American Journal of Applied Mathematics and Statistics, 2018, Vol. 6, No. 2, 61-66
Available online at http://pubs.sciepub.com/ajams/6/2/4

DOI:10.12691/ajams-6-2-4

Binary Logistic Analysis on the Assessment of Students' Academic Performance on School-Based Factors in Some Selected Public Secondary Schools in Akinyele Local Government, Oyo State, Nigeria

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Abstract Education has been acknowledged as a central component that determines the character and social economic development of any nation especially in this era of globalization and technological revolution failure in addressing adequate education in any country could lead to retrograde in both social and economic development. The study aimed at estimating the factors that are capable of influencing students; academic performance at some selected public Senior Secondary Schools Certificate Examination in Akinyele Local Government of Oyo State, Nigeria. This study employed the binary logistic regression to estimate the academic performance based on gender and general academic performance. The students' academic performance were categorized into two: passed if the student has at least five credits including English and Mathematics and failed if otherwise. The result shows that students' performance in senior school certificate examination of public secondary schools in Akinyele Local Government Area of Oyo State will be better if the number of students per teacher follows international best practice (IBP) and library and laboratory are well equipped.

Keywords: *school-base factors, students performance, public schools, logistic regression*

Cite This Article: Ayoola F.J., and Balogun K.O, "Binary Logistic Analysis on the Assessment of Students' Academic Performance on School-Based Factors in Some Selected Public Secondary Schools in Akinyele Local Government, Oyo State, Nigeria." *American Journal of Applied Mathematics and Statistics*, vol. 6, no. 2 (2018): 61-66. doi: 10.12691/ajams-6-2-4.

1. Introduction

In Oyo State, education remains the largest industry and government continues to ensure that funds, instructional material and teaching personnel are made available for the sector. The government has also continuously encouraged secondary education by adopting the social demand approach towards planning the sector and by paying the Senior School Certificate Examinations (SSCE) fees in the State over a long period of time and also by retraining of both teaching and non-teaching staff in the secondary schools. An indication of government's interest in the general education in the state is reflected in the budgetary estimates of the State from 2009 till date. However, the resources are still inadequate due to the population of the state and greater interest of the citizenry on education.

Despite the efforts being made towards ensuring that citizens have equal educational opportunities as well as making other training facilities readily accessible to the users so as to improve students' academic performance in both internal and external examinations, it has been observed that all is not well with the system as a result of the poor performance of students recorded in public examinations in the recent years.

Researchers and stakeholders in education industry have in the recent past identified several factors as the causes of poor performance of students in public examinations. Among such factors identified are poor location of the school, incessant changes in government policies, closure of schools, which is contingent upon teachers' strike action, home-school distance, high student-teacher ratio, lack of supervision, monitoring and evaluation machinery, lack of good textbooks, poor content and context of instruction, poor and non-conductive environment among others.

Many state governments in Nigeria have made several attempts to make a policy that will improve school-based factors such as not to have more than 30 students per class in public secondary schools with a view to improving the performance of students in public examinations. The main thrust of this study therefore, was to establish the trend of students' performance at SSCE in secondary schools Akinyele Local Government of Oyo State, Nigeria. It also sought to find out the percentage of those students based on gender who obtained five credits passed including English and Mathematics with a view to providing relevant data for educational planners, educational policy makers and curriculum planners on the strengths and weaknesses of students' performance in the SSCE. This work focus on the school–based factors that can influence academic performance at SSCE in public Secondary Schools of Akinyele Local Government of Oyo State, Nigeria using binary logistic regression.

2. Review of the Literature

[1] stated that school environment has considerable effect on academic performance that is school environment that is not conducive to learning may lead to under performance. Provision of adequate learning facilities at all levels including equipment and human resources enhances the quality and relevance of imparted skills of learners [2]. Learning involves interaction of students with the environment. Teaching and learning resources include classrooms, laboratories, libraries, playing fields, textbooks among others. Indeed physical resources go a long way in creating conducive environment that promote effective teaching and learning. Based on the above statement the Draft Report on Cost and Financing of Education in Kenya identifies textbook ratio and school facilities as some yard sticks to be used to gauge the quality of secondary school education.

[3] linked performance in examinations to state of teaching and learning resources in schools. He notes that students from poor backgrounds perform poorly in the examinations because the poor are often in areas where schools are seriously deprived of vital facilities, an attitude of helplessness may be inculcated early into children making them feel that being in school is a waste of time.

