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| RESEARCH ARTICLE

The Effect of Educational and Environmental Factors on Students' Academic Performances in Nigerian Universities: A Mixed Linear Model (MLM) Approach

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| ABSTRACT
This study seeks to enrich the existing literature on academic performance in Nigerian universities and recommend a culture of evidence-driven decision-making in the higher education sector. It investigates educational and environmental factors affecting Nigerian university students' academic performances. Data was collected from eight different Schools of the Federal University of Technology, Owerri (FUTO) using the stratified random sampling technique. The educational factors comprise of human resources, physical facilities and instructional materials, while the environmental factors are internet accessibility, transportation, security, students' housing, and electricity. A structured questionnaire was used to collect the data. Principal Component Analysis (PCA) and Mixed Linear Model (MLM) Analysis were used to analyze the collected data. Findings show that among the eight variables studied, only "instructional materials" significantly explained the "Cumulative Grade Point Average" (CGPA) of the students. Though there was a non-significant "Schools" effect, the intra-class correlation Coefficient (ICC) was 22%. This study, therefore, contributes to the development of strategies that can effectively address the poor performance of most Nigerian university students. However, to inform policy initiatives to improve educational quality in Nigerian universities, more studies are required to identify additional factors that may affect students' academic achievements using more universities.

| KEYWORDS

Federal University, Academic Performance, Nigeria, Mixed Model, Principal Component

| ARTICLE INFORMATION

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1. Introduction

Education is universally acknowledged as a crucial determinant of individual and societal development. It plays a pivotal role in shaping individuals' skills, knowledge, and competencies, thereby contributing to economic growth and social progress. In Nigeria, like many other countries, educational institutions are entrusted with the responsibility of imparting knowledge and equipping students with the necessary tools for success in their academic pursuits and future careers. Various factors can influence students' academic performance, both positively and negatively. One important aspect is the availability and quality of educational inputs, including teaching materials, qualified faculty, infrastructure, and instructional resources. These inputs have been identified as essential components that contribute to students' learning experiences and outcomes. In addition to educational inputs, the learning environment itself plays a significant role in shaping students' academic performance (Adesoji & Olatunbosun, 2008). The learning environment encompasses physical, social, and cultural factors within the educational setting.

In Nigeria, it is no longer news that the standard of education has fallen (Duze, 2011; Ukata & Okeke, 2023). Students' performances in the universities have fallen short of expectations (Olatunji *et al.,* 2016) as there is a significant disparity in the academic performance of students despite the crucial relevance of higher education in Nigeria and its potential to spur economic and societal growth (Ali *et al.*, (2009) and Olusola, *et al.*, (2015). While some students perform exceptionally well academically, others have difficulty meeting the benchmarks. For some time, scholars have been increasingly concerned about the academic performance of most university students (Tilley, 2008). Researchers, educators, and trainers have therefore placed a strong emphasis on identifying the factors that significantly affect students' academic performance (Alshammari *et al.,* 2017) with the aim of influencing the students' academic success and hence ameliorating the fallen standard of education. Some of these studies, as noted above, include the availability and quality of educational inputs and the learning environment (Olufemi, Adediran and Oyediran, 2018; Aneke and Akpusugh, 2022). The impact of these factors on students' academic performances within the framework of a Nigerian institution has to be experimentally evaluated. Understanding the relationship between these variables and academic achievement can help guide policy decisions and actions that attempt to raise the standard of higher education and boost student outcomes. Investigating this matter can also further the larger conversation in Nigeria about equity and quality in education. Some of the studies alluded to above are reviewed hereunder.

2. Literature Review

Santrock (2006) described performance as what the student has learned or what skills the student has learned and is usually measured through assessments like standardized tests, performance assessments, e.t.c. Students' academic performance is one of the current educational problems of public interest based on the poor level of students' academic performance, especially in public examinations and various higher institutions. Several studies have been carried out on the factors that affect students' academic performance in schools, colleges and universities. Factors identified and reported to have affected the academic performance of students in different settings are; previous or prior educational performance, self–motivation, social-economic status of students' parents, number of hours of study per day, e.t.c. (Farooq, *et al*, 2011; Ali, *et al*, 2013). Therefore, academic performance is very important in Colleges and Universities.

