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Statistical Exploration of Academic Performance of Students in some Selected Programmes of the University of Cape Coast

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Abstract

Education is a basic human right to which every individual should have access to. Every country designs education that will be suitable for it citizens so as to achieve as a whole the country's educational aims and objectives. Academic performance is a subject of great concern in Ghanaian education and is the main criterion that is used to admit students into both Senior High and University education.

The main objective of the study was to investigate whether there exit exist a relationship between academic performance at the Senior High School (SHS) and that of university. The study answered the following research questions: Which variables significantly contribute to academic performance of the students at University level? ; Are the variables stated reliable to predict the results of students in future?

The data for the study were secondary data obtained from the Data Processing Unit, University of Cape Coast. In all, result of thousand one hundred and fifty three (1153) students were collected. Convenience sampling was used for data collection. Statistical analyses were done using Minitab. Regression analysis was the main statistical tool for this study.

The study revealed that students' Grade Point Average (GPA) at the university has little to do with their previous academic performance at the Senior High School. Programme offered contributes significantly to academic performance at the University. Although, there was a weak relationship between the explanatory variables, there were some variables that contributes or determines students' academic performance.

The study recommends that students performance at the University should not solely based on entry aggregate. Other factors can also be considered such as programme, academic environment, the availability of academic resources, teaching empowerment, student attitude, and finance.

Key Words: Grade Point Average, Entry Aggregate, Programme, Performance, Senior High School

1. Background

Education is a basic human right to which every individual should have access to. In view of this, governments all over the world are committed to providing education to meet the challenges of the complex economic and political systems that face them. Every country designs education that will be suitable for it citizens so as to achieve as a whole the country's educational aims and objectives.

Ghana runs an educational programme that consists of nine (9) years of basic education, .three (3) years of senior secondary education and four (4) years of university education. Academic performance is a subject of great concern in Ghanaian education and is the main criterion that is used to admit students into both senior secondary and university education. According to E. K. Tamakloe et al (1996), "Aptitude tests can be used to predict how an individual will perform on some criterion before instruction or training". Hence aptitude tests are used in selection and placement.

Based on this argument, universities in Ghana use the West African Senior Secondary Certificates Examination (WASSCE) results as a prerequisite for admitting students into the universities to offer various programmes. It is assumed that an individual who performs well in West African Senior Secondary Certificate Examination is likely to perform well at the University. Most often, applicants are offered programmes based on their performance and subject area at the Senior Secondary School level. In the university a programme means a course of academic study or an area of specialization. For example, Bachelor of Art Social Science is a programme. A course is a complete body of prescribed studies constituting a curriculum. The performance of students is assessed by their grade point average (GPA) which is calculated by using the grades obtained by students after their four year programme, the grade point average is then used to classify students. The following table gives classification of students grade point average in the University of Cape Coast.

Table 1: Classification of students Grade Point Average in the University of Cape Coast

Grade Point Average	Class
4.0 – 3.6	First
3.5 – 3.0	Second Class (Upper Division)
2.9 – 2.5	Second Class (Lower Division)
2.4 – 2.0	Third
1.9 – 1.0	Pass
Below 1.0	Fail

Given this background, it is important to assess the underlying assumption that performance by students at the University of Cape Coast requires good performance at the Senior Secondary level.

1.1 Objective of the Study

The main objective of the research was to investigate whether there exit a relationship between academic performance at the Senior Secondary School and that of university. To achieve this, the following objectives were set:

1. To assess the entry aggregate of the students. That is the variation between the various entry aggregate by the students
2. To assess the final grade point average of the students. That is the variation between the final grade point averages of the students.
3. To find out if relationship exists between the final grade point average, entry aggregate and programme of a candidate.
4. To determine how the final grade point average and entry aggregate and programme relate, if relationship exist between them.

1.2 Research Questions

In view of the above objectives the following research questions have been set.

1. Which variables significantly contribute to academic performance of the students at University level?
2. Are the variables stated reliable to predict the results of students in future?

To determine the relationship between Grade Point Average as a dependent and Entry Aggregate and Programme as independent variables, the following hypothesis is to be tested:

H_o : There is no relationship between a candidate's final Grade Point Average and his/her Entry Aggregate and Programme of study.

