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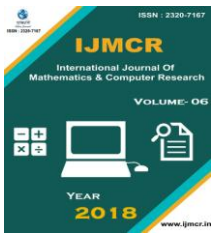

Academic Performance Factors of Malaysian Matriculation Students

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ABSTRACT

The performance of Malaysian Matriculation graduates has gained attention from local universities and researchers, and is always compared with STPM, Diploma and Foundation graduates. This study aims to evaluate the factors that contribute to academic performance of Matriculation students. The factors considered were grouped into four categories; demographic, financial, prior education, and current education. Two datasets (cohorts) were gathered from a Matriculation college administration system. Descriptive statistics and multiple linear regression were used to analyze the data. The results showed that prior education factors ranked first, followed by demographic and current education. The most significant factor of prior education is SPM grade in Mathematics.

KEYWORDS: Matriculation Students; Performance Factors; Multiple Linear Regression

1. INTRODUCTION

Under Malaysia education system, SPM (Malaysian Certificate of Education) holders who plan to further their study at public universities (UAs) can apply for pre-university programmes such as Form Six and Matriculation by the Ministry of Education (MOE) Malaysia, Diploma and Foundation by UAs.

The Malaysian Matriculation Programme is a one or two-year pre-university preparatory programme offered by MOE Malaysia with three streams; Science, Accountancy and Technical. It is designed to prepare students for undergraduate programmes at local and international universities [1]. The programme is currently operating at 12 Matriculation Colleges, three Technical Matriculation Colleges and two MARA Colleges. The curriculum is standardized by the Matriculation Division of MOE. The students will fill up application forms to enter undergraduate programmes at UAs through UPU (University Admission Unit) before the end of their programme. Starting 2016, the graduates are awarded the Matriculation Certificate to ease them in applying positions in the private and public sectors. However, the programme has shown a decline in its reputation as most students regard it as a second choice for pre-university programme. Even though they have enrolled as students, they can still withdraw if offered another programme. This is a common scenario in the first four weeks of the first semester. On average, 200 students per college would withdraw with approximately RM60,000 of parent's money wasted for registration. Due to the shortage of students, Matriculation Division has to make new offers; additional costs to the management.

The academic performance of Matriculation graduates has gained attention from local universities and researchers, and is always compared with STPM, Diploma and Foundation graduates. A study by Arsad *et al*. [2] found that Matriculation graduates performed fairly well compared to Diploma graduates in engineering degrees at UiTM (Universiti Teknologi MARA). Arzuman *et al*. [3] revealed that STPM (Malaysian Higher School Certificate) graduates performance is significantly better than Matriculation graduates in medical degrees. Nopiah *et al*. [4] found that Diploma and Matriculation graduates need more attention in their engineering programmes compared to STPM and Foundation graduates. These lead to a perception that STPM and Foundation are better than Matriculation [5]. The bad perception on Matriculation programme will eventually take toll to future students' motivation and finally affect their retention on the programme.

The Matriculation programme has been established for almost 20 years, and has opened up opportunities for many students as a preparation before taking undergraduate degrees. Thus, the quality and reputation of the programme should be maintained and enhanced by focusing on the factors that affect the academic performance. The objective of this study is to evaluate the factors that contribute to academic performance of Matriculation students and rank

the factors according to their importance. The factors are restricted to the information obtained from administration data (demographic, financial, prior education, and current education).

This study was conducted at one of the Matriculation colleges as the case study and limited to one-year programme and Science stream students. The findings showed that the most importance factors that affect the academic performance of students are prior education, followed by demographic and current education. The most significant factor of prior education is SPM grade in Mathematics. The financial factors (such as family income) were not significantly affecting the students' performance.

2. METHODOLOGY

Science stream students at a particular Matriculation college were selected as the case study. The data were obtained from students' administration system. Two cohorts (sessions) were considered; 2015/2016 and 2016/2017. The two datasets would be used to evaluate the factors that contribute to students' performance and whether there are differences in the findings between datasets. Both datasets include students' information on gender, state of origin, family income, number of family dependents, module and intake enrolled, type of secondary school, and SPM grades for Mathematics, Additional Mathematics, Biology, Chemistry and Physics. These variables (factors) are grouped into four categories; demographic, financial, prior education and current education.

