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RESEARCH ARTICLE

Exploring academic performance of undergraduate students offering Pharmacology course in a Nigerian university: A cross-sectional observational study

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Abstract

Background: Pharmacology students often struggle with academic performance due to the subject's complexity, reliance on rote memorisation, and limited practical exposure. The study's objective is to evaluate factors influencing student performance, identify challenges, propose improvement strategies, and compare outcomes in Pharmacology versus Pharmaceutical Microbiology. **Methods:** A cross-sectional study was conducted among students of Pharmacology and Pharmaceutical Microbiology at Madonna University, Nigeria (July–December 2024). Stratified random sampling ensured proportional representation by year and department. Data were collected via questionnaires, focus groups, and interviews. Quantitative data were analysed with SPSS 23, while qualitative data underwent thematic analysis. Findings were triangulated to enhance validity. **Results:** Pharmacology was consistently perceived as abstract, bulky, and poorly taught, with most students reporting unsatisfactory performance. Pharmaceutical Microbiology was clearer and more engaging, though practical skills remained weak. Regression analysis confirmed course enrollment as a significant predictor of exam performance, while socioeconomic factors were not. **Conclusion:** Student outcomes are shaped by curriculum design and instructional quality. Pharmacology is hindered by content overload and lack of application, whereas Pharmaceutical Microbiology benefits from clarity but requires stronger laboratory training.

Introduction

Pharmacology is a cornerstone of pharmacy and medical education, linking biomedical sciences with clinical application and equipping students with the skills necessary for safe prescribing and evidence-based decision-making (Alsanosi, 2022; Guilding *et al.,* 2023). Despite its centrality, pharmacology education often struggles with effectiveness due to reliance on passive learning strategies and rote memorisation, which limit conceptual understanding and student engagement (Fasinu & Wilborn, 2024).

The subject's inherent complexity—requiring mastery of drug actions, interactions, and therapeutic uses—poses significant cognitive demands that many students find difficult to manage (Eukel *et al.,* 2017). Traditional teaching methods, which rarely accommodate diverse learning styles, further exacerbate disengagement and poor knowledge retention (Gill *et al.,* 2019). Moreover, discrepancies in students' prior knowledge of biology and chemistry create additional barriers to comprehension (Kolb, 2014). These challenges highlight the need for innovative instructional approaches and stronger academic support systems to improve learning outcomes and ensure medication safety in clinical practice (Murphy *et al.,* 2017; Chisholm-Burns *et al.,* 2019).

Evidence from multiple countries consistently reports high failure rates in pharmacology courses, often attributed to heavy cognitive loads and ineffective study strategies (Brown *et al.,* 2022). In Nigeria, several studies have documented similar concerns. Ibrahim and the authors reported widespread difficulties among students in grasping fundamental pharmacological principles, leading to poor academic performance (Ibrahim *et al.,* 2018). Ogunleye and authors found that medical students expressed dissatisfaction with pharmacology teaching methods, citing lack of interactivity and clinical relevance as major barriers (Ogunleye *et al*., 2022). Similarly, a study at the University of Jos identified institutional and personal factors—including inadequate teaching resources, poor study habits, and limited motivation—as significant determinants of pharmacy students' performance. These findings underscore the urgency of addressing both systemic and student-related issues in pharmacology education within the Nigerian context.

Furthermore, challenges in pharmacology often intersect with difficulties in pharmaceutical microbiology, another critical discipline in pharmacy education. Students must understand microbial resistance mechanisms, antimicrobial agents, and infection control, which directly complement pharmacological knowledge. Struggles in microbiology can compound pharmacology-related difficulties, intensify the cognitive burden, and affect overall academic performance.

Against this backdrop, the present study aims to investigate student academic performance in pharmacology and pharmaceutical microbiology, focusing on two distinct but related strands:

• Challenges: The specific obstacles students encounter during learning, such as high cognitive load, ineffective teaching methods, or gaps in prior knowledge.

• Factors: the broader influences shaping performance outcomes, including institutional resources, student attitudes, and socio-cultural contexts.

The objectives of the study are therefore to:

1) Explore the broader factors influencing academic performance, including institutional and personal determinants.

2) Identify the challenges that hinder effective learning and knowledge retention.

