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Determinants of Academic Performance in Ghanaian Polytechnics

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Abstract
The study aimed at using panel data on student test scores to determine the factors influencing academic performance. Data on grade point averages (GPA), demographic and socio-economic features from 131 Female and 271 Male students was obtained from the Examinations Unit and the Student Affairs Unit of Bolgatanga Polytechnic. The Generalised Linear Model (GLM) was employed to study the effect of determinants on the differences among students' academic performances. The results revealed significant contribution of the predictors to the explanatory power of the mean GPA scores with the exception of semester 3 and the Department of Civil Engineering. Thus the performance of students in the Polytechnics improves with decreasing age and decreasing number of credit hours registered in a given semester. Though students admitted on the basis of a decisive factor and through the Matured Entrance Examinations negatively affected students' academic performance, departmental affiliation has a positive impact on the performance of students academically.
Keywords: Academic performance, GPA, Determinants, Ghana, Generalized linear model

1. Introduction

Education is, "something that a decently functioning society obliges people to get a certain amount of, even if they don't really want to" (Finn, 1999). Polytechnic education – a wing of tertiary education in Ghana has come to stay because of the contemporary global move towards technological development following Government directive to run tertiary programmes closing the manpower supply needs of the country (Nsiah-Gyabaah, 2005).
Improving the quality and quantity of the human resource from the Polytechnic remains an important goal for the country. This is in line with the country's subscription of the Millennium Development Goals (MDGs) as well as its own local constitutional requirement. This requires policies that address both demand- and supply-side constraints of education. The provision of more educational facilities tends to ease supply-side constraints to education. This is believed to give the student the easy access and to perhaps guarantee an improved academic performance.
The redefinition of policies that govern Tertiary education, to ensure that all citizens get equal access to Tertiary education, necessitates the search for factors that affect student performance. Most of which employed cross-sectional data to model the determinants of academic performance (Mlambo, 2011; Irfan *et al.,* 2012; Syed *et al.,* 2006; Hijazi *et al.,* 2006; Park *et al.,* 1990).
Incorporating the longitudinal component to study the determinants of students' academic performance, Glewwe *et al.,* (1999) investigated into the nutrition-learning nexus using a unique longitudinal data set, establishing poor performances among malnourished children, after correcting for the effects of unobserved heterogeneity both across and within households. Carlson *et al.,* (2008) conducted a study on the association between time spent in physical education and academic performance of students in Kindergarten through fifth grade and discovered that higher amounts of physical education among girls may be associated with an academic benefit. Using a multidimensional growth profile analysis to examine the baseline change profile of academic performance trajectories during the high school transition for students who went from middle school to high school, Ding (2008) identified a no-change group and four other groups with different change profiles.
This study, however, focuses on the determinants of academic performance in Ghanaian polytechnics by studying changes in the mean Grade Point Average (GPA) scores over time and how these changes depend on the entry qualification, age of students, number of credit hours registered in a semester, time, or biological sex of the student.

2. Materials and Methods

Data on students' grade point average, demographic and socio-economic characteristics pertinent to this study was obtained from the Examinations Department and the Students Affairs Unit of Bolgatanga Polytechnic. A justification why the Generalised Linear Model (GLM) was used in this study is linked to McCullagh & Nelder (1983) who indicated that a good scale in terms of the classical linear regression analysis should combine constancy of variance, approximate normality of errors and additivity of systematic effects. However, there is usually no a priori reason to believe that such a scale exists.
Given the total sample of n students selected. The Grade Point Average (GPA) for the i^{th} student on the j^{th}

semester was denoted by Y_{ij}. It is convenient to group the response variable for the i^{th} student into an (n x 1) vector.

$$Y_i = \begin{pmatrix} y_{i1} \\ y_{i2} \\ \vdots \\ y_{in} \end{pmatrix}, \quad i = 1,2,\cdots,n$$

The vector Y_i is a time-ordered collection of the n response variables for the i^{th} subject. The Y_{ij}'s are often called the components, entries, or elements of Y_i.
The vector of responses, Y_i, for the n subjects (students) is assumed to be independent of one another. Associated with each response, Y_{ij}, there is a (p x 1) vector of covariates.

$$X_{ij} = \begin{pmatrix} X_{ij1} \\ X_{ij2} \\ \vdots \\ Xp \end{pmatrix}, \quad \begin{matrix} i = 1,\ 2,\ \cdots,\ n \\ j = 1,\ 2,\ \cdots,\ k \end{matrix}$$

The X_{ij} is a vector of covariates associated with Y_{ij}, the response variable for the i^{th} subject at the j^{th} measurement occasion (semester). The p-rows of X_{ij} correspond to different covariates.

$$Y_{ij} = \beta_1 X_{ij1} + \beta_2 X_{ij2} + \cdots + \beta_p X_{ijp} + e_{ij}$$

Define $\mu = E(y)$ and $\eta = g(\mu)$ such that $\eta = g\{\mathrm{E}(y)\} = X\beta, \quad y \sim Gaussian$ where μ is the identity link function and η is the linear predictor based on the covariates $X_1, X_2, \cdots, X_p$. The data vector **y**, the mean vector μ and the linear predictor, η, all have n components. By suppressing the link, and regarding the X_j as the p columns of a matrix X, then the standard matrix formulation is written as $E(Y) = X\beta$ where β is the set of parameters written in a vector form (McCullagh and Nelder, 1983).

