

Assessing the Academic Performance of Student's in General Studies Courses using the Hotelling's Squared Approach

Bilesanmi A. O.¹, Sol- Akubude, V. I. P² and Aronu, C. O.^{3*}

¹Department of General Studies, Petroleum Training Institute, Effurun-Delta State, Nigeria

²Department of Mathematics, Chukwuemeka Odumegwu Ojukwu University, Anambra State, Nigeria

³Department of Statistics, Chukwuemeka Odumegwu Ojukwu University, Anambra State, Nigeria

Abstract: - This study examined the performance of the mathematics students and microbiology students on three major general studies courses (GST) using the Hotelling's T^2 approach. The objectives of the study includes: to compare the average performance of students in Microbiology and Mathematics departments on general studies courses (GST), to determine the average score of the students on these courses for Microbiology and Mathematics departments, and to ascertain where significant difference exist between the performance of students on these courses for Microbiology and Mathematics departments. The data for the study was secondary data collected from the Examination and Records Department of Imo State University, Imo State, Nigeria. The exam scores of the students were tested for multivariate normality based on skewness and kurtosis. The findings showed that the data obtained were multivariate normally distributed for microbiology and mathematics respectively. Hence, the data satisfies the required assumption to apply a parametric multivariate method such as the Hotelling's T^2 method. The average performance of the two sets of students using their mean scores showed that the Microbiology Department out-performed the Mathematics Department with a mean score of 59.68% across the three GST courses considered in this study. The performances of the two departments on the selected general courses were found to be significantly different assuming a 95% confidence level.

Keywords: Department, Hotellings's, Kurtosis, Multivariate, Skewness, Performance.

I. INTRODUCTION

Education is one of the most important tools required for human resource development anywhere in the world. The student's performance contributes significantly in producing the best quality graduates who will become great leaders and manpower for the country thus responsible for the country's economic and social development. In most developing countries like Nigeria, academic achievement is viewed as one of the major factors considered by employers in hiring workers especially for the fresh graduates (Olufemi *et al.*, 2018).

Courses offered at year one level by departments in the basic sciences in most Nigerian Universities have little or in most cases do not vary. These courses cut across general studies,

mathematics, introduction to computer, and introduction to statistics. In some quarters, it is believed that students from Microbiology, Mathematics, Statistics and Engineering, do not show the same performance in all their offered courses. Due to the much attention given to courses involving calculations, students of Mathematics for instance, give little or no attention to theoretical courses than their counterparts in other departments with no calculation courses, thereby prone to failing these courses.

Recently, the call for reforms in Nigeria's educational sector has been the aftermath of recurrent poor performance of students in their academic works. Many Institutions of Higher Learning are paying utmost attention to the full implementation of the education reform. The assertion that some courses are better passed by students with regard to discipline and basic foundation is the fulcrum of this research work. Hence, the objectives of the study includes: to compare the average performance of students in Microbiology and Mathematics departments on general studies courses (GST), to determine the average score of the students on these courses for Microbiology and Mathematics departments, and to ascertain where significant difference exist between the performance of students on these courses for Microbiology and Mathematics departments.

II. LITERATURE REVIEW

Alos *et al.* (2015) in their study focused on the importance of having qualified teachers in the field of teaching, and opined that the success of any program is conditioned by the ability of the teacher to teach. If there is failure at this point, the whole structure fails. Hence, the implementation, selection, preparation and supervision of education will be affected.

Akinsolu (2010) examined the number of qualified teachers and how it relates to students' academic performance in public secondary schools in a sample of Local Government Areas (LGA) of Osun State. The study considered twenty-one (21) public secondary schools, one in each LGA from a population of thirty-one (31) LGA in the State. The Senior School Certificate Examination results from 2000/01 to 2004/05 evaluated and employed to analyze the academic performance of the students and reflected some concerns in the school

system. The data were analyzed using ANOVA and Spearman rank correlation coefficient to analyze the data obtained for the study. The findings of the study showed teachers' qualifications, experience and teacher–student ratio have significant association to students' academic performance.

Study by Svodziwa and Kurete, (2017) stated that shortage of accommodation in most campus, gives room for students to rent accommodation off-campus. This is common with most public tertiary institutions in Nigeria due to lack of such facilities in the institutions. In some of the institution's in Nigeria, accommodation is only available on the basis of first come first serve in the first and final year of study while some institutions have only accommodation for female students. This arrangement of living is expected to have significant impact on academic performance of students because unfortunate students who fall in the mist of bad company will definitely lose focus and may not concentrate in their academic quest.