Adegbemile (2011) conducted a study on the availability of human resources and students' academic performance in secondary schools in the North West Geo-Political Zone of Nigeria. The study employed a descriptive survey and found that human resource availability, such as the availability of teachers, has a significant impact on students' academic performance. On the contrary view, Ekundayo and Alonge (2012) discovered that human resources were not significantly related to students' academic performance in both public and private schools in Nigeria by using a Pearson Product moment correlation.

A crucial aspect of the teaching and learning process is the use of instructional materials. Effective pedagogy cannot be promoted without adequate accessibility and usage of instructional materials, which include a variety of tools like textbooks, multimedia tools, and lab equipment. Chang (2009) emphasized the crucial part instructional materials play in raising students' academic performance. According to Slavin (2010), a well-planned and imaginative use of visual aids in lessons should do much to banish lack of interest, supplement the inadequacy of books as well as arouse students' interest by giving them something practical to see and, at the same time helping them to train themselves to think about new things. Research carried out by Okhakhu, Oladiran and Omoike (2016) using a descriptive survey revealed that instructional resources play a significant role in enhancing the performance of students. It was concluded that the main reason for the lack of proper use of instructional materials was the lack of users' education. In a similar dimension, Ajayi and Ayodele (2001) also showed that an adequate supply of instructional resources have a significant effect on students' achievement.

Olaleye (2011) opined that for proper teaching and learning to take place, adequate facilities are required. In Nigerian tertiary institutions, it is observed that lecture halls are overcrowded, and many students stay outside or, at times, miss lectures due to inadequate accommodation. In a Pearson product moment correlation test conducted by Agbonghale and Adavbiele (2018), it was found that there was inadequate equipment/tools in workshops in Technical Colleges in Delta State. A descriptive survey conducted by Amadi and Ezeugo (2019) to examine the availability of these resources on students' academic performance revealed that both students and teachers need facilities for teaching and learning to take place effectively.

Again, environmental factors beyond the classroom walls have been increasingly recognized for their influence on students' academic performance. The increasing accessibility of the internet has transformed education by allowing students to conduct research and access a wealth of instructional resources. Ivwighreghweta and Igere (2014) discovered in a survey that improved internet accessibility had a favorable impact on students' academic performance and research production.

In order for students to arrive at educational facilities on time, efficient transportation methods are essential. Transport has a strong influence on the punctuality and regularity of students for lectures, and students may not perform well academically if most of their time is spent at the bus stop waiting for a vehicle to transport them. These set of students stand the chance of missing lectures, tests or even not being able to submit their assignments, and that would go a long way in affecting their academic performance. A study conducted by Mabosanyinje *et al.* (2016), using multiple regression analysis, revealed that transportation and socio-economic factors have an effect on students' class attendance and greatly affect students' academic performance.

A safe and favorable learning environment is crucially influenced by campus security. A survey by Ojukwu (2017) aimed at investigating the effect of insecurity in the school environment on academic performance revealed that insecurity in the school environment significantly affects the academic performance of students. Another research by Ogwuche and Pinga (2017) also showed that security influences students' academic performance in tertiary institutions.

The standard and convenience of on-campus housing have a big impact on how well students do academically and how they feel about themselves. Research by Maina and Aji (2017) aimed at determining the influence of students' housing on students' academic performance in a Nigerian university revealed that living conditions, which include cleanliness, electricity and water supply, overpopulation and territoriality affect students' academic performance most. A stable electricity supply is essential for fostering a positive learning environment and enabling students' access to educational resources. Furthermore, a study by Akaninwor (1998), which was conducted to investigate the effects of power failure on the teaching and learning process in technical training institutions in Rivers State, found that power failure negatively affects the teaching and learning process and students' academic performance.

The absence of empirical evidence specific to FUTO hinders the development of evidence-based policies and interventions to enhance students' academic outcomes (Kalagbor, 2016). Understanding the factors that impact academic performance within the university can provide valuable insights into areas that require improvement and help guide decision-making for administrators, educators, and policymakers. This research seeks to bridge this knowledge gap by conducting a statistical investigation using a comprehensive dataset collected from eight schools of FUTO. By employing the relevant statistical methodologies, the study will examine the relationships between students' academic performance and various educational and environmental factors. Through this investigation, the research aims to provide valuable insights to educational policymakers, university administrators, and educators in Nigeria. Evidence-based guidance derived from this study can facilitate the development of tailored strategies and interventions to enhance students' academic performance, fostering a culture of academic excellence and contributing to the nation's overall development. Overall, this research contributes to the existing literature on academic performance in Nigerian universities and advances the understanding of the factors that shape students' achievements. By shedding light on the key determinants of success, this study endeavors to empower Nigerian universities to nurture a generation of well-equipped, empowered, and accomplished individuals who can contribute meaningfully to the progress and prosperity of the nation.