3) To examine the coping strategies of students offering Pharmacology and Pharmaceutical Microbiology at Madonna University.

4) To compare the academic performance of students offering Pharmacology to those offering Pharmaceutical Microbiology in Madonna University.

Methods

Study design

This was a cross-sectional descriptive study conducted to achieve the stated objectives of the study. The cross-sectional study design was chosen for its efficiency and ability to gather data from a large population within a limited timeframe. It is well-suited to identifying patterns among variables such as age, gender, year of enrollment, and department-specific characteristics in students' academic performance. The study design combines quantitative data collection via a structured questionnaire employing closed-ended questions and qualitative data from focus group discussions and in-depth interviews. To design the questionnaire, preliminary focus group discussions were conducted with the students in the concerned departments and in-depth discussions with lecturers. The discussions focused on identifying the key challenges and factors affecting students' academic performance in Pharmacology and Pharmaceutical Microbiology courses. The insights from these preliminary discussions informed the development of the final questionnaire used in the study. Details of the information collected with the questionnaire include socio-demographic information, academic attitude, performance of students, and factors affecting students' performance. The participants were meant to supply their performance on the examinations they had taken in the previous session.

Study population and sampling

The study population (a total of 765) comprised all students offering Pharmacology at Madonna University, Nigeria. These include students of the Faculty of Pharmacy in their third, fourth, and fifth years, and students of Medicine (fourth year), Medical Laboratory Science (third year), Optometry (second year), Public Health (third year), and Nursing Science (third year); and Pharmaceutical microbiology (fifth year). Other students who had not taken any Pharmacology exam at the time of the study were excluded.

The sampling process combined elements of random and systematic selection, but to avoid confusion, it is best described as a stratified random sampling design with systematic implementation. First, students were stratified by year of enrolment and department to ensure proportional representation across cohorts.

Within each stratum, participants were then selected using a systematic interval approach (e.g., every n^{th} student from class lists). This hybrid design was chosen to balance representativeness with feasibility: stratification preserved randomness across key subgroups, while systematic interval selection ensured efficiency in large classes where purely random draws would have been logistically difficult. Importantly, this integration reduced potential bias by preventing over-representation of any single subgroup, while still maintaining the probabilistic foundation of random sampling. While the Pharmaceutical Microbiology department was randomly selected from the 6 departments in Pharmacy, the selection of the fifth-year students of Pharmacy offering Pharmaceutical Microbiology was through convenience sampling due to logistical constraints such as scheduling difficulties. Thereafter, the participants therein were selected by using a systematic interval approach, as in other departments. This approach, while practical, weakens representativeness by increasing the risk of selection bias and limiting the generalisability of findings for that subgroup. To mitigate this limitation, triangulation of data sources (questionnaires, focus groups, and interviews) was used to cross-validate responses and reduce the impact of bias from any single sampling method. Nevertheless, the reliance on convenience sampling is acknowledged as a limitation, and future studies should employ fully probabilistic sampling designs to strengthen external validity. Participation was voluntary, and all selected students were informed of the study objectives, the voluntary nature of participation, and the confidentiality of their responses.

The appropriate sample size for this study was initially calculated using Cochran's (1977) formula for large populations at 95% confidence (Z=1.96), *p* = 0.5, and margin of error e=0.05, yielding 385.

For example, in Public Health (N=66):

$$\rightarrow n_0 = \frac{Z^2 P(1-p)}{e^2}$$

$$n_0 = \frac{1.96^2 \times 0.5(0.5)}{0.05^2} = \frac{0.9604}{0.0025} = 384.16 = 385$$

Since the actual population was finite, departmental corrections were applied using Taro Yamane's formula (1967), producing the calculated sample sizes shown in Table I.

$$n_{cal} = \frac{n_0}{1+(\frac{n_{o-1}}{N})}$$

where:

n = the calculated sample size for a finite population

N = the population size

$$n_{cal} = \frac{n_0}{1+(\frac{n_{o-1}}{N})} \frac{385}{\frac{1+385-1}{66}} = 1+5.8182$$

$$\simeq 6.8182$$

$$= \frac{385}{6.8182} = 57$$

Additionally, a 5% attrition rate was factored into the final sample size to account for potential non-responses or incomplete data.

$$\frac{5}{100} x \; 57 = 2.85$$

Adjusted sample size:

$n_{adj.}$ = 57 + 2.85 = 60

The same procedure was applied to all departments, levels of pharmacy, and pharmaceutical microbiology. Final adjusted sample sizes are shown in Table I.

