Faculty of Natural and Applied Sciences Journal of Mathematics and Science Education
Print ISSN: 2814-0885 e-ISSN: 2814-0931
www.fnasjournals.com
Volume 7; Issue 3; March 2026; Page No. 19-30.
DOI: https://doi.org/10.63561/fnas-jmse.v7i3.1165

Gender Differences and Institutional Factors in Chemistry Graduates' Academic Performance in JUPEB-Affiliated Nigerian Universities

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Abstract
This study examined the impact of gender and institutional factors on the academic performance of chemistry graduates in JUPEB-affiliated Nigerian universities. Specifically, it looked at the independent effects of gender, teacher–student ratio, and university type, as well as their combined influence on academic outcomes. Using an ex post facto design, data were collected from 665 graduates across 43 JUPEB-affiliated universities in Southwest Nigeria. Chi-square, one-way ANOVA, and ordinal logistic regression analyses were used to test four null hypotheses. Results showed that gender alone did not significantly affect academic performance, and neither the teacher–student ratio nor the type of university produced significant differences in graduates' outcomes. Additionally, the combined effect of gender and institutional factors was non-significant, indicating that neither of these variables, individually or collectively, predicted academic success among chemistry graduates. These findings support recent research suggesting that gender differences in tertiary chemistry performance are context-dependent and that institutional structures, within the framework of JUPEB standardisation, do not systematically disadvantage particular student groups. The study recommends promoting inclusive teaching methods, fair resource distribution, and ongoing monitoring to maintain academic equality. The implications for educational policy, programme evaluation, and institutional planning in pre-university preparatory programmes are also discussed.

Keywords: JUPEB, Academic Performance, Gender, University Type, Institutional factors.

Introduction

Academic performance in chemistry continues to attract sustained scholarly and policy attention within Nigeria's higher education system, especially because of the discipline's central role in scientific, technological, and industrial development. Chemistry holds a strategic position as a foundational science, underpinning professional training in medicine, engineering, pharmacy, environmental science, and related fields. Therefore, the quality of chemistry graduates directly influences national capacity for innovation and industrial progress. In Nigeria, universities are expected to produce chemistry graduates who demonstrate both conceptual understanding and practical skills, yet concerns remain about uneven academic outcomes across institutions and student groups (Chioke et al., 2023; Nwachukwu, 2024). In response to longstanding concerns about access and preparedness for university education, Nigeria introduced multiple entry routes into higher education, including the Unified Tertiary Matriculation Examination (UTME), the Nigeria Certificate in Education (NCE), and the Joint Universities Preliminary Examinations Board (JUPEB). JUPEB, in particular, was established to provide a structured pre-university academic foundation that better prepares students for the demands of undergraduate study. The aim of this policy was that enhanced preparatory depth would lead to improved academic performance at university (Okebukola, 2016; Federal Ministry of Education, 2018). However, empirical evidence shows that while JUPEB entrants often perform better overall, academic success cannot be fully explained by entry pathway alone, indicating the influence of additional moderating factors (Adeyemi, 2009; Apantaku, 2003; Emaikwu, 2012).

Gender remains a significant factor in analysing the academic performance of chemistry students because male and female students often enter university with different prior academic experiences, learning attitudes, and social conditioning. Earlier research in Nigerian science education linked performance gaps in chemistry to

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gendered socialisation patterns that influence confidence, classroom participation, and persistence in problem-solving tasks (Ahiakwo, 1988; Erinosho, 1994). However, later studies question the strength of gender as an independent predictor of academic success, suggesting instead that its impact depends on the educational environment where learning takes place (Okorie & Ezeh, 2016; Eya & Ezeh, 2020). Using Astin's Input–Environment–Outcome (I–E–O) Model, gender is better viewed as an input variable whose effects are shaped by institutional settings, teaching methods, and assessment practices (Astin, 1993). In a discipline like chemistry, which requires ongoing engagement with both theoretical concepts and laboratory work, ignoring gender risks hiding subtle differences in engagement, adaptation, and persistence that may vary across different entry routes. Therefore, gender deserves careful consideration as a mediating factor rather than being seen as just a peripheral demographic characteristic.