None of the research reviewed above used a mixed model analysis approach. This research applied this methodology because each school is unique and has its own standard, and since each school has its own admission cut-off mark, it can influence students' performances in its school. So, apart from finding the variable effects, we shall also find the school effect and the intra-class correlation coefficient (ICC), which measures the between school heterogeneity and within school dependence.

The remaining sections of the study are divided into four: Section 2 – Methodology, Section 3 – Data Analysis and Discussion, Section 4 – Summary and Conclusion and Section 5 – Recommendations and Limitations.

3. Methodology

3.1 Study Design

This research employs a cross-sectional study design to investigate the effect of educational and environmental factors on students' academic performance in eight schools of FUTO. Cross-sectional studies are well-suited for examining associations between variables at a specific point in time, allowing for the assessment of multiple factors simultaneously.

3.2 Data Collection

Data for this study was obtained from a survey conducted in eight schools in FUTO. The survey collected information on students' academic performance educational, and environmental factors. Academic performance was measured using cumulative grade point averages (CGPA), while educational and environmental factors were assessed through structured questionnaires administered to the participants.

3.3 Sampling Technique

The population size of 16,800 students of 200, 300, and 500 levels from eight FUTO schools—the School of Physical Sciences (SOPS), the School of Biological Sciences (SOBS), the School of Electrical Engineering and Technology (SEET), the School of Agriculture and Agricultural Technology (SAAT), the School of Health Technology (SOHT), the School of Environmental Technology (SOET), School of Basic Medical Sciences (SBMS) and the School of Computing and Information Technology (SCIT) was used for the study. The stratified random sampling with proportion allocation technique was adopted to collect the data from the mentioned schools above. A sample size of 545 participants was calculated from the 16,800 total participants using the Yamane (1967) formula. '

3.4 Measures
A structured questionnaire with three sections was administered to the 545 participants. The demographic information of the respondents made up Section A, and questions (measured on an ordinal scale) about educational and environmental factors were contained in Sections B and C, respectively. A five-point Likert scale format (ranging from 1 – 5) was used to gauge respondents' attitudes and perceptions of the relevant variables as follows: Very Much Available (1), Available (2), Less Available (3), Not Available (4) and Neutral (5); Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4) and Strongly Agree (5) for Sections B and C respectively.

3.5 Variables
Educational inputs include Human Resources, Instructional Materials and Physical Facilities, while environmental inputs include Internet Accessibility, Transportation, Security, Student's Accommodation and Electricity.

3.6 Data Analysis Methods
The collected data were analyzed using Principal Component and Mixed Linear Model Analyses.

3.6.1 Principal Component Analysis
A strong statistical method for data visualization and dimensionality reduction is principal component analysis (PCA). It seeks to reduce the amount of variance in the initial dataset while transforming high-dimensional data into a lower-dimensional space (Jolliffe, 2011). PCA allows for the extraction of significant patterns and relationships, which can be very useful for a variety of sectors, including education, by finding the most crucial factors that account for the data's variability. For instance, Ugwuanyim (1988) used PCA to gauge entrepreneurial readiness decisions in Nigeria as well as to classify plants to species level (Ugwuanyim, 2000). Meng Yi (2018) used PCA to analyze the indicators of teachers teaching ability. Ali (2014) also used PCA in a study to monitor educational prospects in mathematics-related careers in the Upper East Region of Ghana. Again, Aboagye and Mensah (2016) used PCA to study students' academic performance in Mathematics and Statistics in Ghana.

The general formula for calculating the principal components involves matrix operations, which is given as:

$$Y = XW \tag{1}$$

Where:

Y = The transformed data in the lower-dimensional space.

X = The centered data matrix.

W = The matrix of the top k eigenvectors.

