Research article

Does the high school external examination grades and the type of high school attended impact the academic performance of freshmen university students?

Olumide Sunday Adesina[1,*], Lawarence O. Obokoh[1] and Olajumoke Olayemi Salami[2]

[1] Johannesburg Business School, University of Johannesburg, South Africa; adesinao@uj.ac.za, lawrence.obokoh@jbs.ac.za

[2] Department of Science Technology Education, University of Johannesburg, South Africa; olajumokes@uj.ac.za

* **Correspondence:** Email: adesinao@uj.ac.za; Tel: +27833800549, +2348034809642.

Academic Editor: Jun Shen

Abstract: There is a general conception that high school academic performance and the type of school a child attends would determine his/her academic success in the university. In this study, 135 freshmen engineering students were sampled at the Redeemer's University, Osun State, Nigeria. The study aimed to determine if the Unified Tertiary Matriculation Examination (UTME) and the type of school attended impact on academic performance of students in the first year at the university. The results showed that there is a significant relationship between UTME scores and the results of engineering freshmen; that is, students who attended private secondary schools performed somewhat better than students who went to public secondary schools. Also, statistical analyses showed that the type of secondary school attended has a significant relationship with UTME scores in favor of students who attended private secondary schools. This study recommends that the government of Nigeria should make public secondary school more appealing to students who cannot afford private secondary schools by putting measures in place to train and employ qualified teachers, and improve teaching and learning conditions. The study aligns with the Sustainable Development Goals (SDGs) 4, to ensure inclusive and equitable quality education for all and lifelong learning.

Keywords: academic performance, contingency measures, freshmen, STEM, university education

1. Introduction

In the past three decades, there has been a growing demand for privately owned education institutions in Nigeria at all levels. People believed that the privately owned institutions offered better quality education compared to the public or government-owned institution, hence the high patronage of private education outfits as compared to the public and missionary secondary schools, though the major categorization is the public/private. So, exposure, academic success, and overall life success seem to be tied to the type of school a child attends because of the facility and quality of service. Alimi et al. [1] showed that the facilities in private schools were significantly better than those of the public schools with reference to Ondo state, Nigeria. However, the results of the study showed that there was not much difference in the academic performance of the students in the two categories. The study by [2] and [3] showed that high school grades, success in the mother tongue, and mathematics have a positive relationship with a higher rate of success throughout a child's study at university, and a related study can be found in [4]. In the same vein, Lanre-Babalola et al. [5] showed that there was not much difference in the performance in English language tests of students who went to privately owned secondary schools and students who went to public schools. However, Ugochukwu and Nnorom [6] established that there is a relationship between school type and student's overall academic performance. Gamoran [7] showed that students from elite public high schools (e.g., magnet schools) are more effective than regular schools in training students in sciences and STEM subjects. The selective nature of these schools ensures that students are highly motivated and academically prepared. Research by [8] highlighted that students from high-performing chartered schools also tend to do well in university due to the schools' focus on college preparation and supportive learning environments.

Some studies have explored the combined effects of high school grades and the type of school attended on university performance. Udoudo and Akpanobong [9] found that while high school grades were the strongest predictor of university success, the type of high school also played a significant role, with students from private and specialized schools performing better overall. Another study by [10] suggested that the combination of high examination grades and attendance at a high-quality school (regardless of being public or private) had a synergistic effect, leading to higher academic achievement at the university. Nikolic et al. [11] showed that engineering courses could be taught in a dynamic way providing opportunities to implement both traditional and mixed laboratory experiences. The study by [11] consistently demonstrated that both high school external examination grades and the type of high school attended significantly impact university freshmen's academic performance. "Freshmen" refers to first-year university students. High grades serve as a strong predictor of success, while the type of high school a child attends can enhance his/her academic performance. These findings underscore the importance of a solid academic foundation and supportive educational environments in preparing students for higher education. Relative to what exists in the literature, the current study did not just consider private and public secondary schools only, but also missionary secondary schools with a focus on engineering students. So, the current study investigates the relationship between the UTME scores of first-year engineering students and their academic performance in STEM courses, such as physics, chemistry, mathematics, computing, and engineering courses, also determines how the type of secondary school a student attends impacts their academic performance.

The interest in freshmen engineering students was to substantiate if they have sufficient mental

capacity and maturity that will enable them to cope with the rigor of university education, as at that stage of education, there is little influence of parents on their daily activities. It will also help to determine how the quality of education received can make them fit for a university education. In Nigeria, some students pass the university qualifying examination through examination malpractices which makes them unfit for university education, due to a lack of mental capacity to withstand advanced courses, particularly STEM subjects. The comparative analyses will help to determine gaps in secondary school education, measured by academic performance in higher institutions. The research aims to draw the attention of education stakeholders toward equipping students adequately for university education both within and outside the country. Not all parents can afford the school fees paid for private schools, and a well-equipped private secondary school in Nigeria can be likened to a public school in developed countries, so there is a need to bridge the gap between private and public secondary schools. Udoudo and Akpanobong [9] mentioned that students in private secondary schools performed significantly better than their colleagues in public secondary schools occasioned by the challenges in the Nigerian education system, such as ineffective supervision. The authors recommended that education stakeholders should perform their respective roles effectively to bridge the wide gap between public and private secondary schools in Nigeria.

2. Related literature

An important turning point in a student's academic journey occurs during the transfer from high school to university. Numerous studies have investigated the factors that influence academic performance during this transition, with a particular focus on high school external examination grades and the type of school attended [12–15]. This literature review synthesizes research findings on how these factors impact university freshmen's academic performance.

High school external examination grades are often used as a predictor of university success. Some studies have found a favorable relationship between high examination grades and academic performance at the university [16–19]. The study in [20] discovered that scores on standardized tests and high school GPA were reliable indicators of college GPA, with high school GPA being the strongest predictor. Li et al. [21] conducted a meta-analysis that confirmed that high school grades were consistently correlated with higher academic performance in university settings. The research in [22] showed that students who performed well in high school mathematics and science courses tended to perform better in related university courses. Also, Jerrim [19] suggested that students with high grades in high school science were more likely to persist and excel in majors in STEM fields (science, technology, engineering, and mathematics) at the university.

The type of high school, including public, private, and specialized schools, also has a significant impact on how students perform academically in college. Research by [23] indicated that students from private schools often performed better academically in a university compared to their public-school counterparts. This was attributed to the higher academic standards and more rigorous curriculum in private schools. The investigation by [24] showed that the apparent advantage of private school learners diminishes when controlling for family background and prior achievement.