Table I: Departmental populations and sample sizes

Department	Population (N)	Calculated sample size ($n_{cal.}$)	Adjusted sample size ($n_{adj.}$)
Public health	66	57	60
Medical laboratory science	95	77	81
Nursing science	137	102	107
Optometry	86	71	75
Medicine	45	41	43
Pharmacy (300 Level)	108	85	89
Pharmacy (400 Level)	110	86	91
Pharmacy (500 Level)	118	91	96
Pharmaceutical microbiology	118	91	96

Note: n_{cal} = calculated sample size; n_{adj} = adjusted sample size

The sample size for students offering Pharmacology was determined to be 642, as shown above. While Pharmaceutical Microbiology was determined to be 96.

Data source and collection

Primary data were collected using a structured, self-developed questionnaire for quantitative analysis and focus group discussions (FGDs) alongside in-depth interviews (IIs) for qualitative insights. Both instruments were designed to capture information on students' academic performance in Pharmacology and Pharmaceutical Microbiology, the factors influencing performance, the challenges encountered, and the strategies for improvement.

While the cross-sectional design provided a snapshot of student experiences, the integration of quantitative and qualitative methods was not only for efficiency but also to enhance validity and reduce bias. Structured questionnaires yielded measurable patterns in perception and performance, but self-reported data are inherently vulnerable to recall errors and social desirability bias. To address this, focus group discussions and in-depth interviews were employed to triangulate findings, allowing us to probe underlying reasons for survey responses and to capture nuances that numbers alone could not reveal. For example, while survey data quantified the proportion of students who found Pharmacology "*bulky*," qualitative discussions clarified how this perception was linked to teaching style and lack of practical exposure. This methodological triangulation strengthened the credibility of the results by cross-checking consistency across data sources, thereby mitigating the limitations of self-reporting.

The questionnaire was pre-tested in a pilot study to assess clarity and relevance, with feedback used to refine wording and sequencing. Face validity was established through review by a senior faculty member. Internal consistency was assessed using Cronbach's alpha. Three trained research assistants administered the questionnaires during designated class periods, with students completing them on the spot to ensure high response rates.

Semi-structured interview guides were developed for FGDs and IIs. Content validity was ensured through expert review by two pharmacology lecturers and one sociologist. Pretesting with a small group of students helped refine phrasing and flow. Ten FGDs (6–8 participants each) and four IIs with pharmacology and pharmaceutical lecturers were conducted. Sessions were facilitated by two trained assistants, one taking notes and the other recording.

Data analysis

The quantitative data collected from participants were entered into Microsoft Excel, sorted by demographics, transferred to Statistical Package for the Social Sciences (SPSS) version 23, cleaned, and analysed using thematic analysis (Braun & Clarke, 2006). Transcripts were coded inductively, clustered into themes, and refined for coherence. To ensure rigour, two independent coders analysed the transcripts. Intercoder reliability was assessed using Cohen's kappa, with values ≥ 0.75 indicating substantial agreement. Discrepancies were resolved through consensus. Descriptive statistics were used to summarise the data, including frequency distribution and percentages. Since both the predictors and the outcome variable were categorical, Chi-Square was employed to assess whether significant relationships exist before proceeding to more complex modelling. Multinomial logistic regression was further utilised because the proportional odds assumption required for ordinal regression was not satisfied.

Ethical clearance

Before the commencement of the study, ethical approval was obtained from the Research Ethics Committee of Madonna University (Ref. No: MAU/DRC/HD/E/Pharm/2024/018). Participants were informed of the voluntary nature of the study and assured of confidentiality, and informed consent was sought and obtained from all participants before their involvement in the study. The participants' privacy was protected. The study lasted for 6 months.