3.6.2 Mixed Linear Model (MLM)
A statistical method for analyzing data containing both fixed and random effects is known as mixed regression analysis, commonly referred to as mixed-effects models, hierarchical linear models, multilevel analysis models or random coefficient models. It is especially helpful when working with nested or hierarchical data structures, where observations are organized within higher-level units like students in schools or patients in hospitals. Incorporating both within-group variations (fixed effects) and between-group variations (random effects) into the model is possible using mixed regression analysis, giving it a potent tool for capturing the intricacies of real-world data. Charles W. Dunnett, who developed mixed-effects models in 1955, is one of the pioneers in this field. Dunnett suggested using mixed-effects models to perform multiple comparisons in trials involving several treatments. In the 1970s and 1980s, a number of significant contributions strengthened the framework for mixed-effects modeling, which was still evolving at the time. Peter McCullagh and John A. Nelder's work from 1989 marked a significant turning point. They provided a thorough analysis of mixed-effects models and their use in solving numerous statistical issues.

The impact of classroom size on students' academic performance was examined in a study by Srensen and Jespersen (2017) using mixed-effects models. Smaller class sizes were found to result in higher academic results, with classroom size having a major impact on student achievement. A novel drug's effects on patients' blood pressure were investigated using mixed-effects models in a longitudinal study by Gupta *et al.* (2018). In order to get more solid and trustworthy conclusions, the study considered variances within-patients and therapy effects. Mixed-effects models were employed in a study by Johnson *et al.* (2019) to examine how participants' cognitive performance was affected by stress. In order to more accurately examine the impact of stress on cognitive results, the study took into consideration participant differences and repeated measurements. Also, Ugwuanyim, Onwuegbuchulam, Bartholomew and Anikpe (2021) used mixed model analysis to evaluate the performance of Motor Insurance Companies in Nigeria.

MLM is an extension of the linear regression model. For instance, the ith observation with k covariates in a given linear regression model is given as:

$$Y_i = \beta o + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki} + \varepsilon_i \qquad (2)$$
$$i = 1, 2, 3, \ldots, n$$

In mixed models, we need to take care of additional notation to distinguish individuals (e.g. students) from their clusters or groups (e.g. schools). Thus, each cluster is indexed by j, and the total number of clusters will be denoted by N (Azen and Walker, 2021). Thus (2) can be rewritten as follows:

$$Y_{ij} = \beta_{oj} + \beta_{1j} X_{1ij} + \beta_{2j} X_{2ij} + \ldots + \beta_{kj} X_{kij} + \varepsilon_{ij} \qquad (3)$$
$$i = 1, 2, 3, \ldots, n_j \quad (for \;\; jth \; cluster)$$
$$j = 1, 2, 3, \ldots, N$$

Equation (3) is a general case for both the random intercept and the random slope cases. If one is only interested in the random intercept case as in this study, then all the j subscripts in the covariates will be removed, and so we have:

$$Y_{ij} = \beta_{oj} + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki} + \varepsilon_{ij} \qquad (4)$$
$$i = 1, 2, 3, \ldots, n_j \quad (for \;\; jth \; cluster)$$
$$j = 1, 2, 3, \ldots, N$$

Since β_{oj} is random, it has its own error ζ_j. Therefore, β_{oj} can be written as:

$$\beta_{oj} = \beta_o + \zeta_j \qquad (5)$$

ζ_j represents the combined effects of omitted "school" characteristics or unobserved heterogeneity at the "school" level.

Putting (4) and (5) together, we obtain:

$$Y_{ij} = \beta_o + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki} + \zeta_j + \varepsilon_{ij} \qquad (6)$$
$$i = 1, 2, 3, \ldots, n_j \quad (for \;\; jth \; cluster)$$
$$j = 1, 2, 3, \ldots, N$$

Where:

Y_{ij} = the CGPA of the ith student in the jth school (faculty);

$X_{ik} (k = 1, 2, 3, \ldots, 8)$ = educational and environmental factors of the study;

β_o = the intercept;

$\beta_1 - \beta_8$ = the slope coefficients;

ζ_j = the effect of the jth cluster (school);

ε_{ij} = the error due to the ith student in the jth school.

We note that multilevel regression modelling has many levels, but in this research, there are two levels – level 1 (students' level) and level 2 (school level).