Further investigation is still required to determine the accuracy and centrality's predictive significance of academic achievement. The degree to which individuals can accurately self-report their academic standing, specifically their GPA and GRE scores, has been the subject of most of the research examining the relationship between accuracy and performance [25]. Studies that evaluated students' inclination or capacity to falsify their grades can be found in [25] and [26].

A growing amount of research concentrating on characteristics like the Big Five (extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience) and intelligence has been done in the connection between personality traits and academic success. Ding et al. [27] found that in a meta-analysis of other-rated personalities, personality variables (in particular, conscientiousness, emotional stability, and openness to new experiences) are significantly correlated to academic performance. Furthermore, conscientiousness and GPA correlations were higher than those with intelligence. Conscientiousness and academic achievement have been positively connected in recent research [28–33]. However, conscientiousness and neuroticism, agreeableness, extraversion, and openness to new experiences have occasionally been found to correlate significantly with academic success and positive energy [34]. According to another study, people who exhibit conscientiousness or self-monitoring personality traits are highly valued academically and eventually perform better in the workplace [35]. For instance, conscientiousness and fluid intelligence have been found by [36] to be predictive of academic performance. The general capacity to think abstractly, recognize patterns, work through issues, and assess interpersonal dynamics and personality is known as fluid intelligence. According to studies such as [9,37–41], the ability to perform well in school and in an organization is predicted by intelligence. Literature has shown various factors that could impact on academic performance of freshmen and students. The next section contains the methodology adopted by this new study.

3. Materials and methods

This session outlines the materials and methods employed in assessing the performance of freshmen engineering students based on the UTME scores and the type of secondary school they attended.

3.1. Data description

An online survey was conducted with a sample of freshmen engineering students to determine the type of secondary school they attended and their respective UTME scores along with their student number, to help match the student number with the scores. The study involves the students who gained admission in the 2022/2023 academic session and were in their second year in the Faculty of Engineering. Afterwards, the results of the respondents were collected from the University's ICT Center. A purposeful sampling was adopted, and the target participants were freshmen engineering students with a population (N) of 210, using a 5% margin of error (e), and 50% as the population proportion (p). The required sample size was 137 which is close to the 135 obtained. The formula is as follows.

$$sample\ size\ (n) = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p(1-p)}{e^2 N}\right)} \tag{1}$$

$$n = \frac{\frac{1.96^2 \times 0.5(1-0.5)}{0.05}}{1 + \left(\frac{1.96^2 \times 0.5(1-0.5)}{0.05^2 \times 210}\right)} = 137$$

The type of secondary school the students attended was coded as (private = 1, missionary = 2, public = 3). Consequently, 113 (83.7%) of the respondents went to private secondary schools, 10 (7.4%) went to missionary secondary schools, and 12 (8.9 %) went to public secondary schools.

The scores in five chemistry courses comprising CHM 101, CHM 102, CHM 104, CHM 191, and CHM 192 were averaged to obtain the variable "CHM". Two computer engineering courses, CPE 101 and CPE 102, were averaged to obtain the variable "CPE". Seven general study courses, GST 101, GST 102, GST 103, GST 105, GST 109, GST 110, and GST 122, were averaged to get the variable "GST". Three mathematics courses, MTH 111, MTH 112, and MTH 122, were averaged to obtain the variable "MTH". Four physics courses, PHY 101, PHY 102, PHY 103, and PHY 104, were averaged to obtain "PHY". Only one statistics course was offered, namely STA 104, and only one mechanical engineering course was offered, MEE 101. The Nigeria University grading system is as follows: Grade A = 70 and above, Grade B = 60–69, Grade C = 50–59, Grade D = 45–49, Grade E = 40–44, and Grade F = 39 and below. For the categorical analysis, the UTME scores are classified as follows: Fair (below 200), good (200–249), very good (250–299), and excellent (300 and above).

3.2. Data analysis and inference

In this study, we used regression analysis to determine the relationship between the external examination score and the results. Also, symmetric measures based on the contingency coefficients were used to determine the association between the type of secondary school and the grade obtained by the students in the two categories. The statistic is called Pearson's Coefficient and is defined as follows:

$$C = \sqrt{\frac{\chi^2}{N + \chi^2}} \qquad (2)$$

where χ^2 is the chi-square value, N is the total number of observations, and C is the contingency coefficient.

The coefficient C helps to determine if a variable, say "a", is contingent on another variable, "b". If C is zero or close to zero, we say that there is no association between the two variables, and otherwise, there is a relationship. The data analyses were conducted using the Statistical Package for Social Science (SPSS 24) by International Business Machines Corporation (IBM) and software by [42]. Package [43] was used to compute the multinomial logistic regression in the software by [42]. The descriptive statistics are presented in Table 1.

Table 1. Descriptive statistics of freshmen scores.

	UTME	CHM	CPE	GST	MEE	MTH	PHY	STA
Mean	235	50	61	68	71	62	68	58
Minimum	174	22	23	42	0	35	25	40
Maximum	323	73	90	86	97	86	85	85
Count	135	135	135	135	134	135	135	135

Table 1 shows the mean, minimum, and maximum scores of the UTME, as well as the average of all of the courses offered in the first and second semesters. That is, the average of all chemistry courses, the average of all CPE courses, the average of all GSTs, the average of all MTHs, and the average of all PHYs, MEEs, CHMs, and STAs.

4. Results

The results obtained are discussed in this section. Table 2 is the correlation matrix of the UTME and first-year grades of first-year engineering students.

Table 2. Correlation matrix of UTME score and grade of first-year engineering students.

	UTME	CHM	CPE	GST	MEE	MTH	PHY	STA
UTME	1							
CHM	0.491775	1						
CPE	0.403238	0.79299	1					
GST	0.498577	0.744484	0.77205	1				
MEE	0.268361	0.659936	0.643744	0.549405	1			
MTH	0.497939	0.822781	0.725456	0.691546	0.8358	1		
PHY	0.402883	0.746794	0.64254	0.690355	0.625292	0.728172	1	
STA	0.347082	0.734834	0.649081	0.547143	0.476202	0.628385	0.549391	1

Source: Authors

Table 2 shows that all of the variables have a low positive correlation with UTME scores. CHM (0.491775) and GST (0.498577) scores have a fair correlation with the UTME scores. MTH has a high correlation with CHM (0.822781), CPE (0.725456), MEE (0.8358), PHY (0.728172), and STA (0.628385), showing that scores in mathematics impact the scores in other science courses. Table 3 is the multiple regression analysis to determine the relationship between UTME scores and some courses offered in the first year at the university.

Table 3. UTME performance of freshmen engineering students.