Both datasets are analysed using Multiple Linear Regression. First, descriptive statistics is used for sample profiling. Then, the Multiple Linear Regression is used to evaluate all factors that contribute to academic performance. The dependent variable, academic performance (CGPA), is continuous, ranging from 0.00 to 4.00. The independent variables include demographic factors (gender and state of origin), financial factors (family income and number of dependents), prior education factors (type of secondary school and SPM results of five science subjects), and current education factors (module enrolled and intake).

The proposed Multiple Linear Regression model:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_{12} X_{12} + \varepsilon;$$

where Y = CGPA, X_1 = gender, X_2 = state of origin, X_3 = family income range, X_4 = number of dependents, X_5 = type of secondary school, X_6 = SPM result Mathematics, X_7 = SPM result Additional Mathematics, X_8 = SPM result Chemistry, X_9 = SPM result Biology, X_{10} = SPM result Physics, X_{11} = module, and X_{12} = intake.

The Multiple Linear Regression analysis is performed on two datasets as follows:

1) Data Modelling: Multiple Linear Regression is performed using forward selection method. Students CGPA is used as the target variable and connect to the data partition node (70% for training data and 30% for testing data). Forward selection method starts with a dependent variable and one input variable, then other input variables are added sequentially to the model until a predefined stopping rule is fulfilled. A common stopping criterion is that, if an input variable added is not significant at a predefined level of significance, then no additional input variables are added to the model. The common summary measure is R^2 [6].
2) Model Evaluation: The Multiple Linear Regression model is evaluated based on the adjusted R^2, standard error of the estimate, mean square residual, mean absolute error and the equation of the model. After both models were built, a comparison is made. The model that conforms to all or most of the rules of thumb for a good model than others would be chosen. The rules of thumb include the F-test statistic (general fitness of model), the measures of goodness of fit (R^2), serial correlation test (Durbin-Watson test) and multicollinearity test (variance inflation factors, VIF).

3. ANALYSIS AND RESULTS

Table 1 describes of the variables of the administration data. The data were converted from Microsoft Excel format to SPSS format to be analysed using IBM SPSS Modeler V.18. The data have missing values and outliers. The missing values exist due to the students did not take Physics and Biology in SPM. The variables Physics_SPM and Biology_SPM have nominal measurement levels, therefore the cases where missing values exist would be discarded from the datasets. Outliers occurred due to the variable Dependent. Since Multiple Linear Regression is sensitive to outliers, the outliers were also discarded. For both datasets, there are only two continuous variables; CGPA and Dependent. Table 2 shows the summary of the two datasets.

Cohort 2015/2016 dataset has 1,101 students. The input variable Dependent has mean = 4.861, standard deviation = 1.597, and skewness = 0.150; the variable CGPA has mean = 3.142, standard deviation = 0.516, and skewness = -0.144. From 1,101 students, majority are female (73.7%), from daily secondary school (71.8%) and enrolled in the first intake (96.1%). Majority of the students are from the state of Selangor (25.7%) and enrolled in the Module I (41.1%). Most family incomes are ranged from RM1001 to RM2000 and above RM4000 (25.3% and 24.5%, respectively). Most students obtained grade A (60.6%) in SPM Mathematics, and B or C+ for Additional Mathematics and Physics. For SPM Chemistry, most students obtained C+ and C. For SPM Biology, most students obtained B+ and B.

Cohort 2016/2017 dataset has 983 students. The variable Dependent has mean = 4.70, standard deviation = 1.655 and skewness = 0.110; the variable CGPA has mean = 3.0785, standard deviation = 0.46956 and skewness = 0.076. From 983 students, majority are female (71.8%), originated from Johor (37.4%), from Daily Secondary School type (75.6%), have family income ranging from RM1001 to RM2000

(31.7%), and enrolled in the first intake (85.9%) and Module 1 (38.7%). Most students obtained Grade A (63.6%) in Mathematics and B or C+ for Physics. For Additional Mathematics, most students obtained C+ or C. Finally, most students obtained C+ in Chemistry and Biology.

Multiple Linear Regression analysis (forward selection method) was performed on both datasets with CGPA as the target variable (70% training data and 30% testing data).