Results

A total of 628 responses were retrieved for Pharmacology (response rate: 97.8%) and 96 for Pharmaceutical Microbiology (response rate: 100%). As shown in Table II, most Pharmacology participants (71.8%) were aged 21–25 years, with females (59.2%) forming a greater proportion than males (40.8%). The majority enrolled in 2021 (60.8%), and Nursing was the most represented department (17.0%). A significant proportion (86.6%) reported family monthly incomes above ₦300,000, and nearly all (96.5%) had a pre-university science background. In contrast, Table III indicates that Pharmaceutical Microbiology participants were similarly concentrated in the 21–25 age group (88.5%), with comparable gender distribution (59.4% female). All students enrolled in 2019, and while more than half (54.2%) reported family incomes above ₦300,000, this proportion was lower than in Pharmacology. A majority (89.6%) had a science background.

Table II: Socio-demographic characteristics of the students offering pharmacology (N= 628)

Variable	Category	Frequency	Percentage (%)
Age	15–20	132	21.0
	21–25	451	71.8
	26 and above	45	7.2
Gender	Male	256	40.8
	Female	372	59.2
Year of enrolment	2019–2020	187	29.8
	2021	382	60.8
	2022	59	9.4
Faculty/Department	Pharmacy (Years 3–5)	276	44.0
	Nursing	107	17.0
	Medical Lab Science	81	12.9
	Optometry	75	11.9
	Public Health	59	9.4
	Medicine	30	4.8
Religion	Christianity	623	99.2
	Islam	5	0.8
Marital status	Single	617	98.2
	Married	11	1.8
Number of children	0	618	98.4
	1	10	1.6
Family monthly income	Above ₦300,000	544	86.6
	₦100,000–₦300,000	37	5.9
	Less than ₦100,000	47	7.5
Pre-university background	Sciences	606	96.5
	Arts & Social Sciences	22	3.5
Parents' education	Tertiary	532	84.7
	Secondary or below	96	15.3

Table III: Socio demographic characteristics of the students offering pharmaceutical microbiology (N= 96)

Variable	Category	Frequency	Percentage (%)
Age	15–20	6	6.25
	21–25	85	88.54
	26 and above	5	5.21
Gender	Male	39	40.63
	Female	57	59.38
Year of enrolment	2019	96	100
Faculty/Department	Pharmacy (Years 5)	96	100
Religion	Christianity	96	100
Marital status	Single	94	97.92
	Married	2	2.08
Number of children	0	94	97.92
	1	1	1.04
Family monthly income	Above ₦300,000	52	54.17
	₦100,000–₦300,000	44	45.84
Pre-university background	Sciences	86	89.59
	Arts & Social Sciences	10	10.42
Parents' education	Tertiary	56	58.33
	Secondary or below	42	43.75

Performance outcomes differed markedly between the two courses. As summarised in Table IV, most Pharmacology participants earned "*C*" or "*D*" grades (71.8%), with only 4.6% achieving "*A*" and 18.8% "*B*." Practical performance was similarly weak, with less than half (49.2%) rating their skills as satisfactory or excellent. Furthermore, 70.8% of students reported finding the course difficult. By contrast, Table V shows that Pharmaceutical Microbiology participants performed better, with 49.0% earning "*A*" grades and 79.4% considering the course easy. However, practical skills remained a challenge, as 60.4% rated their performance as needing improvement or unsatisfactory. A Pearson Chi-Square test confirmed a significant association between course enrollment and grade distribution, χ^2 (3, N = 724) = 12.14, p = 0.007. Although the effect size was small (Cramer's V = 0.13), this indicates that course enrollment still played a role in shaping performance outcomes, even if it accounted for only part of the variation. Because the proportional odds assumption was violated, multinomial logistic regression was employed. This approach does not assume that grades are ordered, but instead models the relative likelihood of membership in each grade category compared to a chosen reference. The likelihood ratio tests from the multinomial logistic regression further highlighted course enrollment as a significant predictor of exam grade (χ^2 (3) = 13.91, *p* = 0.003). With grade B as the reference, Pharmaceutical Microbiology students had significantly lower odds of being classified into grade C (OR = 0.48, 95% CI [0.27–0.84], *p* = 0.011) or the 'Others' category relative to grade "*B*". No significant difference was observed between the two courses for grade A versus grade B (*p* =0.777). Pre-university background showed a borderline effect (χ^2 (9) = 17.28, *p*=0.045), while family income (χ^2 (3) = 1.05, *p*=0.789) and parental education (χ^2 (18) = 17.55, *p*=0.486) were not significant predictors. Nagelkerke's pseudo-R^2 indicated that the predictors explained approximately 3.8% of the variance in exam grades. The internal consistency analysis of the four-item scale yielded a Cronbach's alpha of 0.58, which is below the conventional threshold of 0.70, suggesting limited internal consistency. Inter-rater reliability was assessed using Cohen's kappa statistic, with values ≥ 0.75 indicating substantial agreement. Discrepancies were resolved through consensus. Overall, while the effect size of the Chi-Square association was small, both descriptive and regression analyses consistently identified course enrollment as the strongest determinant of exam outcomes. In contrast, socioeconomic factors contributed minimally in this sample.