[4] and [2] stated that the lack of basic facilities such as laboratories has compromised the teaching of science subjects. Topics that are meant to be taught practically are taught theoretically as part of adaptive mechanism by teachers due to inadequate resources to enable effective teaching of the same. This ends up affecting negatively students' performance reducing their competitiveness for opportunities whose placement is pegged on performance in such subjects. Various schools adopted different ways of getting physical resources in their schools such as tasking Parents Teachers Association, Old Students Association and Philanthropists to construct one structure or the other.

According to [2] adequacy of teachers is reflected by student teacher ratio. Student teacher ratio reflects the number of student that is handled by one teacher in a stream during a lesson. Low student per teacher ratio means that a teacher will be able to handle fewer students, implying better attention level. High student per teacher ratio implies that a teacher has to handle many students at a go. This will make a teacher to employ teaching methods which are deductive rendering students passive [5,6]. However, there is need to strike balance as extremely low student teacher ratio leads to under utilization of teachers while high student teacher ratio compromises academic performances affecting quality of education. This study therefore seeks to establish the impact of human resource on students' academic performance as reflected by public examination results.

According to [7], Teachers are essential players in promoting quality education in schools because they are catalysts of change. Teachers at all levels of education system should have access to training and ongoing professional development so that they can be able to participate locally and internationally in decisions affecting their teaching environments.

[8] stated that educational management has no choice as to whether to train teachers and other employees or not. This is because the competence of employees will never last forever due to factors such as curriculum change, technological change transfers and promotions. Education reforms processes tend to maintain the classical scheme of incorporating teachers when the proposal has already been defined, counting teachers only as potential trainees and implementers, thus ignoring the importance of teachers' knowledge, experience and active participation in the reform process [9].

[10] investigated gender differences in parental involvement and adolescents" mathematics achievement through a longitudinal study. The sample was taken from national longitudinal study of 13,881 students of class eighth to twelfth from the city Austin in Texas. The scores attained by the students in mathematics test were considered as academic achievement of the students. The findings indicated gender differences in academic achievement.

3. Methodology and Model Specification

3.1. Logistic Regression

Logistic regression can be seen as a special case of generalized linear model and thus analogous to linear regression. The model of logistic regression, however, is based on quite different assumptions (about the relationship between dependent and independent variables) from those of linear regression. In particular the key differences of these two models can be seen in the following two features of logistic regression. First, the conditional distribution p(y/x) is a Bernoulli distribution rather than a Gaussian distribution, because the dependent variable is binary. Second, the estimated probabilities are restricted to the interval [0,1] through the logistic distribution function because logistic regression predicts the probability of the event being positive.

3.2. Model Fitting

$$Y_i = \ln\frac{\pi}{1-\pi} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + U_i \quad (1)$$

Where, Y_i represents students' academic performance (Score was recorded as: 1 if the student has at least five credits including English and Mathematics and 0 otherwise. Π_i = the probability of the student having good academic performance

X_1 represents Number of Students per Teacher (Score was recorded as: 1 – 40 = 1, 41 – 80 = 2, Above 80 = 3)

X_2 represents Number of Students per Class (Score was recorded as: 1 = 1 – 50 = 1, 51 – 100 = 2, Above 100 = 3)

X_3 represents Availability of Library (Score was recorded as: Not Available = 0, Available = 1)
X_4 represents Availability of Laboratory (Score was recorded as: Not Available = 0, Available = 1)
X_5 represents Availability of Water (Score was recorded as: Not Available = 0, Available = 1)
X_6 represents Availability of Toilet (Score was recorded as: Not Available = 0, Available = 1).

3.3. Sources of Data

The instrument is School Based Factors Questionnaire (SBFQ) meant for the principals and heads of departments. Statistical Package for Social Science (SPSS) was used for the statistical data analysis (correlation test, chi-square and logistic regression). The data used in this work were both primary and secondary data and they were collected for 14 selected public senior secondary schools from principals and heads of departments in each school and office of the Local Inspector of Education (LIE) in Akinyele Local Government Area of Oyo, Nigeria with the aid of questionnaires.

4. Result Discussions

Table 1 showed that there were significant relationship at both 0.01 and 0.05 levels of significant between the dependent variable and the different independent variables in both analysis based on gender and combine except the relationship between dependent variable (students' academic performance) and availability of water under male and availability of library under female where it was not significant and only significant at 0.05 level of significant respectively.

