3.56	0.12	
Others (*N*=46)	UCPA	3.04	0.34	-.104
	GCPA	3.54	0.14	

*Statistically significant, $p<0.05$

Table 6. Regression model for predicting graduate CPA

Predictor	B	SE(B)	β
Constant	3.098	0.115	
UCPA	0.159	0.039	0.347
F1	-0.222	0.161	-0.645
F2	0.161	0.150	0.485
F3	-0.264	0.157	-0.639
F4	0.583	0.225	1.061
F1*UCPA	0.063	0.057	0.499
F2*UCPA	-0.061	0.054	-0.487
F3*UCPA	0.081	0.056	0.531
F4*UCPA	-0.205	0.075	-1.142

$p<0.05$; $F(9,602)$, $MSE=14.626$, $p=0.000$, $Adj.R^2=0.17$, for the Regression Model. F1=1 if Civil Engineering, 0 if otherwise. F2=1 if Electrical Engineering, 0 if otherwise, F3=1 if Mechanical Engineering, 0 if otherwise and F4=1 if Others, 0 if otherwise

A second objective of the study was to determine the extent to which program of study as a whole contributes towards GCPA. The result of multiple regression shows that program of study contributes 2.8 per cent towards GCPA in addition to the 12.3 per cent contributed by UCPA. Although the percentage change in contribution is small, it is statistically significant ($p=0.001$), strongly suggesting that program of study is also a predictor of success for the MTVE program, and therefore needs to be considered together with UCPA in students admission.

The third objective of the study was to determine whether undergraduate program of study has a moderating effect on UCPA when predicting GCPA. Multiple regression result shows that UCPA and program of study interact in the prediction of GCPA and is statistically significant (p for F_{change} <0.001) with the interactive term accounting for a further 2.7 per cent of the variance in GCPA making the total variance in GCPA accounted for by the full model to be 16.7 per cent.

Table 7. Regression models for predicting GCPA by program of study

Predictor		B	SE(B)	β
Civil Engineering [1]	Constant	2.875	0.112	
	UCPA	.222**	0.041	0.418
Electrical Engineering [2]	Constant	3.259	0.105	
	UCPA	.098*	0.039	0.198
Mechanical Engineering[3]	Constant	2.834	0.110	
	UCPA	.241**	0.041	0.535
Business and Management[4]	Constant	3.098	0.105	
	UCPA	.159**	0.036	0.315
Others[5]	Constant	3.33	0.394	
	UCPA	0.054	0.131	0.123

*Statistically significant at Alpha=0.05; **Statistically significant Alpha =0.001; [1]$F(1,139) = 29.46$, $MSE = 0.017$, $p < 0.001$, *Adj.* $R^2 = 0.169$; [2]$F(1,154) = 6.28$, $MSE = 0.02$, $p = 0.013$, *Adj.* $R^2 = 0.033$; [3]$F(1,86) = 34.47$, $MSE = 0.019$, $p < 0.001$, *Adj.* $R^2 = 0.278$; [4]$F(1,179) = 19.72$, $MSE = 0.015$, $p < 0.001$, *Adj.* $R^2 = 0.094$; [5]$F(1,44) = 0.486$, $MSE = 0.019$, $p = 0.490$, *Adj.* $R^2 = -0.012$

The statistically significant R^2_{change} upon introduction of the interaction term into the model calls for a separate model for each undergraduate program of study. The descriptive statistics given in Table 5 show that UCPA has the strongest correlation with GCPA for Mechanical Engineering category (r=0.535, p<0.01, n=88) and the weakest for the "Others" category (r=0.16, p>0.05, n=46). As a reminder, the Others category is made up of all undergraduate program of study that cannot be grouped with the other four categories. The absence of correlation between UCPA and GCPA is supported by Truitt (2002) who did a study on 158 MBA students. This means, for some disciplines, UCPA is not associated with GCPA and therefore should not be used as a criterion for students' selection.

Based on the individual regression model, a candidate from the Mechanical Engineering is expected to experience the highest increase in graduate CPA – an increase of 0.241 for each unit of change in UCPA with everything else being constant. The full model for Mechanical Engineering accounts for 27.8 per cent of the variance in GCPA. An increase of 0.222 in GCPA is expected for a candidate from the Civil Engineering discipline, 0.159 for Business and Management and 0.098 for a candidate from the Electrical Engineering discipline with everything else being constant. It is, however, not possible to predict GCPA from UCPA for candidates from the Others category.

As a result of this study, the University is better informed on the interaction between undergraduate program of study and UCPA and therefore can take appropriate steps in the selection of candidates for the MTVE program. Based on this study, two students from different discipline are not expected to perform similarly at graduation. Knowing what predicts is also good from the perspective of training needs, because the University can now pay more attention to the group of students that appear to need it and take the appropriate steps to help them.

Overall, the findings from this study are potentially useful in the prediction of success in the MTVE program. However, as mentioned above, GCPA in the MTVE program does not include students' grades from their teaching practicum – an indicator of graduate professional competence in teaching, which is one of the expected outcomes of a teacher education program. Therefore, a more encompassing operationalisation for the concept of success in graduate education may be necessary.

CONCLUSIONS

The purpose of the current study was to determine the extent to which UCPA and undergraduate program of study contribute towards success in MTVE program. The data appear to support the following conclusions: (a) students who come in with high UCPA tend to graduate with high

GCPA, (b) undergraduate program of study is associated with success in graduate education, (c) the extent to which GCPA can be predicted from UCPA depends on the undergraduate program of study. In others words, UCPA of some undergraduate program of study are better predictors than others.

Regarding students' admission, the findings from this study strongly suggest that UCPA should no longer be used as the sole criterion for admission into the MTVE program or programs where the undergraduate discipline of study is different from the graduate discipline. In cases where a choice has to be made between two applicants, rejection or acceptance of a candidate should not be made without prior consideration of other factors such as their undergraduate program of study. Since the variance in GCPA accounted for by UCPA varies to a maximum of 28 per cent – depending on the undergraduate program of study – a large amount of variance in still left unexplained, which means other factors need to be considered for a better prediction model of GCPA.

This study is based on data from a coursework program and therefore the relationship may not be true for the research program. The operationalisation of graduate success in the current study also excludes professional competence. Therefore, future research could include grades on professional competence – where relevant – in the operationalisation of success in graduate education.

ACKNOWLEDGEMENT

The authors would like to acknowledge the contribution of Assoc. Prof. Dr. Zurinah Suradi towards the analysis and interpretation of the results.

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