	Fair	Good	Very Good	Excellent	
Private	16 (14.16%)	59 (52.2%)	34 (30.01%)	4 (3.53%)	113 (100%)
Missionary	1 (10%)	2 (20%)	6 (60%)	1 (10%)	10 (100%)
Public	1 (8.33%)	9 (75%)	2 (16.67%)	0 (0.00%)	12 (100%)
	18	70	42	5	135

Source: Authors Computation

The chi-square value of the contingency table is 8.614, and the contingency coefficient is 0.245.

Table 3 shows that a total of 113 students went to private school, 10 went to missionary school, and 12 went to public school. The broad categorization is public/private, simply put, a student either went to public missionary or private missionary school. Any student that falls into either of the missionary options is categorized as missionary, for the sake of simplicity. Table 3 shows that 4 (3.53%) of the freshmen engineering students who went to private secondary school made excellent grades in the UTME examination, 34 (30.01%) very good, 59 (52.2%) good, and 16 (14.16%) scored below 200 of 400. Also, 1 (10%) of the freshmen engineering students who went to missionary secondary school made excellent grades in the UTME examination, 6 (60%) very good, 2 (20%) good, and 1 (10%) scored below 200 of 400. For public schools, 0 (0.00%) got excellent grades in the UTME examination, 2 (16.67%) very good, 9 (75%) good, and 1 (8.33%) scored below 200 out

of 400. The contingency coefficient is low at 0.245 showing that there is not much difference in the performance. Figure 1 gives a pictorial analysis without worrying much about the figures.
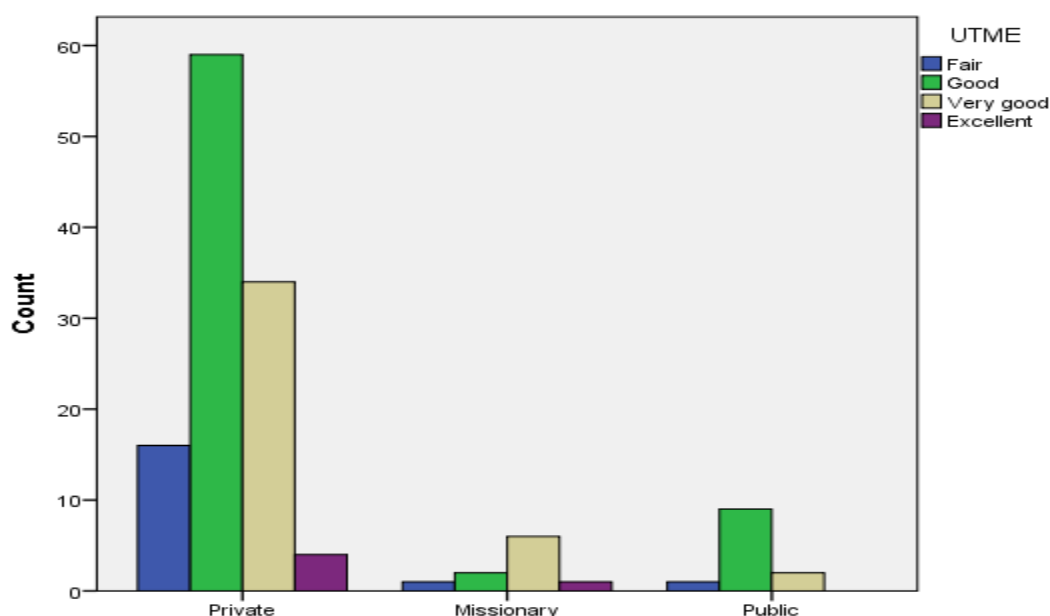

Figure 1. Bar chart showing the performance of students in each category.

Figure 1 shows that most students who went to private secondary schools performed well, majority of the students scored marks greater than 200 but less than 300 of maximum score of 400. Students who went to missionary secondary schools performed excellently, while students who went to public schools performed averagely. Table 4 shows the cross-tabulation of grades based on classification.

From Table 4, a higher percentage of engineering students who attended private secondary school had grades "A" and "B" as compared to the students who went to missionary and public secondary schools. Invariably, a higher percentage of engineering students that attended public and missionary secondary schools had grades "E", "D", and "F". The scores in CPE somewhat mimic that of chemistry except for a little difference. The scores of students who went to public and missionary schools in CPE competed reasonably with the students who went to private secondary schools. In MEE, a higher percentage of engineering students that attended private secondary school had grades "A", "B", and "C" put together as compared to the students that went to missionary and public secondary schools. Invariably, a higher percentage of engineering students who attended public and missionary secondary schools had grades "D", "E", and "F".

In MTH, contrary to CHM, CPE, and MEE, students who went to missionary secondary school outperformed students who went to private and public secondary schools, recording higher grades "A", "B", and "C" put together as compared to the students that went to private and public secondary schools. The PHY grades were a replica of MTH, showing that students who went to missionary secondary school outperformed students that went to private and public secondary schools, recording higher grades "A", "B", and "C" put together as compared to the students who went to private and public secondary schools. The same was recorded in the STA course. The symmetric measures help

to determine the existence and strength of the relationship, if it exists, between two categorical variables.

Table 4. Cross-tabulation of freshmen engineering students' grades based on the classification of secondary school attended.

Grade	A	B	C	D	E	F	Total
				TYPE/CHM			
Private	11 (9.73%	19 (16.81%)	23 (20.35%)	40 (35.40%)	15 (13.27%)	5 (4.42%)	113 (100%)
Missionary	0 (0.00%)	2 (20.00%)	2 (20.00%)	5 (0.50%)	0 (0.00%)	1 (10.00%)	10 (100%)
Public	4 (33.3 %)	1 (8.33%)	2 (16.66)	5 (41.67%)	0 (0.00%)	0 (0.00%)	12 (100%)
				TYPE/CPE			
Private	2 (1.77%)	16 (14.16%)	10 (8.8%)	25 (22.12%)	26 (23.00%)	34 (30.08%)	113 (100%)
Missionary	0 (0.00%)	0 (100.0%)	2 (20.00%))	3 (30.00%)	3 (30.00%)	2 (20.00%)	10 (100%)
Public	0 (0.00%)	2 (16.67%)	1 (8.33%)	5 (41.67%)	3 (25.00%)	1 (8.33%)	12 (100%)
				TYPE/MEE			
Private	7 (6.19%)	5 (4.42%)	4 (3.53%)	7 (6/19%)	13 (11.50%)	77 (68.00%)	113 (100%)
Missionary	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	3 (30.00%)	7 (70.00%)	10 (100%)
Public	2 (16.67%)	0 (0.00%)	2 (16.67%)	0 (0.00%)	2 (16.67%)	6 (0.50%)	12 (100%)
				TYPE/MTH			
Private	3 (2.65%)	3 (2.65%)	9 (7.96%)	30 (26.55%)	44 (38.94%)	24 (21.23%)	113 (100%)
Missionary	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (10.00%)	6 (60.00%)	3 (30.00%)	10 (100%)
Public	0 (0.00%)	2 (16.67%)	1 (8.33%)	5 (41.67%)	4 (33.33%)	0 (0.00%)	12 (100%)
				TYPE/PHY			
Private	4 (3.53%)	0 (0.00%)	1 (0.09)	4 (3.54%)	55 (44.24%)	49 (43.33%)	113 (100%)
Missionary	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (10.00%)	4 (40.00%)	5 (50.00%)	10 (100%)
Public	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (16.67%)	6 (50.00%)	4 (33.33%)	12 (100%)
				TYPE/STA			
Private	0 (0.00%)	10 (8.85%)	16 (14.2%)	41 (36.28%)	25 (22.12%)	21 (18.58%)	113 (100%)
Missionary	0 (0.00%)	1 (10.00%)	1 (10.00%)	2 (20.00%)	3 (30.00%)	3 (30.00%)	10 (100%)
Public	0 (0.00%)	2 (16.67%)	1 (8.33%)	6 (0.50%)	2 (16.67%)	1 (8.33%)	12 (100%)