Table IV: Students' performance in pharmacology course (N= 628)

Variables	Descriptive	Frequency	Percentage (%)
What was your overall grade in the most recent pharmacology exam?	A	29	4.6
	B	118	18.8
	C & F	481	76.4
How would you rate your performance in the practical components of Pharmacology?	Excellent	48	7.6
	Satisfactory	261	41.6
	Needs improvement/ Unsatisfactory	319	50.8
Pharmacology course is easy to pass?	Very easy	44	7.0
	Easy	139	22.1
	Difficult/Very difficult	445	70.8

Table V: Students' performance in pharmaceutical microbiology course (N= 96)

Variables	Descriptive	Frequency	Percentage (%)
What was your overall grade in the most recent pharmacology exam?	A	47	49.0
	B	30	31.3
	C & F	19	19.7
How would you rate your performance in the practical components of Pharmacology?	Excellent	14	14.6
	Satisfactory	24	25.0
	Needs improvement/ Unsatisfactory	58	60.4
Pharmacology course is easy to pass?	Very easy	17	17.7
	Easy	63	65.6
	Difficult/Very difficult	19	16.7

Pharmacology participants identified a lack of qualified lecturers (56.4%) as the most significant challenge, alongside poor study habits (50.5% rarely studied) and inadequate exam preparedness (54.6% felt unprepared), as shown in Table VI. For Pharmaceutical Microbiology, Table VII indicates that time constraint (59.4%) was the predominant challenge. Poor study habits were less common (12.5% studied three to four times weekly), but exam readiness was similarly low, with 64.6% reporting rare preparation.

Table VI: Factors affecting students' performance in pharmacology (N= 628)

Variables	Description	Frequency	Percentage (%)
What do you consider to be the biggest challenge in studying Pharmacology?	Time constraints	196	31.2
	Lack of qualified lecturers	354	56.4
	Lack of reading materials	78	12.4
How often do you study Pharmacology outside class?	Never	86	13.7
	Rarely	317	50.5
	Occasionally	50	8.0
	Daily	120	19.1
	3 to 4 times a week	55	8.8
Do you feel well prepared for Pharmacology exams?	Never	118	18.8
	Rarely	225	35.8
	Sometimes	220	35.0
	Always	65.3	10.4

Table VII: Factors affecting students' performance in pharmaceutical microbiology (N= 96)

Variables	Descriptive	Frequency	Percentage (%)
What do you consider to be the biggest challenge in studying Pharmaceutical microbiology?	Time constraints	57	59.4
	Lack of qualified lecturers	25	26.0
	Lack of reading materials	14	14.6
How often do you study Pharmaceutical microbiology outside class?	Never	9	9.4
	Occasionally	47	49.0
	Daily	28	29.2
	3 to 4 times a week	12	12.5
Do you feel well prepared for Pharmaceutical microbiology exams?	Never	12	12.5
	Rarely	62	64.6
	Sometimes	21	21.9
	Always	1	1.0

Pharmacology participants proposed additional teaching (54.6%), curriculum improvements (59.5%), and greater emphasis on practical applications (40.9%) as strategies to enhance learning (Table VIII). Pharmaceutical Microbiology participants highlighted the need for more practical sessions (68.8%) and additional teaching (25.0%) (Table IX). Collaborative learning was less popular, with 67.7% rarely interested in study groups. Despite these challenges, a majority (80.3%) achieved "*A*" or "*B*" grades.