3. Results and Discussion

The GLM estimates of the analysis are presented in Table 1 along with the standard errors of the estimates and the associated p-values. The parameter estimates for the time variable indicates the direction and number of units of change in the average GPA scores of a student due to a one unit change in semester. The average GPA scores for semester 3 and 5 are about 0.1 units lower than that of semester 1. Whilst semester 4 registered an average GPA of about 0.1 units greater than semester 1, semester 2 was about 0.5 units of an average GPA more than semester 1. However, the p-values associated with the estimates of the time variable indicates that, except for semester 3, all other semesters present in the model were statistically significant at 5% level.
The results of the GLM analysis also indicated that females on average had a GPA of 0.094 more than their male counterparts. Comparing the average GPA score of the students in the seven (7) Departments, students in the Bolgatanga Polytechnic performed significantly better at the 5% significance level (P-Value <0.05), in other Departments than in the Accountancy Department except in the Civil Engineering department.
Direct Qualification (QD) was used as the base for comparison of the effect of the Mode of Entry of the students into the institution on Academic performance,. It was obvious from the results that students who were admitted based on a Decisive Factor (NQ) were about 0.32 units of GPA score lower than those who were admitted based on direct qualification whilst the Matured applicants (QM) who were given admission registered an average GPA score of about 0.25 lower than students with direct qualification: Both variables were statistically significant at the 5% level based on the sample data.
The number of credit hours registered in a particular semester by a student of Bolgatanga Polytechnic varied across semesters. The analysis indicated at 5% level of significance that the number of credit hours registered by a student significantly contributed to students' performance: The GPA of students decreased by about 0.09 GPA units for every additional credit hour registered by a student in a Semester.
Controlling for all other variables in the model, the average GPA scores of the student also decreased with increasing age and this was significant at the 5% significance level: Students' performance decreased by 0.021 GPA units for each year older a student was.
The estimated marginal means for Gender and mode of entry based on the generalized linear model, are shown in Table 2. The marginal GPA on females (2.623) was higher than that of males (2.529). Similarly, the average GPA reported for Entry Qualification into the institution was high for students who were admitted directly and

less for students who had admission based on an influential factor.
Such determinants of students' academic performance as age differences and gender also supports the findings of Aripin *et al.,* (2008) and Hansen *et al.,* (2000) whereas in a math-related study, kyei *et al.,* (2011) found that age difference of students did not significantly influence students' academic performance.
The predictor model for students GPA is given by:

$$\mu = 4.898 + 0.496 * S2 - 0.069 * S3 + 0.101 * S4 - 0.09 * S5 + 0.094 * Female + 0.085 * CVE + 0.373 * EAG + 0.299 * HCIM + 0.413 * IA + 0.105 * MKT + 0.407 * SMS + 0.472 * STA - 0.318 * NQ - 0.254 * QM - 0.09 * CR - 0.021 * Age$$

with a reduced model given by:

$$\mu = 4.898 + 0.548 * S2 + 0.155 * S4 + 0.089 * Female + 0.366 * EAG + 0.294 * HCIM + 0.405 * IA + 0.097 * MKT + 0.403 * SMS + 0.463 * STA - 0.320 * NQ - 0.252 * QM - 0.09 * CR - 0.023 * Age$$

4. Conclusion

The purpose of the study was to determine the factors that influence students' academic performance in the Ghanaian Polytechnics. The data appeared to support the following conclusions: Students' academic performance is affected by a change in level. Thus the performance of a student in the Polytechnic suffers a decline at the beginning of a new academic year. The number of credit hours registered by a student in a given semester and the age of the student has a negative effect on the academic performance of students as they tend to perform poorly with increasing number of credit hours and increased age. Students who were admitted through direct entry requirements performed better academicaly when compared to students who were admitted based on a decisive factor and through the Matured Entry requirement. Gender as well as the Department of the student, also significantly determine the academic performance of students in the Polytechnic.

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Table 1: Parameter estimates and standard errors from generalized linear model on GPA, without interactions

	Model			
	Full Model		Reduced Model	
Variable	**Estimate (SE*)**	**p-values**	**Estimate (SE)**	**p-values**
Female	0.094 (0.031)	0.003	0.089	0.004
Age	-0.02 (0.004)	0.000	-0.023 (0.004)	0.000
Credit Hours	-0.090 (0.004)	0.000	-0.090 (0.004)	0.000
Entry qualification				
NQ	-0.318 (0.051)	0.000	-0.320 (0.051)	0.000
QM	-0.255 (0.037)	0.000	-0.252 (0.037)	0.000
Department				
CVE	0.085 (0.058)	0.147		
EAG	0.373 (0.082)	0.000	0.366 (0.080)	0.000
HCIM	0.299 (0.065)	0.000	0.294 (0.064)	0.000
IA	0.413 (0.074)	0.000	0.405 (0.074)	0.000
MKT	0.105 (0.031)	0.001	0.097 (0.031)	0.002
SMS	0.407 (0.048)	0.000	0.403 (0.048)	0.000
STA	0.472 (0.070)	0.000	0.463 (0.069)	0.000
Semester				
S2	0.496 (0.044)	0.000	0.548 (0.038)	0.000
S3	-0.069 (0.041)	0.092		
S4	0.101 (0.043)	0.020	0.155 (0.036)	0.000
S5	-0.090 (0.043)	0.036		
Intercept	4.898 (0.136)	0.000	4.898 (0.136)	0.000
Observations	1995		1995	
BIC	3697.903		3681.581	

* Standard error of estimate

Table 2: Estimated marginal means

	Delta-Method				*95% Confidence Interval*	
	Margin	***Std. Error***	***Z***	***p-value***		
Gender						
Male	2.529	0.0166	151.96	0.000	2.496	2.562
Female	2.623	0.0252	104.14	0.000	2.574	2.673
Entry Qualification						
QD	2.773	0.0331	83.88	0.000	2.708	2.838
NQ	2.455	0.0384	63.93	0.000	2.380	2.530
QM	2.518	0.0162	155.32	0.000	2.486	2.550