Assumptions:
Let $\mathbf{x}_{ij}$ denote the covariates for the ith student in the jth school, and let $\mathbf{X}_j$ denote the matrix containing all the covariates for all the students in school j. Then,

i. $E(\varepsilon_{ij} \mid X_j, \zeta_j) = 0 \Rightarrow E(\varepsilon_{ij} \mid X_j) = 0$ and $\text{corr}(\varepsilon_{ij}, x_{ij}) = 0$ where

$\text{corr}(\varepsilon_{ij}, x_{ij}) = 0$ is (level-1 exogeneity assumption);

ii. $E(\zeta_j \mid X_j) = 0 \Rightarrow \text{corr}(\zeta_j, x_{ij}) = 0$ where

$\text{corr}(\zeta_j, x_{ij}) = 0$ is (level-2 exogeneity assumption);

iii. $\text{Var}(\varepsilon_{ij} \mid X_j, \zeta_j) = \theta \Rightarrow \text{Var}(\varepsilon_{ij}) = \theta$ and $\text{corr}(\varepsilon_{ij}, \zeta_j) = 0$

iv. $\text{Var}(\zeta_j \mid X_j) = \varphi \Rightarrow \text{Var}(\zeta_j) = \varphi$

v. $\text{cov}(\varepsilon_{ij}, \varepsilon_{i'j'} \mid \mathbf{X}_j, \mathbf{X}_{j'}, \zeta_j, \zeta_{j'}) = 0$ if $i \neq i'$ and $j \neq j'$;

vi. $\text{cov}(\zeta_j, \zeta_{j'} \mid X_j, X_{j'}) = 0$ for $j \neq j'$ (Sophia & Anders, 2012).

3.7 Tests of Hypothesis

3.7.1 Testing for Individual Regression Coefficient

Ho: $\beta_k = 0$

H_1: $\beta_k \neq 0$

The Wald Statistic is used for testing this null hypothesis, which is given as:

$$w = \left(\frac{\hat{\beta}_k}{S\hat{E}(\hat{\beta}_k)} \right)^2 \qquad k = 0, 1, 2\ldots 8.$$

It has an asymptotic $\chi^2(1)$ under the null hypothesis. In practice, the test statistic

$$z = \frac{\hat{\beta}_k}{S\hat{E}(\hat{\beta}_k)}$$

is usually used.

3.7.2 Testing Random-Intercept Variance

H_0: $\varphi = 0$

H_1: $\varphi > 0$

This hypothesis is equivalent to testing the hypothesis that $\zeta_j = 0$, or there is no random intercept in the model.

Likelihood ratio tests are usually used with the test statistic:

$$L = 2(l_1 - l_o)$$

Where l_1 is the maximized log likelihood for the random intercept model (which includes ζ_j), and l_o is the maximized log likelihood for an ordinary regression model (without ζ_j). A correct p-value is obtained by dividing the naïve p-value based on $\chi^2(1)$ by 2 (Sophia & Anders, 2012).

The estimation methods usually adopted in multilevel analyses are the Maximum Likelihood (ML) and the Restricted Maximum Likelihood (REML) methods. Twisk (2019) showed that the discussion about which method is better is irrelevant. However, he noted that for the REML method, the likelihood is totally based on the estimation of the variances in the random part of the model, and as such, when the likelihood ratio test is used for evaluating whether or not a particular variable should be added to the fixed part of the model, the likelihood estimated with REML method is not valid and therefore cannot be used. Again, Azen and Walker (2021) advises estimation by the REML method when the number of clusters is less than 50, and that is why this method is adopted in this research.

We shall calculate further in this work the conditional intra class correlation coefficient (ICC) given by:

$$\rho = \frac{\zeta}{\zeta + \theta}$$

This ICC is an indication of the average correlation of the observations of students in the same school. It also measures school heterogeneity.

All the methods for data analyses described in this section were implemented using SPSS and Python programming language (Version 3.11.3).

4. Data Analysis

The results of the analyses are presented in this section.

4.1 Principal Component

In this study, PCA was used to simplify complex data by highlighting its most important elements. In the questionnaire used, each question (on the variable of interest) had some sub-questions. The sub-question that had the highest factor loading on the first principal component (which has the highest variability) was used to represent the variable. The PCA was carried out using SPSS. The result is as follows:

Table 1: Educational Factors (*on a five-point Likert scale format: Very Much Available, Available, Less Available, Not Available and Neutral*).