Table VIII: Students' performance enhancement in pharmacology course (N= 628)

Variables	Descriptive	Frequency	Percentage (%)
What strategies do you think would help you improve your performance in Pharmacology?	Smaller class sizes	28	4.5
	Additional teaching	343	54.6
	More practical problems	257	40.9
I am interested in participating in a Pharmacology study group?	Never interested	20	3.2
	Rarely interested	378	60.2
	Very interested	230	36.6
Do you believe that the Pharmacology curriculum could be improved to enhance students' performance?	Never be improved	254	40.4
	May be improved	289	46.0
	Should be improved	85	13.5

Table IX: Students' performance enhancement in Pharmaceutical microbiology course (N= 96)

Variables	Descriptive	Frequency	Percentage (%)
What strategies do you think would help you improve your performance in Pharmaceutical Microbiology?	Smaller class sizes	6	6.3
	Additional teaching	24	25.0
	More practical problems	66	68.8
I am interested in participating in a Pharmaceutical Microbiology study group?	Never interested	5	5.2
	Rarely interested	65	67.7
	Very interested	26	27.1
Do you believe that the Pharmaceutical Microbiology curriculum could be improved to enhance students' performance?	Never be improved	12	12.5
	May be improved	64	66.7
	Should be improved	20	20.8

Focus group discussions (FGDs) were conducted among students offering Pharmacology and Pharmaceutical Microbiology, while in-depth interviews (IIs) were held with lecturers teaching the two courses. The thematic analysis revealed the following themes:

Theme 1: Perceived curricular accessibility

This theme explores the varying levels of "*difficulty*" reported by students, identifying a stark contrast between courses based on their complexity and required foundational knowledge.

•Sub-theme: The foundational knowledge gap

Pharmacology was consistently labelled as "*tough*" or "*challenging*," with lecturers attributing this to a lack of early-career science preparation. One lecturer noted, "*Some students find Pharmacology difficult because they were not science inclined in secondary school*" (II, Pharmacology, L2).

•Sub-theme: Semantic and cognitive accessibility

Conversely, Pharmaceutical Microbiology was viewed as more "*digestible*." Students noted the vocabulary felt less "*foreign*," suggesting that linguistic accessibility directly impacts perceived difficulty (FDG, Pharmaceutical Microbiology, S1).

Theme 2: Engagement and performance patterns

This theme highlights how students interacted with different course structures, revealing a preference for theoretical success and real-world application.

•Sub-theme: Theoretical vs. Practical engagement

Lecturers observed that students in Microbiology were "*more engaged*," particularly in theoretical aspects where performance was "*generally strong*" (II, Pharmaceutical Microbiology, L1).

•Sub-theme: Real-world motivation

Collaborative learning and the "*real-world relevance*" of Microbiology content were identified as core motivators, contrasting with the "*struggle to engage fully*" seen in Pharmacology (II, Pharmaceutical Microbiology, L2-3).

Theme 3: Resource-driven structural barriers

Both students and lecturers identified physical and institutional constraints as primary hurdles to achieving mastery, specifically in practical skill development.

•Sub-theme: Material and practical shortfalls

A shared concern across both subjects was the "*lack of adequate resources*" and "*updated laboratory equipment*" (II, Pharmacology, L1; II, Pharmaceutical Microbiology, L1).

•Sub-theme: The demand for enhanced practicality

There were repeated "*calls for more frequent and deeper laboratory sessions*," signalling that students recognise their own skill gaps in practical areas and desire more structured hands-on time (II, Pharmaceutical Microbiology, L2-3).

Discussion

This study explored factors influencing academic performance in Pharmacology and Pharmaceutical Microbiology at Madonna University. Despite advantageous socioeconomic and educational backgrounds—such as high parental education and science-based pre-university preparation—Pharmacology students reported suboptimal outcomes. This paradox underscores that demographic privilege alone does not guarantee success; instead, curriculum design, teaching quality, and student engagement appear to be stronger determinants of performance (Broer *et al.,* 2019; Fokkens-Bruinsma *et al.,* 2021).