Model 1 (Cohort 2015/2016): Figure 1 shows that the most importance predictor for CGPA is AddMath_SPM (0.25), followed by Math_SPM (0.17) and Chemistry_SPM (0.14). Based on the *p*-value of *F*-test, the model is a good fit for the data. All independent variables are significant. The regression line equation is

$$y = 4.057 - 0.086*\text{AddMath\_SPM} - 0.053*\text{Chemistry\_SPM} - 0.119*\text{Math\_SPM} - 0.029*\text{Biology\_SPM} - 0.070*\text{Physics\_SPM} - 0.115*\text{Gender} + 0.047*\text{Module} + 0.033*\text{State} + 0.157*\text{School}.$$

Model 2 (Cohort 2016/2017): Figure 2 shows that the most importance predictor for CGPA is Math_SPM (0.19), followed by State (0.16) and School (0.15). Based on the *p*-value of *F*-test, the model is a good fit for the data. All independent variables are significant. The regression line equation is

$$y = 3.929 - 0.096*\text{AddMath\_SPM} - 0.075*\text{Chemistry\_SPM} - 0.06931*\text{Math\_SPM} - 0.072*\text{Physics\_SPM} + 0.106*\text{Module} + 0.022*\text{State} + 0.159*\text{School}.$$

Table 3 shows the results and summary for each model. The two models (datasets) were compared to check whether both datasets are able to give the same conclusion. From Table 3, both models have approximately similar small mean absolute errors for both training and testing datasets (approximately 0.3). The adjusted R^2 (0.353 and 0.360), the standard error of the estimate and the mean square residual of the two models are also approximately similar. Thus, respectively, only 35.3% and 36% of the variation in CGPA in Model 1 and Model 2 were explained by the factors. Therefore, both models show similar trait in predicting the academic performance of students.

As shown in Table 3, both models did not include the variables IncomeF, Dependent and Intake. However, Model 1 included two more input variables (Gender and Biology_SPM) as compared to Model 2. All input variables showed miniscule differences in the coefficients between the two datasets although the constant for Model 2 was slightly lower compared to Model 1. This shows that the academic performance of Cohort 2016/2017 was slightly lower than Cohort 2015/2016.

As shown in Figure 1 and Figure 2, both models ranked the variable Math_SPM as very importance (ranked second and first in the Model 1 and Model 2, respectively). Also, the variable AddMath_SPM was ranked first and fourth in Model 1 and Model 2, respectively. Thus, the two Mathematics subjects are crucial in determining the academic performance of students during their Matriculation programme. Other importance SPM subjects in predicting the academic performance are Chemistry and Physics. State and School were ranked as second and third in Model 2. However, they were ranked as less importance in Model 1. This shows that the prior education factors in SPM play important roles in predicting the academic performance of Matriculation students.

4. CONCLUSIONS

The objective of this study is to evaluate and rank the factors (variables) that contribute to the academic performance of Matriculation students. The datasets were obtained from two cohorts of a Matriculation programme; 2015/2016 and 2016/2017. Thus, two multiple linear regression equations were constructed. The descriptive statistics of both cohorts (datasets) were similar. However, 2016/2017 showed a significant decreased in the number of students (10.7%) compared to 2015/2016; 983 students for 2016/2017 and 1101 students for 2015/2016. The admission grades for both cohorts are similar. However, due to the difference in the number of students, a slight difference in the regression equations was inevitable. From Table 3, the regression equations of the two cohorts are quite similar; both did not include the input variables IncomeF, Dependent and Intake. However, cohort 2015/2016 included two more input variables compared to 2016/2017 as expected due to the difference in the number of students. Other input variables included in both equations showed miniscule differences in the coefficients.

Figure 1 and Figure 2 agreed that Mathematics is a critical subject in determining the academic performance of students (CGPA) during their Matriculation programme. Nevertheless, Additional Mathematics, Chemistry, Physics and Biology are also important in predicting the CGPA. Hence, prior education factors played major role in predicting the CGPA compared to financial, demographic and current education. This finding is agreed with Amin *et al*. [7], Gaskins [8], Ismail and Othman [9], and Kanagi *et al*. [10], but disagreed with Davidovitch and Soen [11]. Demographic factors played better role than current education factors, and this agreed with Makar [12] and Willenborg [13]. Female students performed better than male students, and a particular state of origin of students performed better than other states. Financial factors showed insignificant role in predicting academic performance, and hence were not included in the regression equations. This contradicts with Kyoshaba [14] finding of a positive relationship between family income and academic performance. The current education factors included in this study were Intake and Module enrolled. Only Module was deem importance with the lowest percentage; the variable Intake was not significant. In conclusion, the findings showed that the most importance factors that affect

Matriculation students' academic performance are prior education factors, followed by demographic factors and current education factors.