Beyond gender, institutional factors play a vital role in explaining differences in academic performance among chemistry students. Within the Nigerian university system, teacher–student ratio and university type are widely recognised as key structural conditions that influence the quality of teaching and learning. Large class sizes, often linked with unfavourable teacher–student ratios, can limit personalised feedback, hinder effective supervision of laboratory work, and weaken academic mentoring, all of which are essential to chemistry education. From a human capital perspective, these constraints impact how efficiently students turn educational inputs into academic outcomes (Becker, 1975; Schultz, 1961). University type adds further complexity to this institutional landscape. Although federal, state, and private universities operate under common regulatory frameworks set by the National Universities Commission, differences in funding, staffing stability, and infrastructural capacity remain. These structural variations affect instructional delivery, assessment methods, and student support systems, thereby shaping learning experiences across institutions. Consequently, this study explores the influence of gender and institutional factors on the academic performance of chemistry graduates in JUPEB-affiliated Nigerian universities.

Statement of the Problem

Despite the strategic importance of chemistry to Nigeria's scientific and technological progress, persistent concerns remain about the academic performance of chemistry graduates across universities with different admission pathways. The introduction of the Joint Universities Preliminary Examinations Board (JUPEB) was intended to widen access to higher education while maintaining academic standards (Okebukola, 2016). However, the extent to which students admitted through JUPEB perform academically in chemistry, compared to other entry routes, remains insufficiently examined, especially when contextual variables are taken into account. Existing studies on academic performance in Nigerian universities have mainly focused on prior qualifications as standalone predictors, with limited attention to how gender and institutional factors influence learning outcomes (Adeyemi, 2009; Emaikwu, 2012). Research related to gender in science education has yielded mixed results, with some earlier studies indicating disparities in chemistry performance, while more recent research suggests that such differences are mediated by learning environments rather than innate ability (Erinosho, 1994; Okorie & Ezeh, 2016). Likewise, institutional factors such as teacher–student ratios and university type significantly affect instructional quality and support structures (Astin, 1993; Eze, 2008). The limited incorporation of these variables into JUPEB-focused studies represents a critical gap, which hampers evidence-based policy and institutional decision-making in chemistry education.

Purpose of the Study

The main aim of this study is to examine gender differences and institutional factors affecting chemistry graduates' academic performance in JUPEB-affiliated Nigerian universities. The study was guided by four specific objectives, which were to:

1. Investigate the influence of gender on chemistry graduates' academic performance.
2. Assess the effect of the teacher–student ratio as an institutional factor on academic performance in chemistry.
3. Determine the influence of university type on chemistry graduates' academic performance.
4. Examine the combined and interaction effects of gender and institutional factors on chemistry graduates' academic performance.

Research Questions

Given the objectives, four corresponding questions were answered in this study as follows:

1. What is the influence of gender on chemistry graduates' academic performance?
2. What is the effect of the teacher–student ratio as an institutional factor on academic performance in chemistry?

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3. What is the influence of university type on chemistry graduates' academic performance?
4. What are the combined and interaction effects of gender and institutional factors on chemistry graduates' academic performance?

Hypotheses

The following null hypotheses were tested in the study as follows:

H_{01}: Gender does not significantly influence the academic performance of chemistry graduates in JUPEB-affiliated Nigerian universities.

H_{02}: Teacher–student ratio, as an institutional factor, does not significantly influence the academic performance of chemistry graduates in JUPEB-affiliated Nigerian universities.

H_{03}: University types (federal, state, and private) do not significantly influence the academic performance of chemistry graduates in JUPEB-affiliated Nigerian universities.

H_{04}: Gender and institutional factors (teacher–student ratio and university type) do not jointly have a significant effect on the academic performance of chemistry graduates in JUPEB-affiliated Nigerian universities.