Haolader et al. (2017) compare the academic performance of students in the Bachelor's degree of Information Technology (BIT) having Arts and Science backgrounds in universities of Uganda. The study considered a sample of 202 final year students using the purposively sampling to select students from two universities in Uganda. These students were categorized on the basis of their A' level backgrounds (130 Arts and 72 Sciences). The study employed the Welch's t-test to determine the difference between the performance of the two groups and a simple linear regression analysis was used to examine the nature of relationship among students' performance between semesters. The findings of the study revealed that there's a significant difference in the academic performance of the two groups, with the science group outperforming arts. However, it was found that there is a more linear increase in the performance of Arts students from semester one through semester five. In addition, finding showed that Arts students performed slightly better than Science counterparts in some course units. In conclusion, the study noted that Science students perform better than Arts students in the overall semester final examination with Arts students having room for improvement in their performance.

Olufemi et al. (2018) examined the factors supposed to be affecting students' academic performance in Colleges of Education in southwest, Nigeria. The descriptive and inferential statistics were used for analyzing data obtained for the study. The findings showed that 52.4% of the respondents were between 20 – 24 years of age, majority are female (67.6%), supported by family/guardian (88.9%), stayed off-campus (69.8%), had personal motivation for studying Education (65.8%) and bold (91.1%). Also, results of parental background revealed that the parents were married (63.8%), educated (68.2%), and earned average income of ₦60,604.5/month.

III. METHODS AND MATERIAL

3.1 Method of Data collection

The data on the performance of year one student of Microbiology and Mathematics students of Imo State University, Owerri for 2017/2018 session, were collected from the Examination and Records Department of the institution. The data is a secondary data since the data did not originate from the researcher directly. The data collected are the student's scores on three General Study Courses (GST Courses) for second semester .They are GST 102(Use of English) GST 108,(Entrepreneurship Education) ,GST 104 (Psychology).

3.2 Method of Data Analysis

The method of analysis adopted in this research work is the Hotteling's T² Technique. The Hotteling's T² is a multivariate generalization of the student's t-test in the univariate situation.

3.2.1 One Sample Case of the Hotelling's T² Approach

Consider the hypothesis

$$H_0: \mu = \mu_0$$

versus

$$H_a: \mu \neq \mu_0$$

and a random sample X_1, X_2, \dots, X_n from $N_p(\mu, \Sigma)$ (Onyeagu, 2003).

Suppose \bar{X} and S be the mean and standard deviation of the random variable.

$$(n-1)s = \sum_{j=1}^n (X_j - \bar{X})(X_j - \bar{X})' \sim W_p(\Sigma, n-1) \tag{1}$$

When H_0 is true

$$\bar{X} - \mu_0 \sim N_p\left(0, \frac{\Sigma}{n}\right) \tag{2}$$

$$\sqrt{n}(\bar{X} - \mu_0) \sim N_p(0, \Sigma)$$

\bar{X} and S are independent.

$$\begin{aligned} T^2 &= (n-1)\sqrt{n}(\bar{X} - \mu_0)'[(n-1)S]^{-1}(\bar{X} - \mu_0)\sqrt{n} \\ &= n(\bar{X} - \mu_0)'S^{-1}(\bar{X} - \mu_0) \sim \frac{p(n-1)}{n-p} F_{p, v-p+1, \alpha} \end{aligned} \tag{3}$$

The decision rule is to reject the null hypothesis when

$$T^2 > T_{p, n-p, \alpha}^2 \left(T_{p, n-p, \alpha}^2 = \frac{p(n-1)}{n-p} F_{p, v-p+1, \alpha} \right)$$

Accept otherwise.

3.2.2 The Two Sample Case of the Hotelling's T² Approach

Suppose we consider two independent random samples {X_j, j=1, 2, ..., n₁} and {Y_j, j=1, 2, ..., n₂} from N_p(μ₁, Σ) and N_p(μ₂, Σ) respectively. Interest is in testing the hypothesis that both samples came from the same distribution.

H₀: μ₁=μ₂

versus

H_a: μ₁≠μ₂

Let,

$$A_1 = \sum_{j=1}^{n_1} (X_j - \bar{X})(X_j - \bar{X})' \tag{4}$$

$$A_2 = \sum_{j=1}^{n_2} (Y_j - \bar{Y})(Y_j - \bar{Y})' \tag{5}$$

$$S_1 = \frac{\sum_{j=1}^{n_1} (X_j - \bar{X})(X_j - \bar{X})'}{n_1 - 1} \tag{6}$$

$$S_2 = \frac{\sum_{j=1}^{n_2} (Y_j - \bar{Y})(Y_j - \bar{Y})'}{n_2 - 1} \tag{7}$$

The pooled estimate S of the variance - covariance matrix

$$S = \frac{(n_1 - 1) S_1 + (n_2 - 1) S_2}{n_1 + n_2 - 2} \tag{8}$$

The test statistic for the two sample case is written as

$$T^2 = \frac{n_1 n_2}{n_1 + n_2} (\bar{X} - \bar{Y})' S^{-1} (\bar{X} - \bar{Y}) \tag{9}$$

$$T^2 \sim \frac{p(n_1 + n_2 - 2)}{n_1 + n_2 - p - 1} F_{p, n_1 + n_2 - p - 1, \alpha}$$