Source: Authors' Computation

In Table 5, multivariate analysis of variance (MANOVA) is presented, where the UTME score is the predictor while MTH, CPE, MEE, CHM, PHY, and STA are the dependent variables. The null hypothesis is where all of the group means are equal, while the alternative hypothesis is where at least one group mean differs from another group.

Table 5. MANOVA.

	Df	Pillai	approx F	num Df	den Df	Pr(>F)
Ind. Variables	1	0.3362	10.721	6	127	< 1.269e-09 ***
Residuals	132					

The P-value < 1.26e-09 ***, is practically zero. Therefore, it is evident that there are sufficient reasons to reject the null hypothesis in favor of the alternative where at least one group's mean vector differs from the rest. The Pillai's Trace test statistic, which shows how the independent variable impacts the response variables, plays a similar role as the partial eta squared method. Proceeding to partial eta squared, if the value of partial eta squared is 0.14 or greater, we can say that the effect size is large. Table 6 shows the partial eta-squared's results.

Table 6. Partial eta squared.

Parameter	Eta2 (partial)	95% CI
independent_var	0.34	(0.21, 1.00)

One-sided CIs: upper bound fixed at [1.00].

Since the value of partial eta squared $= 0.34 > 0.14$, the effect of the independent variable on the dependent variables is high. This means that the UTME score has a high impact on the score in MTH, CHM, MEE, PHY, STA, and CPE. Table 7 shows the symmetric measures.

Table 7. Symmetric measures**.**

	Contingency Coefficient
TYPE/CHM	0.286
TYPE/CPE	0.225
TYPE/MEE	0.292
TYPE/MTH	0.304
TYPE/PHY	0.199
TYPE/STA	0.174

Source: Authors

Table 7 shows that classification of the type of secondary school attended has the strongest association with the MTH (0.304) grade, followed by MEE (0.292), CHM (0.286), CPE (0.225), PHY, and STA with low associations with the type of secondary school attended. Figures 2–7 show the grades obtained based on the type of secondary school attended. The figures help to see and better discuss the relationship between the type of secondary school attended and the grade obtained. Table 8 shows the multinomial logistic regression of the relationship between the type of secondary school attended and academic performance.

Table 8. Coefficients of multinomial logistics.

	Int.	UTME	CHM	CPE	GST	MEE	MTH	PHY	STA
Missionary (2)	-7.5488	0.00268	0.0419	-0.1203	0.0796	-0.0097	0.2167	-0.1126	-0.316
Public (3)	-0.1126	-0.0123	-0.0451	0.0677	-0.0831	0.00603	-0.1408	0.1619	0.0152

Residual Deviance: 91.59689

AIC: 127.5969

$$In\left(\frac{p(\text{Public} = 3)}{p(\text{Private} = 1)}\right)$$

$$= -0.1126 - 0.0123 * UTME - 0.0451 * CHM - 0.0677 * CPE - 0.0831 * GST$$
$$+ 0.00603 * MEE - 0.1408 * MTH + 0.1619 * PHY + 0.0152$$
$$* STA \qquad (3)$$

The UTME score (-0.0123) has a negative impact on the log odds of probability of a student who went to a missionary school and private school. The UTME score of students who went to missionary schools relative to private decreases by 0.0123.
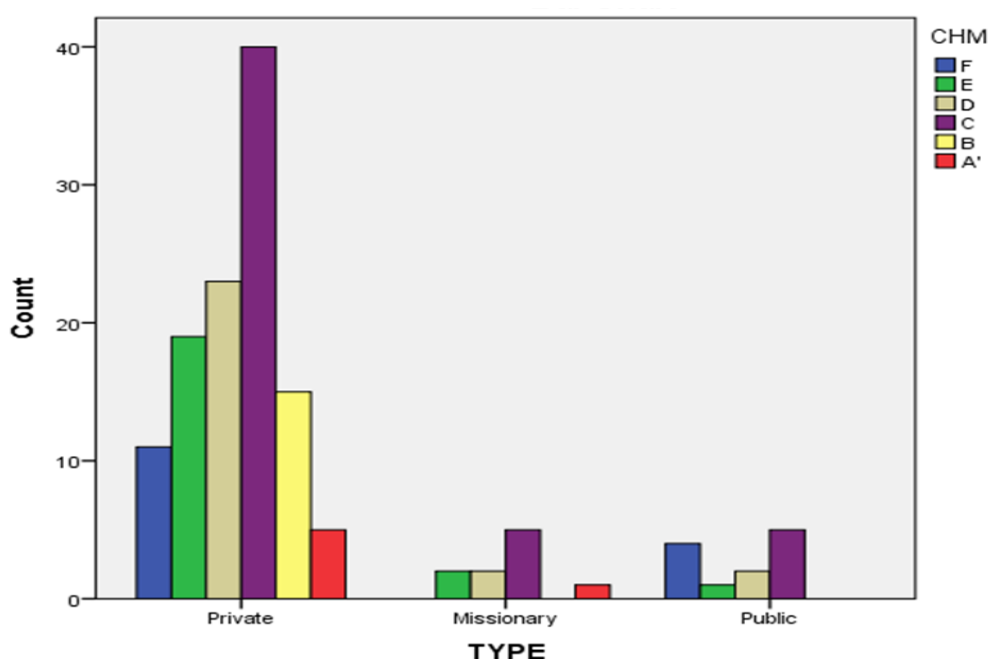
$$In\left(\frac{p(\text{Missionary} = 2)}{p(\text{Private} = 1)}\right)$$

$$= -7.5488 + 0.0027 * UTME + 0.0419 * CHM - 0.1203 * CPE + 0.0796 * GST$$
$$- 0.0097 * MEE + 0.2167 * MTH - 0.1126 * PHY - 0.316$$
$$* STA \qquad (4)$$

Odds are the ratio of the probability of an event happening to the probability of an event not happening. The UTME score (0.0332) has a positive impact on the log odds of the probability of a student who went to a missionary school and private school. The UTME score of students who went to missionary school relative to private increases by 0.0332.