A key finding is that the bulkiness and abstract nature of Pharmacology content, coupled with reliance on rote memorisation, contributed to poor outcomes. These perceptions align with prior work highlighting cognitive overload in content-heavy curricula (Guilding *et al.,* 2023; Fasinu & Wilborn, 2024). However, alternative explanations must also be considered. Departmental culture, individual motivation, and assessment strategies may compound these challenges, suggesting that performance gaps cannot be attributed solely to curriculum structure. The triangulated data—survey responses contextualised by focus groups and interviews—reinforce that instructional quality and limited practical exposure were recurrent themes across participants (Mengesha *et al.,* 2025).

The inferential analyses provide further nuance. Although the Chi-Square test revealed only a small effect size, the consistent statistical signal indicates that course enrollment exerted a meaningful influence on performance. In other words, the differences between Pharmacology and Pharmaceutical Microbiology were not random but reflected structural contrasts in how the courses were designed and delivered. The regression results reinforce this interpretation: while socioeconomic variables such as family income and parental education were not significant predictors, course enrollment consistently shaped grade outcomes. This pattern suggests that institutional and curricular factors outweighed demographic privilege, echoing prior evidence that teaching approaches and curriculum organisation are more decisive than background characteristics (Eukel *et al.,* 2017; Broer *et al.,* 2019; Fokkens-Bruinsma *et al.,* 2021).

In the present study, the limited number of items likely contributed to the reduced Cronbach's alpha value. However, it is important to note that reliability coefficients such as Cronbach's alpha are highly sensitive to the number of items in a scale. Short scales often yield lower values, even when items are conceptually coherent (Cortina, 1993). High coefficient alpha does not always mean a high degree of internal consistency since alpha is also affected by the length of the test. If the test length is too short, the value of alpha is reduced (Streiner, 2003). While this does not invalidate the scale, it does highlight the need for cautious interpretation of findings. Researchers have argued that short scales may still be useful in exploratory contexts or when participant burden must be minimised, provided that their limitations are acknowledged (Sharma *et al.,* 2004). Future research should consider expanding the item pool to strengthen measurement reliability. Thus, while the findings remain informative for exploratory purposes, replication with longer scales is recommended to ensure greater robustness.

By contrast, Pharmaceutical Microbiology was perceived as more accessible and engaging, with stronger theoretical performance. Yet, practical skills remained weak, pointing to structural limitations in laboratory training. This discrepancy highlights that theoretical clarity does not automatically translate into applied competence, consistent with experiential learning models (Kolb, 2014). Limited laboratory resources and insufficient exposure to advanced tools may explain this gap, suggesting that both courses face distinct but equally important barriers: Pharmacology struggles with conceptual overload, while Pharmaceutical Microbiology requires stronger integration of theory and practice (Brown & White, 2019).

The challenges reported—lack of qualified lecturers, poor study habits, and inadequate exam preparedness—further emphasise the interplay between institutional resources and student behaviours. While socioeconomic background provided a supportive foundation, the inferential results confirm that instructional quality and active learning strategies are more decisive. This interpretation is consistent with evidence linking teaching approaches to student outcomes (Eukel *et al.,* 2017; Broer *et al.,* 2019).

Limitations

This research was conducted only with students offering the Pharmacology course at Madonna University. Moreover, some students (Nursing, Medical Laboratory Science, and third-year Pharmacy) were unavoidably absent from the focus group discussions due to community service and industrial training, which may restrict the generalisation of findings to the wider student population. The study was also limited to a single institution, which constrains external validity and the applicability of results to other contexts.

Methodologically, the descriptive design restricts the ability to establish causal relationships between variables. Although inferential analyses (Chi Square and multinomial logistic regression) confirmed that course enrollment was a statistically significant predictor of exam performance, the effect size was small, and the explained variance was limited. This indicates that while course structure and delivery influenced outcomes, other unmeasured factors likely contributed.