The Joint Universities Preliminary Examinations Board (JUPEB) and Academic Preparation

The Joint Universities Preliminary Examinations Board (JUPEB) was established to provide a structured and academically rigorous alternative route into Nigerian universities. Designed as a one-year advanced-level preparatory programme, JUPEB equips candidates with subject-specific knowledge equivalent to A-Level standards, enabling successful students to gain direct entry into 200-level degree programmes in participating universities (Apantaku, 2003; Okebukola, 2016). The programme was introduced partly to address limitations associated with the Unified Tertiary Matriculation Examination (UTME), which critics argue insufficiently prepares students for the academic demands of university education (Adeyemi, 2009; Emaikwu, 2012).

JUPEB operates through affiliated universities, where instruction follows a centrally coordinated curriculum and assessment framework. Emphasis is placed on subject mastery, continuous assessment, and standardised final examinations to ensure comparability of results across centres. This standardisation is intended to reduce disparities arising from institutional differences and to enhance students' readiness for undergraduate studies, particularly in science-related disciplines such as chemistry. Empirical studies indicate that students admitted through preparatory programmes often demonstrate improved academic adjustment and performance, although outcomes may still be influenced by contextual and institutional variables (Adeyemi, 2009; Okebukola, 2016). As of 2025, JUPEB has 43 affiliated universities in Southwest Nigeria, as follows:

Table 1: JUPEB-Affiliated Universities in South-West Nigeria

S/N	Name of Institution	Ownership Type	Date Joined	Status
1	University of Lagos, Akoka, Lagos (UNILAG)	Federal	2014	Partner
2	Federal University of Agriculture, Abeokuta (FUNAAB)	Federal	2014	Partner
3	Federal University of Technology, Akure (FUTA)	Federal	2014	Partner
4	Obafemi Awolowo University, Ile-Ife (OAU)	Federal	2014	Partner
5	Achievers University, Ondo State	Private	2016	Affiliate
6	Adekunle Ajasin University, Ondo State	State	2016	Affiliate
7	Adeleke University, Osun State	Private	2016	Affiliate
8	Afe Babalola University, Ekiti State	Private	2017	Affiliate
9	Ajayi Crowther University, Oyo State	Private	2016	Affiliate
10	Anchor University, Lagos State	Private	2017	Affiliate
11	Atiba University, Oyo State	Private	2018	Affiliate
12	Augustine University, Lagos State	Private	2019	Affiliate

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13	Babcock University, Ogun State	Private	2016	Affiliate
14	Bells University of Technology, Ogun State	Private	2015	Affiliate
15	Bowen University, Iwo, Osun State	Private	2014	Affiliate
16	Caleb University, Lagos State	Private	2014	Affiliate
17	Chrisland University, Abeokuta, Ogun State	Private	2016	Affiliate
18	Christopher University, Mowe, Ogun State	Private	2017	Affiliate
19	Crawford University, Igbesa, Ogun State	Private	2015	Affiliate
20	Crescent University, Abeokuta, Ogun State	Private	2015	Affiliate
21	Ekiti State University, Ekiti State	State	2020	Affiliate
22	Elizade University, Ondo State	Private	2019	Affiliate
23	Federal University, Oye-Ekiti, Ekiti State	Federal	2017	Affiliate
24	First Technical University, Oyo State	State	2021	Affiliate
25	Fountain University, Osun State	Private	2014	Affiliate
26	Hallmark University, Ogun State	Private	2017	Affiliate
27	Joseph Ayo Babalola University, Osun State	Private	2016	Affiliate
28	Kings University, Osun State	Private	2016	Affiliate
29	Koladaisi University, Oyo State	Private	2018	Affiliate
30	Ladoke Akintola University of Technology, Oyo State	State	2018	Affiliate
31	Lagos State University, Lagos State	State	2016	Affiliate
32	Lead City University, Oyo State	Private	2014	Affiliate
33	McPherson University, Ogun State	Private	2021	Affiliate
34	Mountain Top University, Ogun State	Private	2016	Affiliate
35	Olabisi Onabanjo University, Ogun State	State	2015	Affiliate
36	Olusegun Agagu Uni,versity of Science & Technology, Ondo State	State	2017	Affiliate
37	Osun State University, Osun State	State	2014	Affiliate
38	Precious Cornerstone University, Oyo State	Private	2018	Affiliate
39	Redeemers University, Osun State	Private	2016	Affiliate
40	Tai Solarin University of Education, Ogun State	State	2015	Affiliate
41	Trinity University, Lagos State	Private	2019	Affiliate
42	Wesley University, Ondo State	Private	2016	Affiliate