Figure 2. Bar chart of the type of secondary school and chemistry grade of freshmen engineering students.

Figure 2 shows that most of the students have a credit pass in chemistry followed by grades "D" and "E". The same trend can be seen in students who went to missionary schools, but a high percentage of students had below 40% among the students who went to public schools.
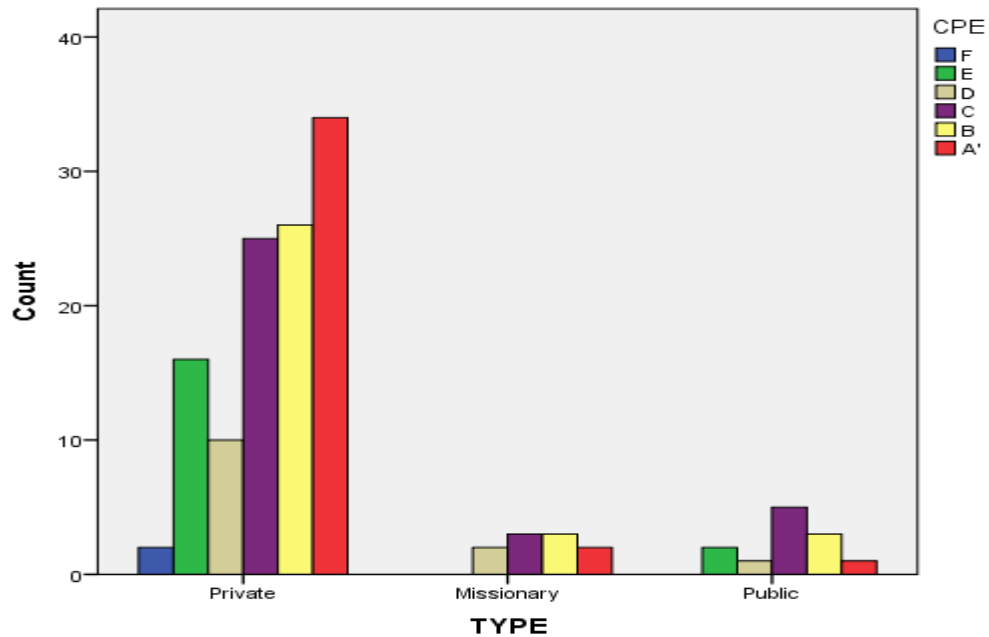
Figure 3. Bar chart of the type of secondary school and CPE grade of freshmen engineering students.

Figure 3 shows that students who went to private schools performed very well in CPE as discussed earlier. While students who went to public and missionary schools performed averagely.
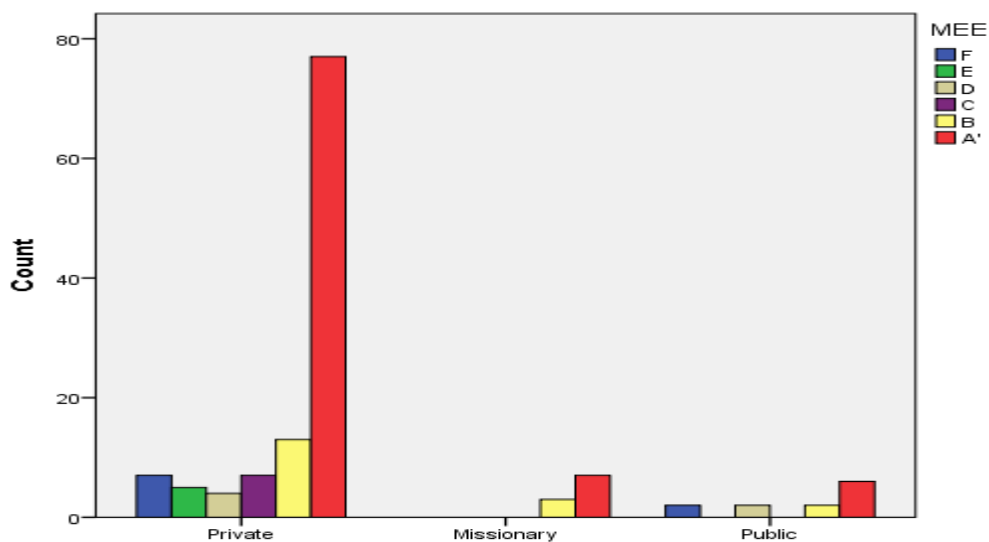

Figure 4. Bar chart of the type of secondary school and MEE grade of freshmen engineering students.

Figure 4 shows that most students who went to private schools performed very well in MEE, while students who went to public and missionary schools performed somewhat averagely.

Figure 5. Bar chart of the type of secondary school and MTH grade of freshmen engineering students.