Table 1. Summary of the Correlation Analysis

	Gender	Students Performance	No Of Students Per Teacher	No Of Students Per Class	Availability Of Library	Availability Oflaboratory	Availability Of Portable Water	Availability Of Toilet
Students Performance	Male	1	-0.305**	-0.488**	0.048**	0.271**	-0.006	0.118**
	Female	1	-0.260**	-0.447**	0.028*	0.270**	0.043**	0.184**
	Both	1	-0.282**	-0.466**	0.036**	0.269**	0.021*	0.150**
No Of Students Per Teacher	Male	-0.305**	1	0.697**	0.538**	-0.157**	0.295**	0.196**
	Female	-0.260**	1	0.665**	0.583**	-0.190**	0.271**	0.147**
	Both	-0.282**	1	0.681**	0.560**	-0.173**	0.282	0.172
No Of Students Per Class	Male	-0.488**	0.697**	1	0.160**	-0.370**	0.098**	-0.214**
	Female	-0.447**	0.665**	1	0.151**	-0.401**	0.070**	-0.293**
	Both	-0.466**	0.681**	1	0.156**	-0.385**	0.084**	-0.254**
Availability Of Library	Male	0.048**	0.538**	0.160**	1	0.376**	0.378**	0.545**
	Female	0.028*	0.583**	0.151**	1	0.378**	0.420**	0.538**
	Both	0.036**	0.560**	0.156**	1	0.378**	0.396**	0.542**
Availability Oflaboratory	Male	0.271**	-0.157**	-0.370**	0.376**	1	0.349**	0.691**
	Female	0.270**	-0.190**	-0.401**	0.378**	1	0.393**	0.703**
	Both	0.269**	-0.173**	-.385**	0.378**	1	0.370**	0.697**
Availability Of Portable Water	Male	-0.006	0.295**	0.098**	0.378**	0.349**	1	0.297**
	Female	0.043**	0.271**	0.070**	0.420**	0.393**	1	0.271**
	Both	0.021*	0.282**	0.084**	0.396**	0.370**	1	0.282**
Availability Of Toilet	Male	0.118**	0.196**	-0.214**	0.545**	0.691**	0.297**	1
	Female	0.184**	0.147**	-0.293**	0.538**	0.703**	0.271**	1
	Both	0.150**	0.172**	-0.254**	0.542**	0.697**	0.282**	1

Table 2. Summary of Tests of Model Coefficients

			Chi-square	Df	Sig.
Step 1	Male	Step	1526.868	6	.000
		Block	1526.868	6	.000
		Model	1526.868	6	.000
Step 1	Female	Step	1235.827	6	.000
		Block	1235.827	6	.000
		Model	1235.827	6	.000
Step 1	Combined	Step	2714.629	6	.000
		Block	2714.629	6	.000
		Model	2714.629	6	.000

Table 3. Summary of Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	5218.808[a]	.267	.357
1	5591.153[a]	.216	.292
1	10890.036[a]	.238	.320

Table 4. Summary of Coefficient of Logistic Regression

		B_0	B_1	B_2	B_3	B_4	B_5	B_6
Male	Estimates (B)	1.989	0.025	-1.603	1.107	1.195	-0.075	-1.233
	Significance	0.000	0.850	0.000	0.000	0.000	0.324	0.000
	Exp(B)	7.389	1.026	0.201	3.026	3.304	0.928	0.291
	S.E	0.235	0.134	0.075	0.135	0.184	0.076	0.122
Female	Estimates (B)	0.948	0.100	-1.373	0.424	1.096	0.122	-0.521
	Significance	0.000	0.432	0.000	0.001	0.000	0.106	0.000
	Exp(B)	2.580	1.105	0.253	1.529	2.992	1.129	0.594
	S.E	0.228	0.127	0.070	0.128	0.185	0.075	0.116
Combined	Estimates (B)	1.453	0.055	-1.477	0.747	1.140	0.031	-0.868
	Significance	0.000	0.547	0.000	0.000	0.000	0.552	0.000
	Exp(B)	4.278	1.057	0.228	2.111	3.127	1.032	0.420
	S.E	0.163	0.092	0.051	0.092	0.129	0.053	0.083

The probability of the model chi-square was less than 0.001 in both analyses based on gender and combined. The null hypothesis that there is no difference between the model with only a constant and the model with independent variables was rejected. The existence of a relationship between the independent variables and the dependent variable was supported, which means there is relationship between dependent variables and the independent variables i.e. there is relationship between students' academic performance and number of students per teacher (X_1), number of students per class (X_2), availability of library (X_3), availability of laboratory (X_4), availability of water (X_5), and availability of toilet (X_6). However, the chi-square value of male is higher than that of female while the value of combined is almost addition of the two.