2. Methodology

The data for the study were secondary data obtained from the Data Processing Unit, University of Cape Coast. In all, result of thousand one hundred and fifty three (1153) students of the batch of 2010/2011 academic year students were collected. The involved offered Bachelor of Commerce, Bachelor of Education (Social Science), Bachelor of Management studies and Bachelor of Art (Social Science). These programmes were used for the study because these were the top four programmes in the university at the point of the study that required good result from applicants before entry. The data collected were made up of students who entered with West African Senior Secondary Certificates, their entry aggregate, their final grade point average (GPA) and programme offered at the university were collected for the study. Convenience sampling was used during the study period. Convenience sampling because these results were found to be most appropriate and available for the study.

2.1 Regression Model and the Required Conditions

Regression is used to predict the value of one variable on the basis of the other variables. The technique involves developing mathematical equation that describes the relationship between the variable to be forecast, which is called the dependent variable (y), and the variables that the statistician believes are related to the dependent variable, called independent variables $(x_1, x_2, ..., x_K)$. To conduct regression analysis, we analyse a critical part, the error variable, ϵ, of the model. The probability distribution of error variables must satisfy the following conditions:

1. The probability distribution of the error variables are normal.
2. The mean of the distribution is zero.
3. The standard deviation, σ_{ϵ}, of the error term, ϵ is a constant.
4. The errors are independent.

The dependent variable, *y*, is related to the independent variables $x_1, x_2, .., .x_k$ by

$$y = \beta_o + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k + \varepsilon$$

Where the coefficients β_o, β_1, β_2,…, β_k are to be determined. In this equation, the dependent variable, y, is said to be linearly related to the independent variables.
If we are interested only in determining whether relationship exists between the variables, we employ correlation analysis or draw scatter diagrams.

The total variation in the dependent variable (measured by $\left[\sum (y_i - y)^2\right]$ is called the total sum of squares, SST. This can be decomposed into two parts; the explained variation measured by sum of squares of regression, SSR and unexplained variation measured by sum of squares errors, SSE. That is, the total variation in the data, SST is

$$SST = SSR + SSE$$

If SSR is large relative to SSE, the coefficient of determination, R^2 (which is the proportion of variation in the dependent variable that is explained by the independent variables) will be high, signifying a good model. However, if SSE is large, it means that most of the variation in the dependent variable will be unexplained, which indicates that the model provides a poor fit and consequently has little validity. If SSR is large enough relative to SSE it is inferred that at least one coefficient is not equal to zero. In order to determine the significance of SSR, we compute the ratio of the two mean squares; Mean sum of squares of regression (MSR) and Mean sum of squares error (MSE). Mean square is the sum of squares divided by its degree of freedom, i.e. MSR = SSR/k and MSE = SSE/n-k-1. Also the ratio of two mean square gives the value of the statistic that has an F distribution, as long as the underlying population is normal.

A large value of F indicates that most of the variation in *y* is explained by the regression model and that the model is useful. This leads to the rejection of the Null hypothesis. A small value of F indicates that most of the variation in *y* is unexplained, and this leads to the non-rejection of H_0. We reject H_o if $F > F_{\alpha,k,n-k-1}$ for a specified significance level, α.
As the main objective of the study, one of the research questions of was transformed into the following hypotheses:

$$H_o : \beta_i = 0$$
$$H_1 : \beta_i \neq 0 \quad (\text{for } i = 1,2,...,k)$$

The hypothesis H_o means that none of the variables; entry aggregate and programme is related to *y*, grade point average and H_1 means that one of the variables determines, *y*, grade point average.