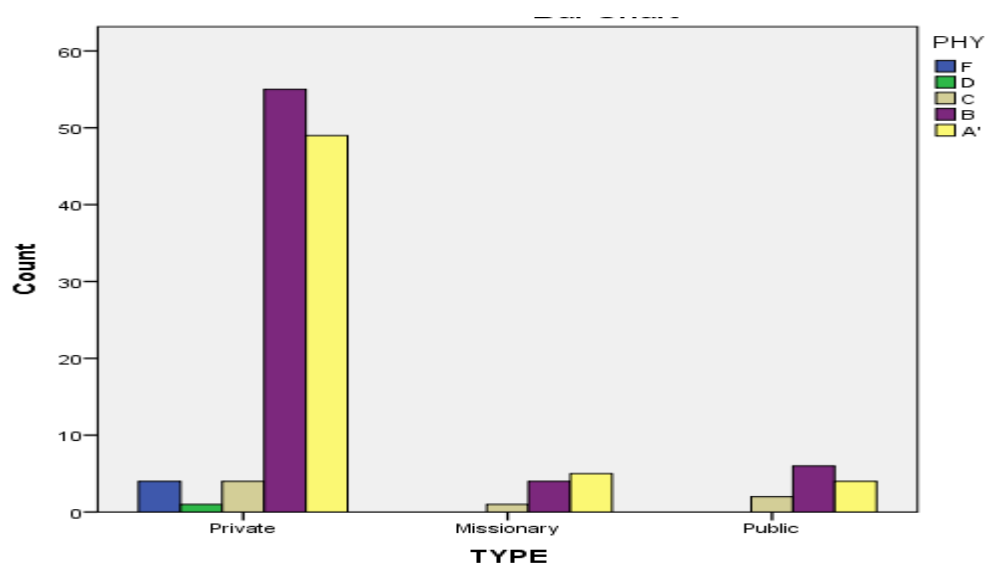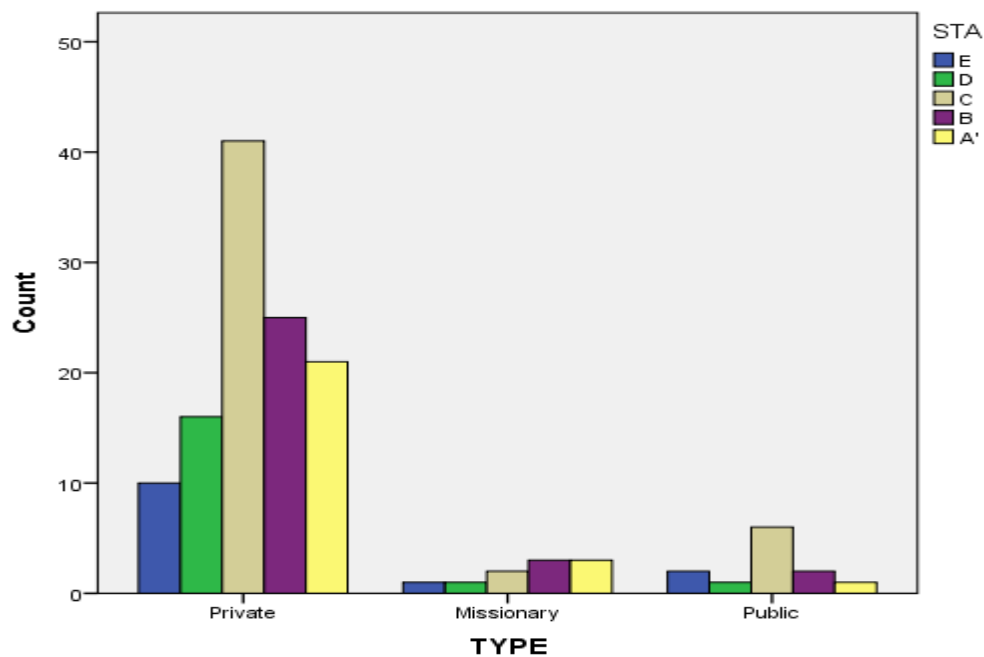Figure 5 shows the bar chart that pictorially explains the values in Table 4.

Figure 6. Bar chart of the type of secondary school and PHY grade of freshmen engineering students.

Figure 6 shows that most of the students had grades "A" and "B" in physics and the minority had grades "C" and below. The same trend can be seen in students who went to missionary schools.

Figure 7. Bar chart of the type of secondary school and STA grade of freshmen engineering students.

Figure 7 shows that most of the students who went to public schools had a credit pass in statistics, the same as students who went to missionary schools.

5. Discussion and conclusions

The study delved into major factors that impact the academic performance of first-year students, and sampled the engineering students at Redeemer's University in Nigeria. The students had various academic backgrounds and learning models, hence the need to investigate what could impact academic performance in their first year at the university. This study examined the possible relationship between the students' UTME score, which serves as the unified examination that qualifies the student for admission into the university, and academic performance in their first year at the university. The study showed a significant relationship between UTME score and the academic performance of freshmen engineering students based on the multinomial logistic regression analysis. The study also showed that most of the students who attended private secondary schools performed somewhat better in their first year at the university than those students who attended public secondary school or missionary school, which is consistent with [6] and [9].

Statistics from this study also revealed that students who went to private secondary schools significantly outnumbered students who went to public or missionary secondary schools in enrollment in private universities. The study suggests that future studies should investigate (preferably a qualitative study or a mix of qualitative and quantitative) why most of the students who attended a private secondary school chose to attend a private university rather than a government-owned university (a) from the student's perspective, and (b) from the parent's perspective. The outcome of the research would help in policymaking and improve the quality of

education in Nigeria. Government and education stakeholders should make education at the grassroots a priority because some students struggle to cope with academic demands at the university owing to a poor foundation from their secondary school. Government and stakeholder involvement would help achieve the sustainable development goal (SDG) 4, which is to ensure inclusive and equitable quality education for all and lifelong learning. This study recommends that government at all levels should make public institutions more appealing to students who cannot afford private institutions by putting measures in place in the areas of qualified and committed manpower, and improved teaching and learning facilities. The outcome of this study applies to nations that share the same characteristics as Nigeria. Governments should give priority to education because the future relies so much on education, and most importantly, STEM education. Future studies can extend beyond engineering students and include STEM programs such as health sciences, physical sciences, and computing.

Author contributions

Olumide Sunday Adesina: Conceptualized, data curation, formal analysis, investigation, methodology, project administration, software, original draft, validation, visualization, original draft, review & editing; Lawarence O. Obokoh: Conceptualization, resources, supervision, validation, original draft, review & editing; Olajumoke Olayemi Salami: Original draft, review & editing. All authors have approved the final version of the manuscript for publication.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Acknowledgement

Conflict of interest

No potential conflict of interest was reported by the authors.

Ethics declaration

The authors declare that due permission was obtained from the participants who participated in this study, and the procedure guiding human participation in research was followed. Participants were assured of confidentiality and anonymity, and they voluntarily consented to participate in the research. The secondary students' grades were formally obtained from the University.

References

1. Alimi, O.S., Ehinola, G.B. and Alabi, F.O., School Types, Facilities and Academic Performance of Students in Senior Secondary Schools in Ondo State, Nigeria. *International Education Studies,* 2012, 5(3): 44–48.

2. Richardson, M., Abraham, C. and Bond, R., Psychological correlates of university students' academic performance: A systematic review and meta-analysis. *Psychological Bulletin*, 2012, 138(2): 353–387. http://dx.doi.org/10.1037/a0026838

3. Van der Zanden, P.J., Denessen, E., Cillessen, A.H. and Meijer, P.C., Domains and predictors of first-year student success: A systematic review. *Educational Research Review*, 2018, 23: 57–77.