Finally, although the questionnaire was administered anonymously and complemented by qualitative focus groups and interviews, self-report bias remains a potential limitation. Students may have understated difficulties or overstated engagement due to social desirability or uncertainty about how their responses would be interpreted. This bias could have influenced the balance of themes, for example, by amplifying positive accounts of teaching while minimising critical perspectives. The inclusion of quantitative measures alongside qualitative narratives helped reduce this risk by providing converging evidence, but future research should incorporate objective indicators such as attendance records or observational data and employ longitudinal designs to track changes in perceptions over time. Such approaches would provide a more comprehensive understanding of the multifactorial influences on student performance.

Conclusion

The integration of findings from focus group discussions, questionnaires, and interviews revealed clear differences in how students perceived and performed in the two courses. In Pharmacology, challenges such as the overwhelming volume of content, reliance on memorisation of complex drug mechanisms, and limited practical applications were compounded by uninspired teaching methods and inadequate resources. These concerns were mirrored in the survey data, where over 70% of students found the course difficult, less relevant to their careers, and rated their practical performance as unsatisfactory. By contrast, Pharmaceutical Microbiology was perceived as more accessible and engaging, with simplified content, clear teaching styles, and stronger theoretical outcomes. Yet, practical skills remained weak, largely due to limited laboratory resources and insufficient exposure to advanced tools.

Importantly, the inferential analyses confirmed that course enrollment was a statistically significant predictor of exam performance, even though the effect size was small and the explained variance was limited. This finding underscores that differences in performance were not random but reflected structural contrasts in curriculum design and delivery. While socioeconomic variables such as family income and parental education were not significant predictors, the regression results highlighted that instructional quality and course structure consistently shaped outcomes. Thus, the challenges in Pharmacology stem primarily from its abstract, bulky, and theory-heavy nature, whereas the relative success of Pharmaceutical Microbiology lies in its clear structure and relatable content, though undermined by weak practical training.

Taken together, these results emphasise that improving student performance requires multifaceted interventions—strengthening curriculum and pedagogy, expanding practical training opportunities, and addressing broader institutional and motivational factors. The statistical evidence reinforces that course design and instructional approaches outweigh demographic privilege in determining outcomes. This report provides actionable feedback to policymakers and faculty for revising Pharmacology training content and highlights the urgent need for evidence-based strategies to improve Pharmacology education in Nigeria. As this is a pilot study, a nationwide investigation is planned to validate and extend these findings across diverse institutional contexts.

Recommendations

Curriculum rationalisation: Inferential analyses confirmed that course enrollment significantly influenced performance, even though the effect size was small. To address the disproportionate challenges faced by Pharmacology students, the syllabus should be streamlined to reduce cognitive overload and prioritise core conceptual understanding (Jegede *et al.,* 2024).

Evidence-based pedagogy: Regression results showed that socioeconomic background variables were not significant predictors, underscoring that instructional quality matters more than demographic privilege. In response to participant requests for more engaging instruction, traditional lectures should be supplemented with role playing, small group discussions, and computer-assisted learning methods that students themselves identified as preferred facilitators of learning (Sharma *et al.,* 2004).

Bridging the theory-practice gap: While Pharmaceutical Microbiology students demonstrated stronger theoretical performance, inferential findings highlighted that course design consistently shaped outcomes. To correct the observed disparity where laboratory competence lags behind theoretical scores, there must be a strategic increase in practical exposure and hands-on laboratory assessment (Brown et al., 2022).

Faculty realignment: The statistical evidence reinforced that course structure and delivery outweighed socioeconomic factors in determining outcomes. To transition from the memorisation-heavy culture identified in student performance patterns, faculty development programmes should focus on retraining educators to foster applied learning and clinical reasoning (Uma *et al.,* 2013).

Given the descriptive, cross-sectional design and single-institution setting, these findings should be interpreted cautiously. Although the regression controlled for background variables and confirmed that course enrollment was the most consistent predictor of performance, the small effect size indicates that other unmeasured factors also contribute. Future multi-institutional studies employing robust inferential designs are needed to validate these findings and disentangle the relative impact of socioeconomic background, curriculum design, and instructional quality across diverse contexts (Becker & Park, 2011).

Ethics approval and informed consent

Before the commencement of the study, ethical approval was obtained from the Research Ethics Committee of Madonna University (Ref. No: MAU/DRC/HD/E/Pharm/2024/018). Participants were assured of confidentiality, and informed consent was obtained from all participants before their involvement in the course of this research.

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