2.2 Estimating the coefficient and assessing the model

If the model fit is poor, we do not proceed to find the coefficients of that model. However, we check the model by performing the following:

1. The coefficients and the statistics used to assess the model is generated.
2. Diagnose the violation of required conditions.
3. Assume the model's fitness by considering the following statistics: standard error of estimate, coefficient of determination, and the F – test of ANOVA. Having met the above conditions, we can now use the model to predict or estimate the expected value of the dependent variable. The equations used are; standard error of estimate,

$$S_{\varepsilon} = \sqrt{\frac{SSE}{n-k-1}}$$

Coefficient of determination, is given by

$$R^2 = 1 - \frac{SSE}{\sum\left(y_i - \bar{y}\right)^2} \quad \text{or } R^2 = 1 - \frac{SSE}{SST}.$$

2.3 Multiple Comparisons of Means

To make multiple comparisons of a set of treatment means, a number of procedures are used which, under various assumptions, ensure that the overall confidence level associated with all the comparisons remains at or above 100(1 - α)% level.

One of the widely used techniques is the Bonferroni method. The method is used for pair-wise comparisons or contrasts among *k* treatment means. If a set of contrast has been specified a priori but not orthogonal, the *t*-test is used but with a Bonferoni correction.

In this case, if *g* tests (number of comparisons) are involved and the overall Type 1 error is to be held at α, then the significance level for individual test (each of the *g* test) is set at $\alpha' = \frac{\alpha}{g}$. For example, to maintain $\alpha = 0.05$ in making five comparisons, we use a significance level of $\alpha' = \frac{0.05}{5} = 0.01$.

3. Result

Table 2 Summary Statistics of the Data

Variable	N	Max.	Min.	Mean	Median	Mode	Standard deviation
GPA	1153	3.8980	0.8578	2.7066	2.7066	3.1269	0.5292
Entry AGGR.	1153	18.0000	6.0000	11.6600	12.0000	10.0000	2.8900

A look at table 2 shows that most of the students were admitted with aggregate 10 and again, most of them had grade point average of 3.129. A grade point average of 3.129 means that most of the students had second class upper division. The worst performing students had a grade point average of 0.878 which is fail. The table also reveals that entry aggregate is widely spread than grade point average. This thus not means that the performance of students at the university is better than that of senior secondary school. What it means that comparing the range of grade point average to that of the entry aggregate, the range of entry aggregate is widely spread than that of entry aggregate. Hence, that margin in the standard deviation.

Table 3 : Summary Statistics of Students entry Aggregate

			GRADE POINT AVERAGE			
Aggregate	**Nº of students**	**Percentage**	**Maximum**	**Minimum**	**Mean**	**Standard deviation**
6.00	34	2.948	3.8423	1.5660	2.6638	0.7016
7.00	71	6.157	3.8268	1.6213	2.7705	0.5804
8.00	84	7.285	3.6846	1.5106	2.6265	0.5713
9.00	89	7.718	3.6769	1.4013	2.724	0.5441
10.00	177	15.351	3.6308	1.3203	2.7905	0.4872
11.00	56	4.856	3.7654	1.3504	2.6746	0.5777
12.00	173	15.004	3.8780	1.1128	2.7116	0.5417
13.00	127	11.014	3.7727	1.4453	2.6684	0.4943
14.00	155	13.443	3.7008	1.1683	2.6569	0.5115
15.00	74	6.418	3.6912	1.4844	2.6894	0.4927
16.00	58	5.030	3.4654	1.5526	2.6571	0.4876
17.00	41	3.555	3.6434	0.8578	2.6948	0.5475
18.00	14	1.214	3.2500	2.0878	2.7215	0.3660

The Table 3 gives the sample size (the total number of students) allocated to the various entry aggregate, aggregate six (6) to aggregate eighteen (18). A look at the table shows that the mean grade point average falls in the range (2.6265 – 2.7905). The maximum grade point average (3.8780) was obtained by a student with 12 and the minimum (0.8578) was obtained by a student with aggregate 17. The table again shows that more than half of these students applied with aggregate ranging from ten to fourteen. Aggregate six is most widely spread out and aggregate eighteen is the least spread out. This implies that students with aggregate 18 performed better than students with aggregate 6, this is supported by the means of their grade point average, the mean of students with aggregate 18 is 2.7215 while that of students with aggregate 6 is 2.6638.