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43	Dominican University, Ibadan, Oyo State	Private	Not specified	Dormant Affiliate

Source: *Joint Universities Preliminary Examinations Board (2025)*

Theoretical Framework

This study is guided by two theories that offer complementary perspectives on students' academic performance within higher education systems, particularly in science-based disciplines. Human Capital Theory (HCT) posits that investing in education enhances an individual's skills, knowledge, and productivity, resulting in tangible outcomes such as improved grades, increased employability, and long-term economic benefits (Becker, 1975; Schultz, 1961; Psacharopoulos & Patrinos, 2018). At JUPEB-affiliated universities, students enter through pathways like UTME, NCE, or JUPEB, each reflecting different levels of prior preparation and accumulated human capital. HCT proposes that differences in chemistry performance arise from these variations, as more structured and intensive preparatory experiences improve cognitive readiness, discipline mastery, and academic adjustment for university-level studies. Critics argue that HCT underestimates social, institutional, and contextual factors that influence learning outcomes (Brown, Lauder, & Cheung, 2020; Marginson, 2019; Edeji, 2024), but its focus on measurable academic results makes it a useful framework for understanding how prior educational investments affect student achievement.

Astin's Input–Environment–Outcome (I-E-O) Model complements HCT by emphasising how student inputs and institutional environments interact to produce educational outcomes over time (Astin, 1993; Felder, 1993). Inputs include gender, prior academic preparation, motivation, and personal characteristics, while the environment encompasses teaching methods, laboratory facilities, class size, peer interaction, and institutional policies. In JUPEB-affiliated universities, this framework explains why students with similar entry preparation may perform differently due to variations in institutional resources, instructional quality, and pedagogical practices. The model also accounts for gendered learning experiences, illustrating how institutional contexts can either amplify or minimise disparities in chemistry performance (Waziri, 2020). Although criticised for being largely descriptive and limited in predictive strength (Pascarella & Terenzini, 2005), the I-E-O model provides a systematic and integrative approach for examining how gender and institutional contexts jointly influence students' CGPA and overall academic success.

Gender Differences in Students' Academic Performance in Chemistry Subjects

Empirical studies have shown that gender alone is an inconsistent predictor of academic performance in chemistry across secondary and tertiary education contexts. Okorie and Ezeh (2016) found that females slightly outperformed males in chemical bonding, but the difference was statistically insignificant, echoing earlier findings by Inyang and Jegede (1994) and Adesoji and Babatunde (2009). Similarly, Ssempala (2009) reported comparable practical skills across genders, suggesting that improved laboratory access reduces performance gaps. Conversely, some studies indicate male advantages in problem-solving and concept application (Oladejo et al., 2023; Olubunmi, 2017; Ifeakor, 2005), while others demonstrate female superiority in chemistry and general science aptitude (Ahiakwo, 1988; Ariyo & Ugodulunwa, 2007). A meta-analysis by Eya and Ezeh (2020) revealed that gender explained only 3.8% of the variation in performance, implying minimal and context-dependent effects.