IV. DATA ANALYSIS

4.1 Multivariate normality test of the performance of students

Table 1: Multivariate Normality Test Based on Skewness for performance of Microbiology and Mathematics Department

Department	U test value	df	p-value	Remark
Microbiology	0.0209	3	0.9992	Multivariate normal
Mathematics	2.9661	3	0.3969	Multivariate normal

The result of the multivariate normality test based on skewness presented in table 1 showed that the data obtained were multivariate normally distributed with U values of 0.0209 and 2.9661 for microbiology and mathematics

respectively. The p-values were found to be greater than significant value of 0.05 (p-value= 0.9992 and 0.3969 > 0.05).

Table 2: Multivariate Normality Test Based on Kurtosis for performance of Microbiology and Mathematics Department

Department	W test value	df1	df2	w1	w2	p-value	Remark
Microbiology	13.849	5	1	1.12	1.60	0.1679	Multivariate normal
Mathematics	11.381	5	1	1.12	1.60	0.1478	Multivariate normal

The result of the multivariate normality test based on kurtosis presented in table 2 showed that the data obtained were multivariate normally distributed with W test values of 13.849 and 11.381 for microbiology and mathematics respectively. The p-values were found to be greater than significant value of 0.05 (p-value= 0.1679 and 0.1478 > 0.05). Hence, the data satisfies the required assumption to apply a parametric multivariate method such as the Hotelling's T² method.

4.2 Two Sample Hotelling's T² Method for assessing the performance of Microbiology and Mathematics Department

The mean performance for the two departments was obtained as:

$$\text{MAT} = \begin{bmatrix} 51.11 \\ 46.78 \\ 46.31 \end{bmatrix} \text{ and } \text{MCB} = \begin{bmatrix} 69.62 \\ 67.51 \\ 67.75 \end{bmatrix}$$

It was found that the mean score for microbiology was higher than students from mathematics.

The pooled estimate of the variance-covariance matrix was obtained as:

$$S_{\text{Pooled}} = \begin{bmatrix} 98.83 & -5.16 & -0.43 \\ -5.16 & 99.78 & 4.22 \\ -0.43 & 4.22 & 109.76 \end{bmatrix}$$

R-console Output of Hotteling’s T-square Two sample Test

Test stat: 60.848

Numerator df: 3

Denominator df: 2

P-value: 0.01621

The result of the analysis found a T-square value of 60.848 and a p-value of 0.02 which was found to be less than $\alpha=0.05$ assuming 95% confidence level. This result implies that there exists significant difference between the performances of the two departments on GST courses.

V. CONCLUSION

This study examined the performance of mathematics students and microbiology student on three major general courses. The exam scores of the students were tested for multivariate normality based on skewness and kurtosis. The findings

showed that the data obtained were multivariate normally distributed for microbiology and mathematics respectively. Hence, the data satisfies the required assumption to apply a parametric multivariate method such as the Hotelling’s T2 method.

The average performance of the two sets of students using their mean scores showed that the Microbiology Department out- performed the Mathematics Department with a mean score of 59.68% across the three GST courses considered in this study. The performances of the two departments on the selected general courses were found to be significantly different assuming a 95% confidence level.

This study found out that student in mathematics performs poor in general courses, we recommended that more attention should be given to these categories of student in other to improve their performance on these general courses.

REFERENCES

- [1]. Akinsolu, O. A. (2010). Teachers and Students’ Academic Performance in Nigerian Secondary Schools: Implications for Planning. *Florida Journal of Educational Administration & Policy Summer*, 3(2): 86-103.
- [2]. Alos, S. B., Lawrence C. Caranto, Juan Jose T. David, (2015). Factors Affecting the Academic Performance of the Student Nurses of BSU. *International Journal of Nursing Science*, 5(2): 60-65.
- [3]. Haolader, F. A., Hakim, W., Kassim, K. and Mubarak, H. R. (2017). A Comparative Study on the Academic Performance of Students in Bachelor’s Degree of Information Technology Having Arts and Science Background in Uganda. *World Journal of Educational Research*, 4(2): 257-273.
- [4]. Olufemi, O. T., Adediran, A. A. and Oyediran, W. O. (2018). Factors Affecting Students’ Academic Performance in Colleges of Education in Southwest, Nigeria. *British Journal of Education*, 6(10): 43-56.
- [5]. Onyeagu, S. I. (2003). *A First Course in Multivariate Statistical Analysis*. Mega Concept. Publisher, Akwa, Anambra State, Nigeria.
- [6]. Sovodziwa . G. and Kurete, T. (2017) The psychological consequences of Cohabitation among Students Tai Solarin university of Education , ijagun , Ogun State , Nigeria. *Ozean Journal Of Applied Science*, 6(2) 65-70.