TABLES

Table 1. Description of Variables

Variable	Role	Type	Measurement Level	Description
CGPA	Target	Continuous	Ratio	Student's CGPA: 0.00-4.00
Gender	Input	Binary	Nominal	0=Female, 1=Male
State	Input	Categorical	Nominal	State of origin: 0=Johor, 1=Melaka, 2=N.Sembilan, 3=Pahang, 4=Perak, 5=Selangor, 6=Others
IncomeF	Input	Categorical	Nominal	Family income: 0=no information, 1=RM0-1000, 2=RM1001-2000 3=RM2001-3000, 4=RM3001-4000, 5=above RM4000
Dependent	Input	Continuous	Ratio	Number of family dependents: 0-99
School	Input	Categorical	Nominal	Type of secondary school: 0=Full boarding, 1=Daily school
Math_SPM	Input	Categorical	Ordinal	SPM Grades for Mathematics, Additional Mathematics, Physics, Chemistry, and Biology: 0=A+, 1=A, 2=A-, 3=B+, 4=B, 5=C+, 6=C, 7=D, 8=E
AddMath_SPM	Input	Categorical	Ordinal	
Physics_SPM	Input	Categorical	Ordinal	
Chemistry_SPM	Input	Categorical	Ordinal	
Biology_SPM	Input	Categorical	Ordinal	
Intake	Input	Categorical	Nominal	Intake enrolled: 0=1st intake, 1=2nd intake
Module	Input	Categorical	Nominal	Module enrolled: 0=module 1, 1=module 2, 2=module 3

Table 2. Summary of Datasets Cohort 2015/2016 and Cohort 2016/2017

Variable		Cohort 2015/2016		Cohort 2016/2017		Variable		Cohort 2015/2016		Cohort 2016/2017	
		Freq.	%	Freq.	%			Freq.	%	Freq.	%
Gender	0=Female	811	73.7	706	71.8	AddMath_SPM	0=A+	12	1.1	6	0.6
	1=Male	290	26.3	277	28.2		1=A	61	5.5	46	4.7
State	0=Johor	219	19.9	368	37.4		2=A-	103	9.4	70	7.1
	1=Melaka	183	16.6	243	24.7		3=B+	192	17.4	128	13.0
	2=N.Sembilan	155	14.1	48	4.9		4=B	254	23.1	191	19.4
	3=Pahang	104	9.4	2	0.2		5=C+	260	23.6	234	23.8
	4=Perak	145	13.2	0	0.0		6=C	217	19.7	254	25.8
	5=Selangor	283	25.7	250	25.4		7=D	2	0.2	54	5.5
	6=Others	12	1.1	72	7.3	Physics_SPM	0=A+	4	0.4	6	0.6
IncomeF	0=no information	37	3.4	17	1.7		1=A	11	1.0	11	1.1
	1=RM0-1000	211	19.2	132	13.4		2=A-	70	6.4	113	11.5
	2=RM1000-2000	279	25.3	312	31.7		3=B+	196	17.8	216	22.0
	3=RM2001-3000	164	14.9	160	16.3		4=B	319	29.0	269	27.4
	4=RM3001-4000	140	12.7	121	12.3		5=C+	313	28.4	236	24.0
	5=above RM4000	270	24.5	241	24.5		6=C	166	15.1	123	12.5
School	0=Full boarding	311	28.2	240	24.4		7=D	22	2.0	9	0.9
	1=Daily school	790	71.8	743	75.6	Chemistry_SPM	0=A+	13	1.2	11	1.1
Intake	0=1st intake	1058	96.1	844	85.9		1=A	27	2.5	36	3.7
	1=2nd intake	43	3.9	139	14.1		2=A-	92	8.4	103	10.5
Module	0=module 1	452	41.1	380	38.7		3=B+	151	13.7	134	13.6

	1=module 2	281	25.5	347	35.3		4=B	235	21.3	204	20.8
	2=module 3	368	33.4	256	26.0		5=C+	269	24.4	236	24.0
Math_SPM	0=A+	259	23.5	232	23.6		6=C	276	25.1	194	19.7
	1=A	667	60.6	625	63.6		7=D	38	3.5	65	6.6
	2=A-	112	10.2	88	9.0	Biology_SPM	0=A+	7	0.6	6	0.6
	3=B+	50	4.5	28	2.8		1=A	65	5.9	32	3.3
	4=B	13	1.2	10	1.0		2=A-	117	10.6	88	9.0
							3=B+	247	22.4	176	17.9
							4=B	278	25.2	235	23.9
							5=C+	207	18.8	259	26.3
							6=C	125	11.4	133	13.5
							7=D	53	4.8	50	5.1
							8=E	2	0.2	4	0.4