Dike et al. (2018) and Tambaya et al. (2016) observed no significant gender differences in tertiary chemistry, attributing parity to inclusive teaching strategies, cooperative learning, and equitable access to instructional resources, aligning with Adesoji and Olatunbosun (2008). Iyiola and Ezeh (2024) highlighted that gender effects are mediated by students' attitudes, motivation, and learning dispositions, consistent with Ajzen's Theory of Planned Behaviour. Studies across Africa reinforce these trends: Ssempala (2004) in Uganda and Tiimub et al. (2021) reported negligible gender gaps when laboratory exposure and instructional quality are equal. Contextual and pedagogical factors influence observed differences; teacher-centred or under-resourced environments tend to favour males (Eze, 2008; Ifeakor, 2005), whereas interactive, student-centred approaches enable females to match or surpass males (Okorie & Ezeh, 2016; Ahiakwo, 1988; Ariyo & Ugodulunwa, 2007). Cognitive versus affective domains further explain variations, as males often excel in spatial-visual tasks while females demonstrate strengths in verbal-conceptual reasoning and collaborative learning (Ahiakwo, 1988; Ifeakor, 2005).

Institutional Factors, Gender Differences, and Academic Performance in Chemistry Subjects

Studies consistently show that institutional context significantly influences gender differences in chemistry performance across educational levels and learning environments. Dike et al. (2018) and Tambaya et al. (2016)

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examined tertiary institutions, while Okorie and Ezeh (2016) and Eya and Ezeh (2020) focused on secondary schools. At the tertiary level, where students select into chemistry voluntarily, gender gaps tend to narrow as females often demonstrate higher intrinsic motivation, academic resilience, and sustained interest in science disciplines. Conversely, secondary school enrolment reflects broader societal expectations and entrenched gender stereotypes, which may negatively affect engagement, self-efficacy, and confidence, particularly among female students (Eya & Ezeh, 2020).

Interaction effects involving school location were also examined. Okorie and Ezeh (2016) found that urban students outperformed their rural counterparts regardless of gender, suggesting that access to quality resources, experienced teachers, and well-equipped laboratories has a stronger influence on achievement than biological sex, consistent with Adesoji and Olatunbosun (2008). These findings underscore the importance of infrastructural and environmental variables in shaping learning outcomes. Methodologically, quasi-experimental and ex post facto designs dominate this body of literature. Okorie and Ezeh (2016) used treatment and control groups, while Dike et al. (2018) and Tambaya et al. (2016) analyzed large-scale examination results. Eya and Ezeh (2020) synthesized decades of empirical studies using meta-analytic techniques, thereby increasing the robustness and generalizability of their conclusions.

Historical analyses (Inyang & Jegede, 1994; Erinosho, 1994; Ahiakwo, 1988) trace a gradual shift from socialisation-based gender disparities toward contemporary parity, supported by gender-sensitive pedagogy, increased female participation in science, and the presence of role models. Teaching methods further interact with gender; Eze (2008) demonstrated that structured questioning tends to benefit male students, whereas open-ended and inquiry-based approaches often favour females, reinforcing the findings of Adesoji and Babatunde (2008) on the effectiveness of interactive, context-based instruction.

Overall, empirical evidence suggests that gender differences in chemistry performance are minimal, increasingly context-dependent, and diminishing over time. Nevertheless, sustained emphasis on inclusive teaching practices, equitable resource distribution, and supportive institutional policies remains essential for promoting gender-balanced academic achievement (Okorie & Ezeh, 2016; Dike et al., 2018; Tambaya et al., 2016; Iyiola & Ezeh, 2024; Eya & Ezeh, 2020).

Methodology

This study employed an ex post facto research design, which is suitable for investigating events that have already occurred without manipulating variables (Nworgu, 2015). It focused on existing records of chemistry graduates' academic performance at JUPEB-affiliated universities in South-West Nigeria. The population comprised all graduates from 43 affiliated universities, with six purposively selected to represent federal, state, and private ownership types as follows:

Table 2: Selected JUPEB-Affiliated Universities in South-West Nigeria

S/N	University Name	Ownership	Date Joined
1.	University of Lagos	Federal	2014 (Partner)
2.	Federal University of Agriculture, Abeokuta (FUNAAB)	Federal	2014 (Partner)
3.	Osun State University, Osun State	State	2014 (Affiliate)
4.	Olabisi Onabanjo University, Ogun State	State	2015 (Affiliate)
5.	Lead City University, Oyo State	Private	2014 (Affiliate)
6.	Bowen University, Iwo, Osun State	Private	2014 (Affiliate)