Table 4: Summary Statistics of the Programme offered by Students of 2010/2011 academic year

			GRADE POINT AVERAGE			
Programme	**N**	**%**	**Max.**	**Min.**	**Mean**	**Stand. dev**
B. A.(Social Science)	261	22.636	3.7008	1.1128	2.7697	0.4967
B. of Commerce	248	21.509	3.8423	1.4928	2.7013	0.5858
B. of Management Studies	151	13.096	3.8780	1.3203	2.5884	0.5752
B. of Education (Social Science)	493	42.758	3.7727	0.8578	2.7016	0.4957

The table gives the sample size (the total number of students) allocated to the various programmes i.e. B. A. Social Science, Bachelor of Commerce, Bachelor of Management Studies and Bachelor Education (Social Science). Again, from the table, on the average the means of the grade point average of the three programmes {B.A. Social Science, Bachelor of Commerce and Bachelor of Education (Social Science)} falls into the same range (2.7013 – 2.7697) almost the same within rounding errors, compare to that of Bachelor of Management Studies which is 2.5884. The maximum grade point average (3.8780) was obtained by Bachelor of Management Studies student and the minimum (0.8578) by Bachelor of Education (Social Science) student, the programme that is most widely spread is Bachelor of Commerce and Bachelor of education (Social Science) is the least spread out programme.
Generally, from the three tables, it is observed that the mean grade point averages in terms of aggregate and programme are almost the same. The best grade point average was obtained by a student with aggregate twelve (12) who offered Bachelor of Management Studies, the worse grade point average was obtained by a student with aggregate seventeen (17) who offered Bachelor of Education (Social science).

3.1 One-Way Analysis of Variance for Final Grade Point Average Among The Various Programmes
Based on the difference in final grade point average among the programme observed in the table 3.2 above, one way analysis of variance was conducted among the programmes. The result is shown in Table 4.

Table 5: One- way ANOVA Among the Various Programmes

Source	DF	SS	MS	F	p
Treatment	3	3.145	1.048	3.770	0.010
Error	1149	319.505	0.278		
Total	1152	322.650			

The coefficient of determination and the adjusted coefficient of determination are given respectively by R- sq = 1.7% and R-sq = 1.3%.
Table 4 gives *p*- value which is equal to 0.010 and F- value of 3.770.The small p- value and F- value means that we can reject the null hypothesis

$$H_o : U_1 = U_2 = U_3 = U_4$$

that all group means of the four programmes are equal. This means that the mean GPA's of students enrolled in the various programmes are different. The small value of coefficient of determination means that students' performance has little to do with programme of study alone. The value R-sq = 1.7% indicates that 1.7% of students of final grade point average is explain by programme of study. Therefore, the performance of a student may be determined by considering other variables in addition to programme of study. The table below shows chi – square test of association between Classes and Programme.

Table 6: Chi – Square Test of Association Between Classes and Programmes

	Value	**Degree of Freedom**	**P-value**
Pearson Chi - square	40.232	15	0.000
Likelihood Ratio	40.449	15	0.000
Linear-to-linear association	1.969	1	0.1610

From table 6, the p-value of 0.1610 shows that we reject H_o and conclude that there is association between Classes of students and the programme offered , which implies that statistically there is association of significance between students' Classes and Programme. This really confirms the test statistic above that there exist significance difference between students programme and grade point average since students classes are calculated using their grade point average.
Table 7: Correlation Matrix of the Study Variables

	Grade Point Average	**Programme**	**Class**
Programme	-0.047		
Class	-0.955	0.048	
Entry Aggregate	-0.033	0.477	0.006

Table 7 is the correlation matrix of the study variables. The table shows a very weak correlation between the study variables. These low correlations imply that programme of study and entry aggregate have virtually no relationship with grade point average. One interesting observation is the correlation 0.477 which is between entry aggregate and programme. This correlation which is almost 0.5 shows that students entry aggregate has an indecisive relationship to do with programme of selection, all students have equal chances of been selected into any of the four programmes. It means that all categories of fresh students can be found in all the programmes of study at the University.