4. Nguyen, D.K., Duong, V.B., Nguyen, C.C., Nguyen, T. and Tran, H.H., Factors affecting grade 6 students' learning following the B-Learning model. *Multidisciplinary Reviews*, 2024, 7(8): 2024180. https://doi.org/10.31893/multirev.2024180

5. Lanre-Babalola, F.O., Oresanwo, A.M., Onyeka, N.C., Adelu, A.O. and Aderemi, T.A., Nexus between School Type and Academic Performance of Students in English Language in Nigeria: A Case Study of Some Selected Secondary Schools in Ibadan. *Acta Universitatis Danubius. Relationes Internationales*, 2023, 16(1): 26–39.

6. Ugochukwu, A.V. and Nnorom, S.U., Relationship Between School Type And Students' Academic Performance In Secondary Schools In Education District Vi, Lagos State. *Turkish Online Journal of Qualitative Inquiry (TOJQI)*, 2021, 12(6): 9288–9294.

7. Gamoran, A., Student Achievement in Public Magnet, Public Comprehensive, and Private City High Schools. Educational Evaluation and Policy Analysis, 1996, 18(1): 1–18. https://doi.org/10.2307/1164227

8. Tiippana, N., Korhonen, T. and Hakkarainen, K., Teachers' External Networking: Expanding Pedagogical Practices in Finland. *Teacher Educator*, 2024, 1–22. https://doi.org/10.1080/08878730.2024.2341379

9. Udoudo, N.J. and Akpanobong, U.E., *Bridging The Gap in Teaching and Learning Between Public and Private Secondary Schools In Nigeria: The Responsibility of All Stakeholders*. The State of Secondary education in Nigeria, West and Solomon Corporate Ideals Ltd, 2020.

10. Thiele, T., Singleton, A., Pope, D. and Stanistreet, D., Predicting students' academic performance based on school and socio-demographic characteristics. *Studies in Higher Education*, 2016, 41(8): 1424–1446. https://doi.org/10.1080/03075079.2014.974528

11. Nikolic, S., Grundy, S., Haque, R., Lal, S., Hassan, G.M., Daniel, S., et al., A ranking comparison of the traditional, online and mixed laboratory mode learning objectives in engineering: Uncovering different priorities. STEM Education, 2023, 3(4): 331–349. https://doi.org/10.3934/steme.2023020

12. Ayebale, L., Habaasa, G. and Tweheyo, S., Factors affecting students' achievement in mathematics in secondary schools in developing countries: A rapid systematic. *Statistical Journal of the IAOS*, 2020, 36(S1): S73–S76. https://doi.org/10.3233/sji-200713

13. Cummings, K.M., Deane, K.C., McCall, B.P. and DesJardins, S.L., Exploring Race and Income Heterogeneity in the Effects of State Merit Aid Loss Among Four-Year College Entrants. *Journal of Higher Education*, 2022, 93(6): 873–900. https://doi.org/10.1080/00221546.2022.2042155

14. Ogegbo, A.A. and Ramnarain, U., Teachers' Perceptions of and Concerns About Integrating Computational Thinking into Science Teaching After a Professional Development Activity.

African Journal of Research in Mathematics, Science and Technology Education, 2022, 26(3): 181–191. https://doi.org/10.1080/18117295.2022.2133739

15. Wilson, N.C., Examining the Impact of Systemic Tensions on Agency and Identity: The Multiple Positions of Reggie in Production-Centered, Technology-Mediated Activity. *Cognition and Instruction*, 2021, 39(2): 181–209. https://doi.org/10.1080/07370008.2020.1820506

16. Fronzetti Colladon, A. and Grippa, F., The Importance of Being Honest: Correlating Self-Report Accuracy and Network Centrality with Academic Performance. *Journal of Psychology: Interdisciplinary and Applied*, 2018, 152(5): 304–324. https://doi.org/10.1080/00223980.2018.1459443

17. Horton, A.B., Pring, A.M., Rudaizky, D. and Clarke, P.J.F., The relationship between worry and academic performance: examining the moderating role of attention control. *Anxiety, Stress and Coping*, 2024, 1–16. https://doi.org/10.1080/10615806.2024.2308673

18. Liu, Y., Jungić, V., Burazin, A., Vimbelo, S., Bayaga, A., Goundar, S., et al., Impact of Video Lectures on Students' Performance and Analysis of Viewer Demographics in Online Courses. *International Journal of Mathematical Education in Science and Technology*, 2022, 53(1): 2217–2242. https://doi.org/10.1080/01605682.2023.2253852

19. Jerrim, J., The power of positive emotions? The link between young people's positive and negative affect and performance in high-stakes examinations. *Assessment in Education: Principles, Policy and Practice*, 2022, 29(3): 310–331. https://doi.org/10.1080/0969594X.2022.2054941

20. Alajimi, M., (2022). The Effect of an Online Teaching Approach on Students' Acquisition of Social Studies Skills at the Intermediate Stage in Kuwait. Pedagogy and Curriculum Skills at the Intermediate Stage in Kuwait. *The International Journal of Pedagogy and Curriculum*, 2022, 29(1): 101–113. https://doi.org/10.18848/2327-7963/CGP/v29i01/101-118

21. Li, X., Zhou, Y. and Wijaya, T.T., The effect of hawgent dynamic mathematics software on mathematics achievement: A meta-analysis. *Al-Jabar : Jurnal Pendidikan Matematika*, 2022, 13(1): 175–188. https://doi.org/10.24042/ajpm.v13i1.11711

22. Hakimi, S., Hejazi, E. and Lavasani, M.G., The relationships between personality traits and students' academic achievement. *Procedia - Social and Behavioral Sciences*, 2011, 29: 836–845. https://doi.org/10.1016/j.sbspro.2011.11.312

23. Wyness, G., Macmillan, L., Anders, J. and Dilnot, C., Grade expectations: how well can past performance predict future grades? *Education Economics*, 2023, 31(4): 397–418. https://doi.org/10.1080/09645292.2022.2113861

24. Pei, Z., Pischke, J.S. and Schwandt, H., Poorly Measured Confounders are More Useful on the Left than on the Right. *Journal of Business and Economic Statistics*, 2019, 37(2): 205–216. https://doi.org/10.1080/07350015.2018.1462710

25. Njonge, T., Influence of Psychological Well-Being and School Factors on Delinquency, during the Covid-19 Period Among Secondary School Students in Selected Schools in Nakuru County : Kenya. *International Journal of Research and Innovation in Social Science*, 2023, 7(2), 1175–1189. https://doi.org/10.47772/IJRISS