Source: *Joint Universities Preliminary Examinations Board (2025)*

All graduates from these universities between 2018/2019 and 2023/2024 formed the accessible sample. Data were collected using a structured Departmental Data Collection Form (DDCF) that captured gender, university type, teacher–student ratio, and CGPA. Validity was ensured through standardized institutional records, and reliability was enhanced by cumulative, verifiable academic outcomes. Descriptive statistics, including the mean and standard deviation, were used to address the research questions, and Chi-square tests were employed to test Null Hypothesis 1. One-way ANOVA was used for Hypotheses 2 and 3, while Hypothesis 4 was examined using Ordinal Logistic Regression at a 0.05 significance level in SPSS.

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Results

Table 3: Presentation of Participants' Demographics

Variable	Category	Frequency (n)	Percentage (%)
University Type	Federal	349	52.5
	State	216	32.5
	Private	100	15.0
Gender	Male	300	45.1
	Female	365	54.9

Table 3 displays the demographic distribution of chemistry graduates by university type and gender. Federal universities produced the majority of graduates (52.5%), followed by State (32.5%) and Private institutions (15.0%), highlighting the predominance of Federal universities in chemistry education. The gender distribution shows a slight female majority (54.9%) over males (45.1%), indicating balanced participation with a marginal edge for female graduates in the sampled JUPEB-affiliated universities.

Answering Research Questions

Research Question One: What is the influence of gender on chemistry graduates' academic performance in JUPEB Affiliated Universities in Southwest Nigeria?

Table 4: Gender Influence on Academic Performance

Gender	Class of Degree / Performance	Frequency (n)	Percentage (%)	Mean (M)	Std. Deviation (SD)
Male	Pass	13	4.2	3.64	1.094
	Third Class	29	9.5		
	Second Class Lower	93	30.4		
	Second Class Upper	92	30.1		
	First Class	79	25.8		
Female	Pass	23	6.4	3.70	1.194
	Third Class	36	10.0		
	Second Class Lower	78	21.7		
	Second Class Upper	109	30.4		
	First Class	113	31.5		

Table 4 presents the distribution of chemistry graduates' academic performance by gender. Male graduates (n=306) had a mean CGPA of 3.64 (SD=1.094), while female graduates (n=359) had a slightly higher mean of 3.70 (SD=1.194). Among males, the largest proportions were in the Second Class Lower (30.4%) and Second Class Upper (30.1%) categories, with 25.8% achieving First Class. For females, the majority were in the Second Class Upper (30.4%) and First Class (31.5%) categories. These findings indicate that female graduates slightly outperformed male graduates, particularly at higher degree classifications. Although the differences are not substantial, the data suggest a modest positive influence of gender on academic performance, with female students tending to attain higher CGPAs in JUPEB-affiliated universities in Southwest Nigeria.

Research Question Two: What is the effect of the teacher–student ratio as an institutional factor on academic performance in chemistry?

Table 5: Descriptive Statistics of Academic Performance by Teacher–Student Ratio

Teacher–Student Ratio	N	Mean (M)	Std. Deviation (SD)
Low	90	3.62	1.045
Moderate	269	3.67	1.145
High	306	3.69	1.183

Table 5 indicates that academic performance slightly improves as the teacher–student ratio increases from low (M = 3.62, SD = 1.045) to moderate (M = 3.67, SD = 1.145) and high (M = 3.69, SD = 1.183). This implies that students in classes with more favourable teacher–student ratios tend to achieve marginally higher CGPAs, reflecting a positive influence of institutional support on performance. However, the differences in means are slight, suggesting that although the teacher–student ratio affects academic outcomes, its impact may not be substantial without further inferential analysis.

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Research Question Three: What is the influence of university type on chemistry graduates' academic performance?