Table 8: Bonferroni Test of Difference of Mean GPA of Various Programmes

(i) Programme	(j) proramme	Mean Difference (i-j)	Sig. Error	Sig.
B. A. Social Science	BCom	0.0683919	0.0467618	0.863
	BMS	0.1812983	0.0539161	**0.005**
	BED Social Sc.	0.0681107	0.0403665	0.551
BCOM	B.A. Social Sc.	-0.0683919	0.0467618	0.863
	BMS	0.129064	0.0544318	0.230
	BED Social Sc.	-0.0002812	0.0410524	1.000
BMS	B. A. Social Sc.	-0.1812983	0.0539161	**0.005**
	BCOM	0.1129044	0.0544316	0.230
	BED Social Sc.	-0.113187	0.0490467	0.127
BED Social Science	B. A. Social Sc.	-0.0681107	0.0403665	0.551
	BCom	0.0028120	0.0410524	1.000
	BMS	0.1131877	0.0490467	0.127

Table 8 gives the differences of the mean grade point average among the various programmes. The table reveals that among the programmes, there is a significance difference (0.005) in the grade point average of B. A. Social Science and Bachelor of Management Studies. This also supports the value of the test statistics that there is a difference among the mean of the grade point average of the various programmes.

We can now confirm from Table 7 that Bachelor of Arts (Social Science)) was the best performing programme followed by Bachelor of Education (Social Science),Bachelor of Commerce and Bachelor of Management Studies. The respective mean performances are grade point average 2.7698, 2.7016, 2.7014 and 2.5885.

Table 9: Best Regression: Grade Point Average versus Programmes and Entry Aggregate

Variables	R-sq	R-sq(adj)	Mallow C-P	St.Dev.	P1	P2	P3	Entry Aggr.
1	0.7	0.6	10.2	0.52761			X	
1	0.5	0.4	12.8	0.52819	X			
2	1.0	0.8	9.0	0.52710	X		X	
2	1.0	0.8	9.1	0.52711			X	X
3	1.7	1.4	3.1	0.52552		X	X	X
3	1.2	1.0	8.0	0.52663	X		X	X
4	1.7	1.3	5.0	0.52573	X	X	X	X

In the table P1, P2, and P3 denotes Bachelor of Arts Social Science, Bachelor of Commerce and Bachelor of Managements studies respectively. It shows all the possible best combinations of the predictor variables that can be used to build the regression equation. The extracted regression equation is therefore given as

Grade Point Average = 3.05 – 0.147P2 – 0.0251entry aggregate

This is because it has a high coefficient of determination R^2 (1.7%) the smallest mallows C – P (3.1) and a small standard deviation (0.52552). The regression analysis of the model in equation is given in Table 9 below.

Table 10: Regression Analysis: Grade Point Average versus P2, P3, and Entry Aggregate

Predictor	Coefficient	St. Error Coff.	T	P
Constant	3.0506	0.1256	24.28	0.000
P2	-0.1473	0.0661	-2.23	0.026
P3	-0.2100	0.0597	-3.52	0.000
Entry Aggregate	-0.0250	0.0088	-2.83	0.005

It can be seen from Table 10 that the P- values of the test of significance of the selected variables in the model are all negligible. These suggest that student's final grade point average is significantly determined by the selected variables. That is Bachelor of Commerce, Bachelor of Management Studies and Entry Aggregate.

3.2 Interpretation of Regression Coefficient

Although each assessment measurement offers a different perspective , all agree in their assessment of how well the model fits the data, because all are based on the sum of squares error, SSE. We now interpret and test the individual coefficients and the model to predict and estimate.

It is recalled from the general regression equation above that

$$Y = B_0 + B_1X_1 + B_2X_2 + ...B_JX_J$$

with reference to Equation 4.1, K = 4 since only four variables are involved. The intercept, B_0 = 3.0506 is the average grade point average when no independent variables are included in the equation. In other words, this is to say that the student scored grade point average of 3.0506 when his or her programme and aggregate are ignored. This is actually impracticable, because if zero is outside the range of values of the explanatory variables (as is the case here). The relation between grade point average and Bachelor of Commerce programme is described by B_1 = 0.147. The coefficient B_1 = 0.147 species that for each student who offered Bachelor of Commerce his or her grade point average decreases by 0.147 provided other programmes are held constant. Similarly, the relationship between grade point average and Bachelor Managements Studies is described by B_2 = 0.210. This is interpreted to mean that for each student who offered Bachelor of Management Studies his or her grade point average decreased assuming other programme and entry aggregate are held constant. Again, B_3 = 0.0251is interpreted to mean that for each student who applied with entry aggregate , his or her grade point average decreases by 0.0251 provided programme offered is held constant.