Table 3. Model 1 and Model 2 Results and Summary

Model 1 (Cohort 2015/2016)			Model 2 (Cohort 2016/2017)		
Partition		Forward	Partition		Forward
Training	Minimum Error	-1.577	Training	Minimum Error	-1.096
	Maximum Error	1.438		Maximum Error	0.984
	Mean Error	0		Mean Error	0
	Mean Absolute Error	0.334		Mean Absolute Error	0.311
	Standard Deviation	0.417		Standard Deviation	0.383
	Linear Correlation	0.601		Linear Correlation	0.605
	Occurrences	774		Occurrences	689
Testing	Minimum Error	-1.236	Testing	Minimum Error	-1.173
	Maximum Error	0.949		Maximum Error	0.948
	Mean Error	-0.021		Mean Error	0.003
	Mean Absolute Error	0.327		Mean Absolute Error	0.292
	Standard Deviation	0.403		Standard Deviation	0.368
	Linear Correlation	0.602		Linear Correlation	0.563
	Occurrences	327		Occurrences	294

Model Summary	Model 1 (2015/2016)	Model 2 (2016/2017)
R	0.601	0.605
R Square	0.361	0.366
Adjusted *R* Square	0.353	0.360
Std Error of Estimate	0.419	0.385
Mean Square Residual	0.176	0.148
F Regression	47.908	56.221
Sig. Regression	0	0

FIGURES

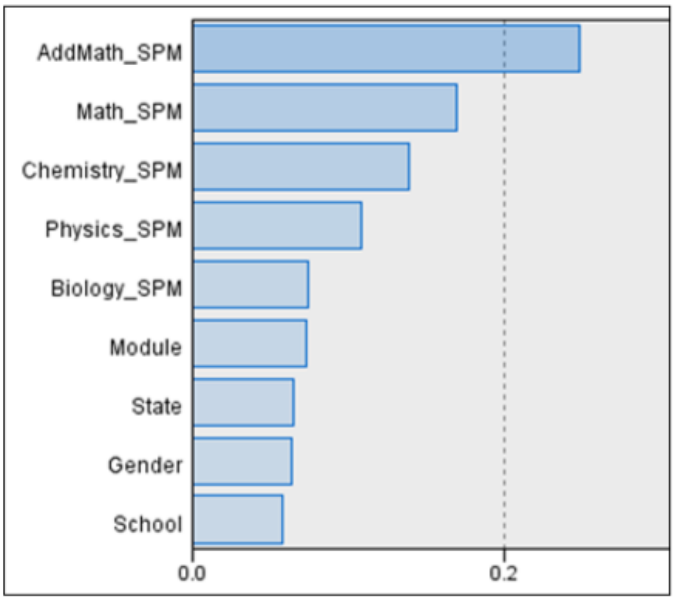

Figure 1. Predictors' Importance for Model 1

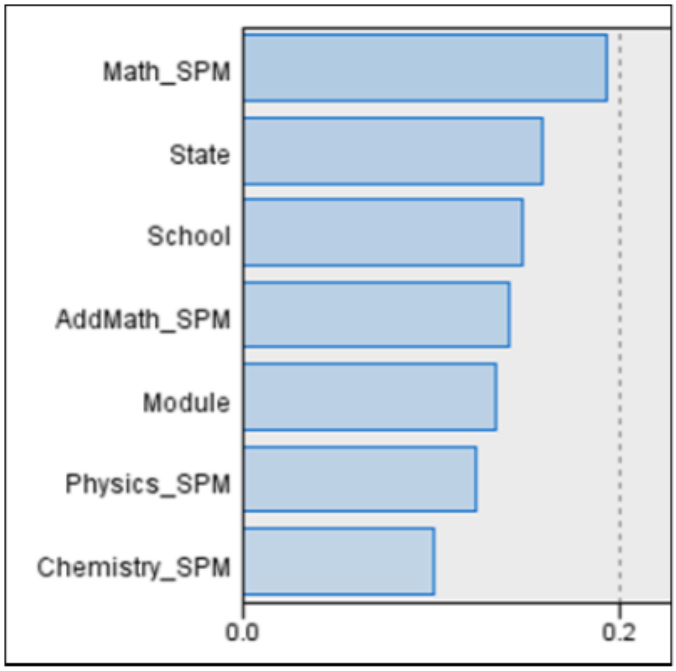

Figure 2. Predictors' Importance for Model 2

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