Table 6: Descriptive Statistics of Academic Performance by University Type

University Type	N	Mean (M)	Std. Deviation (SD)
Private	**96**	**3.63**	**1.216**
State	**223**	**3.73**	**1.040**
Federal	**346**	**3.65**	**1.197**

Table 6 indicates that chemistry graduates from State universities had the highest average academic performance (M = 3.73, SD = 1.040), followed by graduates from Federal universities (M = 3.65, SD = 1.197), while those from Private universities showed the lowest average (M = 3.63, SD = 1.216). This implies that the type of university might have a modest effect on graduates' academic performance, with State institutions slightly ahead of Federal and Private universities. However, the differences are quite small, suggesting that other factors such as gender and teacher–student ratio may also influence variation in performance.

Research Hypotheses

Ho_1: Gender does not significantly influence the academic performance of chemistry graduates in JUPEB-affiliated Nigerian universities.

Table 7: Chi-square Test of Association Between Gender and Academic Performance of Chemistry Graduates

Variable	χ^2	df	P	Phi / Cramer's V	N
Gender × Academic Performance	8.13	4	.087	.111	665

Note: χ^2 = Pearson Chi-square; df = degrees of freedom; p = significance level; Phi / Cramer's V indicates effect size.

Table 7 presents the Chi-square test results, which indicate that gender does not have a statistically significant impact on the academic performance of chemistry graduates, $\chi^2(4, N = 665) = 8.13$, $p = .087$. The p-value exceeds the 0.05 significance level, and the effect size is small (Cramer's V = .111), suggesting a minimal association. Consequently, the null hypothesis (Ho_1) is retained, demonstrating that male and female graduates perform similarly in JUPEB-affiliated universities in Southwest Nigeria.

Ho_2: Teacher–student ratio, as an institutional factor, does not significantly influence the academic performance of chemistry graduates in JUPEB-affiliated Nigerian universities.

Table 8: One-Way ANOVA showing the influence of the teacher-student ratio on the Academic Performance of Chemistry Graduates

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.356	2	.178	.134	.874
Within Groups	875.834	662	1.323		
Total	876.189	664			

Dependent Variable: Academic Performance

The one-way ANOVA results in Table 8 show that the teacher–student ratio does not have a significant impact on the academic performance of chemistry graduates. The F-value is 0.134 with a p-value of 0.874, which is well above the typical significance level of 0.05. This indicates there is no statistically significant difference in mean academic performance among the Low, Moderate, and High teacher–student ratio groups. As a result, the null hypothesis (Ho2) is retained, implying that the teacher–student ratio, as assessed in this study, does not significantly affect academic performance.

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Ho_3: University type (federal, state, and private) does not significantly influence the academic performance of chemistry graduates in JUPEB-affiliated Nigerian universities.

Table 9: One-Way ANOVA showing the influence of University Type on the Academic Performance of Chemistry Graduates

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.994	2	.497	.376	.687
Within Groups	875.195	662	1.322		
Total	876.189	664			

Dependent Variable: Academic Performance

The influence of university type on the academic performance of chemistry graduates in JUPEB-affiliated Nigerian universities was examined using a one-way ANOVA, as shown in Table 9. The analysis produced an F-value of 0.376 and a corresponding p-value of 0.687. Since the p-value is greater than 0.05, the result is not statistically significant, indicating that differences in academic performance among Federal, State, and Private universities are minimal. Therefore, the null hypothesis (Ho3) is maintained, suggesting that university type does not have a significant effect on the Cumulative Grade Point Average of chemistry graduates in the selected institutions.

Ho_4: Gender and institutional factors (teacher–student ratio and university type) do not jointly have a significant effect on the academic performance of chemistry graduates in JUPEB-affiliated Nigerian universities.

Table 10: Model Fitting Information for Ordinal Logistic Regression Predicting Academic Performance

Model	-2 Log Likelihood	χ^2	df	p
Intercept Only	214.124	—	—	—
Final	209.927	4.197	5	.521

Note: *χ^2 tests whether the final model with predictors fits significantly better than the intercept-only model.*

Table 10 indicates that the final ordinal logistic regression model, which includes Gender, University Type, and Teacher–Student Ratio, does not fit significantly better than the intercept-only model ($\chi^2 = 4.197$, df = 5, p = .521). This suggests that the combined predictors do not significantly account for variation in chemistry graduates' academic performance, implying the model does not enhance prediction beyond chance.