26. Studer-Luethi, B., Boesch, V., Lusti, S. and Meier, B., Fostering cognitive performance in older adults with a process- and a strategy-based cognitive training. *Aging, Neuropsychology, and Cognition*, 2023, 30(5): 837–859. https://doi.org/10.1080/13825585.2022.2105298

27. Ding, A.C.E., Glazewski, K., Pawan, F., Mitten, C., Collier, Z.K., Leite, W.L., et al., Developing and integrating digital resources in online mathematics instruction and assessment during

Covid-19. *International Journal of Mathematical Education in Science and Technology*, 2024, 31(1): 1–13. https://doi.org/10.1080/02671522.2021.1961291

28. Ali, M.R., Uppal, M.A., Jose Renato, P.J., Qasim, H., Shafi, A. and Arif, W., Educators' relationships and its impacts on students' educational outcomes in higher educational institutions of Pakistan. *Cogent Education*, 2023, 10(2): 2282802. https://doi.org/10.1080/2331186X.2023.2282802

29. Al-Abdullatif, A.M. and Alsaeed, M.S., Evaluating visible learning: Mathematics teachers' practices in technology-enhanced classrooms. *Cogent Education*, 2019, 6(1): 1686798. https://doi.org/10.1080/2331186X.2019.1686798

30. Christopoulos, A. and Sprangers, P., Integration of educational technology during the Covid-19 pandemic: An analysis of teacher and student receptions. *Cogent Education*, 2021, 8(1): 1964690. https://doi.org/10.1080/2331186X.2021.1964690

31. Kanevski, M., Booth, J.N., Oldridge, J., McDougal, E., Stewart, T.M., McGeown, S., et al., The relationship between cognition and mathematics in children with attention-deficit/hyperactivity disorder: a systematic review. *Child Neuropsychology*, 2022, 28(3): 394–426. https://doi.org/10.1080/09297049.2021.1985444

32. Yorganci, S., A study on the views of graduate students on the use of GeoGebra in mathematics teaching. *European Journal of Education Studies*, 2018, 4(8): 63–78. https://doi.org/10.5281/zenodo.1272935

33. Wong, J.T., Bui, N.N., Fields, D.T. and Hughes, B.S., A Learning Experience Design Approach to Online Professional Development for Teaching Science through the Arts: Evaluation of Teacher Content Knowledge, Self-Efficacy and STEAM Perceptions. *Journal of Science Teacher Education*, 2023, 34(6): 593–623. https://doi.org/10.1080/1046560X.2022.2112552

34. Dogan, O.K., Han-Tosunoglu, C., Arslan, N., Cakir, M. and Irez, S., Middle School Graduates' Understandings of Scientific Inquiry and Its Relation to Academic Achievement. *International Journal of Science and Mathematics Education*, 2024, 22(1): 143–166. https://doi.org/10.1007/s10763-023-10365-y

35. Lin, Y.C., Using a drawing method to investigate pre-service teachers' beliefs, knowledge and emotions about mathematics teaching and learning. *Asia-Pacific Journal of Teacher Education*, 2022, 50(5): 474–497. https://doi.org/10.1080/1359866X.2021.1880546

36. Chamorro-Premuzic, T. and Furnham, A., Personality, intelligence and approaches to learning as predictors of academic performance. *Personality and Individual Differences*, 2008, 44(7): 1596–1603.

37. Galimullina, E., Ljubimova, E. and Ibatullin, R., SMART education technologies in mathematics teacher education - ways to integrate and progress that follows integration. *Open Learning*, 2020, 35(1): 4–23. https://doi.org/10.1080/02680513.2019.1674137

38. Haleva, L., Hershkovitz, A. and Tabach, M., Students' Activity in an Online Learning Environment for Mathematics: The Role of Thinking Levels. *Journal of Educational Computing Research*, 2021, 59(4): 686–712. https://doi.org/10.1177/0735633120972057

39. Lin, Y.N., Hsia, L.H., Sung, M.Y. and Hwang, G.H., Effects of integrating mobile technology-assisted peer assessment into flipped learning on students' dance skills and self-efficacy. *Interactive Learning Environments*, 2019, 27(8): 995–1010. https://doi.org/10.1080/10494820.2018.1461115

40. Rodríguez Andrés, A., Otero, A. and Amavilah, V.H., Knowledge economy classification in African countries: A model-based clustering approach. *Information Technology for Development*, 2022, 28(2): 372–396. https://doi.org/10.1080/02681102.2021.1950597

41. Rencewigg, R. and Joseph, N.P., Enhancing presentation skills: a comparative study of students' performance in virtual and physical classrooms. *Multidisciplinary Reviews*, 2024, 7(7): 2024156. https://doi.org/10.31893/multirev.2024156

42. R Core Team, *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria, 2023. Available from: https://www.R-project.org/.

43. Venables, W.N. and Ripley, B.D., Modern Applied Statistics with S-PLUS. Springer, New York, 2013.

Author's biography

Dr. Olumide Sunday Adesina holds a B.Sc (Hons.) in Data Science and Business Analytics (London), a B.Sc. (Hons) in Mathematics from the University of Ilorin, MBA (Ogbomoso), M.Sc. in Statistics (Lagos) and a Ph.D. in Statistics (Ogun), Nigeria. He is a postdoctoral research fellow at the University of Johannesburg in South Africa. He is a lecturer in the Department of Mathematics and Statistics at Redeemer's University in Nigeria. His area of specialization is mathematical statistics, computational statistics, and data science. He is a fellow of the Royal Statistical Society in London. He has published over 50 scholarly articles, book chapters, and conference papers in reputable outlets.

Prof. Lawarence Ogechuckwu Obokoh (PhD, MBA, FCA) is the Director of MBA programs at the Johannesburg Business School. He is a Professor of Finance and Small Business Development. A Chartered Accountant and Fellow of the Institute of Chartered Accountants of Nigeria (ICAN), Prof Obokoh brings a wealth of expertise to his roles. Prof Obokoh earned his PhD from the University of Wales, Aberystwyth (now Aberystwyth University), in the United Kingdom. He also holds an MBA with Cum Laude honors from Obafemi Awolowo University in Nigeria, where he began his academic career as a Graduate Assistant and advanced to the rank of full Professor in 2015. His research interests encompass public finance, public policy, SME development, and digital transformation and sustainability. Prof Obokoh has contributed extensively to academic literature, with numerous journal articles and conference proceedings to his name.

Dr. Salami Olajumoke Olayemi is a postdoctoral researcher in the Department of Science and Technology Education at the University of Johannesburg in South Africa. She is a lecturer at the Federal University Oye Ekiti in Nigeria. Her research interests include curriculum instruction in mathematics education via technology.