S/No.	Variables	Selected Components	No. of Respondents
1	Human resource	Availability of qualified lecturers	545
2	Instructional materials	Availability of prints, e.g. Textbooks, manuals, study guide etc.	545
3	Physical facilities	Availability of well-equipped libraries	545

Table 2: Environmental Factors (*on a five-point Likert scale format: Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree*).

S/No.	Variables	Selected Components	No. of Respondents
1	Internet accessibility	There are facilities to access the internet in my lecture hall.	545
2	Transportation	There is waste of time on the road due to pick and drop from the shuttle.	545
3	Security	There is availability of security operation within the school	545
4	Students' accommodation	The distance covered from my place of residence to school is relatively short.	545
5	Electricity	There is enough power supply in my lecture hall.	545

4.2 Descriptive Statistics

Table 3: Descriptive Statistics

	N	Min	Max	Mean	Std. Dev
CGPA	545	1.10	4.68	3.1251	.63137
Human_resources	545	1	5	3.99	.766
Instructional_materials	545	1	5	3.81	.938
Physical_facilities	545	1	5	3.66	.970
Internet_accessibility	545	1	5	1.73	.994
Transportation	545	1	5	3.49	1.182
Security	545	1	5	3.07	1.178
Students_accommodation	545	1	5	2.98	1.140
Electricity	545	1	5	2.08	1.129
Valid N (listwise)	545				

Interpretation:
In Table 3, the CGPA of students in the sample ranges from 1.10 to 4.68, with an approximate mean of 3.13. The relatively low standard deviation indicates that the CGPA values are moderately clustered around the mean. The other variables represent the perceived levels of different educational and environmental factors in the context of the research. For example, Human resources has an average score of approximately 3.99, indicating that, on average, participants perceived the quality of human resources (faculty, staff, etc.) to be relatively high.

4.2 Mixed Linear Model Analysis

The analysis is conducted using a mixed linear model, which accounts for both fixed effects (predictor variables) and random effects (cluster/grouping structure). In this case, the clusters or groups are the different schools within the university, as mentioned in section 2.3 above

Table 4: Mixed Linear Model Results

Model:	**Mixed LM**	**Dependent Variable:**	**CGPA**
No. Observations:	**545**	**Method:**	**REML**
No. Groups:	**8**	**Scale:**	**0.3824**
Min. group size:	**17**	**Log-Likelihood:**	**-538.73**
Max. group size	**166**	**Converged:**	**Yes**
Mean group size:	**68.1**		

	Coef.	**Std. Err.**	**z**	**P>|z|**	**[0.025**	**0.975]**
Intercept	2.914	0.252	11.586	0.000	2.421	3.407
Security	-0.021	0.025	-0.844	0.399	-0.069	0.028
Students_accommodation	0.02	0.024	0.849	0.396	-0.027	0.068
Physical_facilities	-0.017	0.029	-0.572	0.568	-0.074	0.041
Transportation	0.031	0.024	1.293	0.196	-0.016	0.078
Instructional_materials	0.062	0.031	1.973	0.048	0.000	0.123
Human_resources	-0.042	0.037	-1.149	0.251	-0.115	0.030
Electricity	0.038	0.025	1.547	0.122	-0.01	0.087
Internet_accessibility	0.008	0.028	0.283	0.777	-0.047	0.062
1|School	0.007	0.027	0.274	0.784	-0.046	0.060
Group Var	0.025	0.030				

Interpretation:
Based on the analysis, the individual factors (Security, Physical facilities, Students accommodation, Transportation, Human resources, Electricity, and Internet accessibility) have no statistically significant effect on students' CGPA. However, Instructional materials is statistically significant (p = 0.048), suggesting that they may have a positive impact on academic performance.

Furthermore, the cluster (School) is not statistically significant (p = 0.784), suggesting that the differences in CGPA between schools may not be significant in this analysis. In order words, there is no school effect. The estimated group variance is 0.025, also known as error variance or, residual variance, or unexplained variation (Twisk, 2019), indicates the error associated with each student's CGPA. In general, the cluster result shows that the specific school a student belongs to doesn't have a significant impact on their academic performance (CGPA).