The values of Cox & Snell R Square and the Nagelkerde R Square 0.267 and 0.357, 0.216 and 0.292, 0.238 and 0.320 for male, female and combined respectively suggesting that between 26.7% and 35.7%, 21.6% and 29.2%, 23.8% and 32% of the variability is explained by these set of variables. This implied that the variability in dependent variable was well explained by these set of variables in male students' performance than female students' performance and general students' performance.

Since none of the independent variables had standard error value larger than 2, it means that there was no numerical problems such as having a large ratio of predictors to cases, multicolinearity, sparseness, or complete separation among the independent variables, therefore the results can be interpreted.

The regression models for the log-odds in favour of passed (male, female and combined respectively) from the table above were:

$$\ln\frac{\pi_m}{1-\pi_m} = 1.989 + 0.025x_1 - 1.607x_2 + 1.107x_3 + 1.195x_4 - 0.075x_5 - 1.233x_6$$

$$\ln\frac{\pi_f}{1-\pi_f} = 0.948 + 0.100x_1 - 1.373x_2 + 0.424x_3 + 1.096x_4 + 0.122x_5 - 0.521x_6$$

$$\ln\frac{\pi_c}{1-\pi_c} = 1.453 + 0.055x_1 - 1.477x_2 + 0.747x_3 + 1.140x_4 + 0.031x_5 - 0.868x_6$$

The table above provided information about the contribution or importance of each of six predictor variables. The test is Wald test; the value of statistic for each predictor is in the row labeled significance. Among all the six independent variables, the contribution of only two variables (Number of students per teacher and availability of water) were not significant in the predictive ability of the model for both analyses based on gender and combined.

4.1. Estimating the Odds Ratios

To estimate odds, the model is exponentiated as

$$\frac{\pi_m}{1-\pi_m} = e^{1.989+0.025x_1-1.607x_2+1.107x_3+1.195x_4-0.07x_5-1.123x_6}$$

$$\frac{\pi_f}{1-\pi_f} = e^{0.948+0.100x_1-1.373x_2+0.424x_3+1.096x_4+0.122x_5-0.521x_6}$$

$$\frac{\pi_c}{1-\pi_c} = e^{1.453+0.055x_1-1.477x_2+0.747x_3+1.140x_4+0.031x_5-0.868x_6}.$$

The values in the column exp(B) are the odd ratio for each of the independent variables, it represented the change in odds of being in one of the categories of outcome when the value of a predictor was increase by one unit. The odd ratios of number of students per teacher, availability of library, availability of laboratory, availability of water were greater than 1 from the above table indicated that the increase in any of these variables the more likely the increase of the students performance; and the odd ratios of number of students per class and availability of toilet are less than 1 indicate that the increase in any of these variables the less likely the increase of the students performance. However, number of students per teacher and availability of water are not significant.

4.2. Prediction of Probabilities

The probability of passed (Male, Female and Combined respectively) is obtained by applying the logistic transformation:

$$\pi_m = \frac{e^{1.989+0.025x_1-1.603x_2+1.107x_3+1.195x_4-0.075x_5-1.233x_6}}{1+e^{1.989+0.025x_1-1.603x_2+1.107x_3+1.195x_4-0.075x_5-1.233x_6}}$$

$$\pi_f = \frac{e^{0.948+0.100x_1-1.373x_2+0.424x_3+1.096x_4+0.122x_5-0.521x_6}}{1+e^{0.948+0.100x_1-1.373x_2+0.424x_3+1.096x_4+0.122x_5-0.521x_6}}$$

$$\pi_c = \frac{e^{1.453+0.055x_1-1.477x_2+0.747x_3+1.140x_4+0.031x_5-0.868x_6}}{1+e^{1.453+0.055x_1-1.477x_2+0.747x_3+1.140x_4+0.031x_5-0.868x_6}}$$

Table 5. Summary of Prediction of Probabilities

	Π_1	Π_2	Π_3	Π_4	Π_5	Π_6
Male	0.51	0.17	0.75	0.77	0.48	0.23
Female	0.52	0.20	0.60	0.75	0.53	0.37
Combined	0.51	0.19	0.68	0.76	0.51	0.30

Where
Π_1 = the probability of reporting odds for number of students per teacher
Π_2 = the probability of reporting odds for number of students per class
Π_3 = the probability of reporting odds for availability of library
Π_4 = the probability of reporting odds for availability of laboratory
Π_5 = the probability of reporting odds for availability of portable water
Π_6 = the probability of reporting odds for availability of toilet.