Table 11: Analysis of Variance

Source	Degrees of freedom	Sum of Squares	Mean Sum of Squares	F	P
Regression	4	15.3553	1.3388	4.84	0.001
Residual Err.	1148	317.2748	0.2764		
Total	1152	322.6501			

We see from the analysis of variance that F = 4.84, this leads to a very negligible p- value of 0.001. These values imply that the extracted model can be used to predict the final grade point average of students with a very high degree of precision.

4. Discussion

Some important results in both the analysis need some extent of discussions. These are:

1. Analysis of data based on the various entry aggregate.
2. Analysis of data based on the various programmes.
3. The real variables that significantly determine students academic output.
4. The low correlation between the variables

The analysis of the data reveals that students academic performance with regards to the entry aggregate do not differ. Although students are admitted based on their Senior Secondary Certificate Examination, this analysis has reveal that the mean grade point average for one thousand one hundred fifty three students who entered the University with aggregates ranging from six (6) to eighteen (18) do not differ. This is not surprising because the group with the best GPA average is those who entered with aggregate ten and those with the worse GPA average entered with aggregate eight. The best student in this analysis entered the University with aggregate twelve (12) and a student who entered with aggregate (14) came out with grade point average of 3.7008 which is first class and a student who entered with aggregate six (6) came out with grade point average of 1.9228 which is pass.

However, the analysis shows that for the various programmes offered by these students the mean grade point average for the programmes Bachelor of Commerce , Bachelor of Arts (Social Science),Bachelor Education (Social Science) and Bachelor of Management Studies differ. This is not surprising because these are programmes being offered by different schools and departments with different lecturers and courses. Even though, the grade point differs their weight is the same that is on the average the performance of the four programmes can be classified under second class lower division.

Therefore, from the two variables discussed, entry aggregate and programme, it is not surprising that the correlations between the variables are very low. The low correlation depict that the link between these two explanatory variables (entry aggregate and programme) and the dependent grade point average is very weak.

Meanwhile, the analysis reveals that some of these variables can significantly contribute or determines academic performance and therefore can be used to develop a model that can predict students' grade point average. In chapter four, a regression equation was obtained as: Grade Point Average = 3.05 -0.147P2 – 0.210P3 -0.0251 entry aggregate.
The equation makes use of three variables, Bachelor of Commerce, Bachelor of Management Studies and Entry aggregate.

5. Conclusion

The research identifies variables that explain academic performance of 2010/2011 academic year students of university of Cape coast who offered Bachelor of Arts (Social Science), Bachelor of Commerce, Bachelor of Management Studies, Bachelor of Education (Social Science). The main objective of the study was to identify variables that determine the academic performance of these students. The performance of students been assessed along three dimensions.
First, students' performance has been assessed based on their entry aggregate, it is revealed that students' grade point average at the end of their four year study has little to do with their previous academic performance at the senior secondary school, it is observed that students with good senior secondary school aggregate can performed badly and vise versa.
Secondly, the programme offered by students also contributes to their academic performance at the University, because of different field of study, schools or departments and different teaching skills students' academic performance based on programme of study differ a little.

Finally, the research or study reveals that there is a weak relationship between the explanatory variables, meanwhile it shows that there are some of these variables that contribute or determines students' academic performance.
This is related to the research by Justina E. Forjargbo (1996) who did some study on prediction of students' potential in chemistry using Basic Education Certificate Examination (BECE) results. She discovered that there is a slight positive relation between BECE and achievement in chemistry at West African Senior Secondary Certificates Examination (WASSCE). Hence, the variables studied under this study might contribute or determines the academic performance of the students. It is therefore recommended that students performance at the University should not solely based on entry aggregate and programme being offered alone. Other factors can

also be considered such as academic environment, the availability of academic resources, teaching empowerment, student attitude, and finance. However, it is recommended that further studies should be conducted to consider some of these factors and possible cover more pogrammes being offered by the University over a given period of time.

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