4.2.1 Calculation of Intra Class Correlation

As noted in section 2.7.2 above,

$$\rho = \frac{.007}{(.007 + .025)} = 0.22$$

This indicates that the average correlation of students' CGPA from the same school is 22%. It also indicates that about 22% of the total variability in CGPA is due to differences between schools (Azen & Walker, 2021).

5. Discussion of Results

The mixed regression analysis revealed that, among the examined educational and environmental factors, only "instructional materials" demonstrated a statistically significant positive effect on students' CGPA. This suggests that access to and utilization of instructional materials could contribute to improved academic performance. The descriptive statistics highlighted the mean and variability of these factors among the participants. While some factors exhibited moderate means (e.g., Instructional materials, Physical facilities), others had lower means (e.g., Internet accessibility, Electricity).

Among the various research studies discussed in the literature review, the research by Okhakhu, Oladiran and Omoike (2016) supports the results from the mixed regression analysis. The use of instructional resources to aid understanding and retention of difficult concepts was emphasized in their research.

Again, the research showed that "schools" do not significantly affect students' CGPA. This could be a result of all the students in FUTO doing many general courses together from their one hundred level to two hundred level. Given this finding, is it also worthwhile for different admission cut-off points to be implemented for different schools?

Furthermore, the finding of the ICC value of 22% shows the discrepancy in students' grades in each school, and this agrees with the assertion in the literature review above that there is a significant disparity in the academic performance of students in Nigerian institutions. With CGPA scores ranging from 1.10 to 4.68 and a mean of 3.13 (See Table 3), most of the students do not apply themselves seriously to their studies, and this underscores the need for instructional materials to aid students in understanding the materials taught in the class. Could the finding of ICC of 22% lend support to the work of Hedges and Herdberg (2007), as reported in Aczen and Walker (2021), who considered an ICC value of 15.6% a typical value in educational research? This is a poser to Education experts in the Faculties of Education in the Nigerian Universities.

6. Summary and Conclusion

6.1 Summary

This study examined the educational and environmental factors affecting students' academic performance in a Nigerian institution. It sought to understand how these variables affect students' cumulative grade point averages (CGPA). It also sought to know the contribution of the schools themselves to academic success. The examination covered a variety of areas, including human resources, instructional materials, physical facilities, internet accessibility, transportation, security, student accommodation, and electricity. The investigation gave insights into how these factors affect students' CGPAs. The availability and use of 'instructional materials' stood out as a significant positive predictor of CGPA. The rest of the variables did not show statistically significant individual impacts. The study used a mixed model analysis to account for clustering within the schools.

The study also showed that there is not only a lack of school heterogeneity in the students' CGPA, but the students' scores have a lot of disparity.

6.2 Conclusion

The importance of instructional materials in influencing students' academic performance in a Nigerian university is the key finding of this study. This emphasizes the critical role that well-designed and easily accessible instructional materials have in encouraging improved academic performance. This study emphasizes the necessity for educational institutions and policymakers to prioritize the availability of top-notch teaching resources, such as textbooks, multimedia tools, and lab supplies. These resources support effective pedagogy, aid students in developing a deeper knowledge, and improve learning outcomes. It is vital to understand that while the individual effects of other components may not have been noticed in isolation, their combined influence within the larger learning environment cannot be disregarded.

7. Recommendations and Limitations

7.1 Recommendations

Universities should make investments in the creation, availability, and efficient use of a variety of instructional materials. To improve the overall quality of education, this can involve using contemporary texts, multimedia tools, and up-to-date lab equipment. Although a variety of educational and environmental factors were evaluated in the current study, it is vital to recognize that there may be other uninvestigated variables that have a major impact on students' academic success. To increase the explanatory power of the model, researchers should keep an open mind about discovering new components and including them in the study.

The finding of non-significant school effect questions the rationale of different cut-off points for different schools during admission. The university administration may look into this.

Further studies can be embarked upon on this subject by incorporating random slope investigation into the model. There is no gainsaying the fact that though findings suggest an ordinary linear regression model, the calculation of ICC has enriched our insight into the research.

7.2 Limitations

The following were the limitations of this study:

1. This research was carried out at Federal University Technology, Owerri, Imo State, Nigeria; therefore, the findings of this study cannot be generalized beyond this university.
2. During the data collection process, respondents may have been biased and provided untrue information when completing the questionnaire.

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