4.3. Test of Hypothesis Using Wald Statistic

As earlier mentioned in the methodology Wald statistic follows a chi –square distribution with 1 degree of freedom. The test was carried out at 0.05 level of significant.

H_0: β_1 (Number of Students per Teacher is independent of Students' Performance)

H_1: β_1 (Number of Students per Teacher is dependent of Students' Performance)

P=0.850 > α = 0.05, P=0.432 > α = 0.05,P=0.547 > α = 0.05, it is not statistically significant.

H_0: β_2 (Number of Students per Class is independent of Students' Performance)

H_1: β_2 (Number of Students per Class is dependent of Students' Performance)

P=0.000 < α = 0.05, P=0.000 < α = 0.05, P=0.000 < α = 0.05, it is statistically significant.

H_0: β_3 (Availability of Library is independent of Students' Performance)

H_1: β_3 (Availability of Library is dependent of Students' Performance)

P=0.000 < α = 0.05, P=0.000 < α = 0.05, P=0.000 < α = 0.05, it is statistically significant.

H_0: β_4 (Availability of Laboratory is independent of Students' Performance)

H_1: β_4 (Availability of Laboratory is dependent of Students' Performance)

P=0.000 < α = 0.05, P=0.000 < α = 0.05, P=0.000 < α = 0.05, it is statistically significant.

H_0: β_5 (Availability of Water is independent of Students' Performance)

H_1: β_5 (Availability of Water is dependent of Students' Performance)

P= 0.324> α = 0.05, P=0.106> α = 0.05, P=0.552 > α = 0.05, it is not statistically significant.

H_0: β_6 (Availability of Toilet is independent of Students' Performance)

H_1: β_6 (Availability of Toilet is dependent of Students' Performance)

P=0.000 < α = 0.05, P=0.000 < α = 0.05, P=0.000 < α = 0.05, it is statistically significant.

Rank of Factors Based on Contribution

	Rank of Factors					
	1	**2**	**3**	**4**	**5**	**6**
Male	X_2	X_6	X_5	X_1	X_3	X_4
Female	X_2	X_6	X_1	X_5	X_3	X_4
Combined	X_2	X_6	X_5	X_1	X_3	X_4

Interpretation: The above table showed the rank of each factor based on their contribution or importance to the good academic performance of students. It showed that the availability of laboratory is the most important factor to the good academic performance of students followed by the library while number of students per class is the least important factor to the good academic performance of students followed by availability of toilet in both analyses based on gender and general performances.

Summary: The study was conducted to determine the school–based factors that are capable influencing academic performance at SSCE in public Secondary Schools of Akinyele Local Government.

Findings showed that out of the six selected factors to influence the student academic performance, (number of students per teacher, number of students per class, availability of library, availability of laboratory, availability of portable water and availability of toilet), four factors (number of students per class, availability of library, availability of laboratory, and availability of toilet) were found to have significant effect on the predictive binary logistic regression model fitted while all six factors had significant relationship with students academic performance either negative or positive correlation in both analyses (i.e. whether analysis is based on gender or not). It also showed that there was no much difference in academic performance of male and female students in both logistic regression and correlation analyses because both were almost equal in term of signs, ranks and even in term of magnitude.

5. Conclusion

There are various factors inside and outside school that contribute to the quality of academic of students. This study only focused only on some of the school-based factors that influence the students' academic performance.

After the analysis (both correlation and binary logistic regression) it was concluded that number of students per class, availability of library, laboratory and toilet are significant predictors for good performance of students in public secondary schools in Akinyele Local Government area of Oyo State. Number of students per teacher and availability of portable water also had significant relationship with students' academic performance. Therefore, the selected school-based factors have considerable impact on good academic performance of students in Akinyele Local Government area of Oyo State.

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