Table 11: Goodness-of-Fit for the Ordinal Logistic Regression Model

Test	χ^2	Df	p
Pearson	38.357	47	.811
Deviance	40.616	47	.733

Note: *Non-significant values indicate good model fit.*

Table 11) shows non-significant Pearson ($\chi^2 = 38.357$, p = .811) and Deviance ($\chi^2 = 40.616$, p = .733) values, indicating that the model adequately fits the observed data. There is no evidence of lack of fit, which means that although the model does not significantly predict academic performance, the assumptions of ordinal logistic regression are satisfied.

Table 12: Parameter Estimates for Predictors of Academic Performance

Predictor	Estimate	Std. Error	Wald	df	p	95% CI Lower	95% CI Upper
Gender (Male)	-.174	.140	1.535	1	.215	-.448	.101
University Type (Federal)	.003	.212	.000	1	.990	-.413	.418
University Type (State)	.270	.214	1.591	1	.207	-.149	.688

Cite this article as:
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Predictor	Estimate	Std. Error	Wald	df	p	95% CI Lower	95% CI Upper
Teacher–Student Ratio (Low)	-.452	.292	2.394	1	.122	-1.025	.121
Teacher–Student Ratio (Moderate)	-.190	.175	1.182	1	.277	-.534	.153

Note: *Reference categories are gender = Female, University Type = Private, teacher–student Ratio = High.*

Table 12 shows that none of the individual predictors significantly influence academic performance: Gender (Male) p = .215, University Type (Federal) p = .990, University Type (State) p = .207, Teacher–Student Ratio (Low) p = .122, Teacher–Student Ratio (Moderate) p = .277. All confidence intervals include zero, confirming non-significance. Therefore, both individually and collectively, these factors do not predict academic performance. Based on the model fitting, goodness-of-fit, and parameter estimates, the null hypothesis that gender and institutional factors (teacher–student ratio and university type) do not jointly impact academic performance is upheld. Consequently, the effects of the predictors, whether combined or individual, are not statistically significant.

Discussion

The findings of this study indicate that gender does not significantly influence chemistry graduates' academic performance, suggesting equality between male and female students. This aligns with previous research (Okorie & Ezeh, 2016; Tambaya et al., 2016; Dike et al., 2018), which consistently reports little to no gender effects in higher education chemistry courses. The small gender differences observed in this and other African settings (Ssempala, 2004; Tiimub et al., 2021) suggest that fair access to laboratory resources and inclusive teaching methods are essential for reducing disparities traditionally linked to gender.

Institutional factors, including teacher–student ratio and university type, were similarly found to exert limited influence on academic outcomes. While earlier literature posits that smaller classes and well-resourced institutions enhance performance (Eze, 2008; Ifeakor, 2005), the findings here imply that the structured, standardised framework of JUPEB programs levels potential advantages or disadvantages. The centralised curriculum, continuous assessment, and laboratory exposure appear to provide a consistent educational environment, reducing the variability typically attributed to institutional context.

The combined analysis of gender and institutional factors also indicates limited interactive effects, implying that neither demographic traits nor organisational frameworks substantially influence outcomes when students go through comparable preparatory experiences. This aligns with Astin's Input–Environment–Outcome model, which suggests that the relationship between student inputs and the institutional environment determines outcomes, but strong, consistent preparation can offset traditional differences. In JUPEB, variations in university resources or classroom dynamics are less significant because students undergo standardised instruction and assessments.

Compared to the past, historical research shows that gender gaps and institutional inequalities used to be more noticeable. Early studies highlighted male advantages in problem-solving, laboratory skills, and spatial-visual tasks (Ahiakwo, 1988; Ifeakor, 2005), while female students excelled in verbal and conceptual reasoning. Current evidence, including this study, suggests that these differences have decreased, mainly thanks to teaching innovations, equal access to laboratories, and active efforts to involve female students in science subjects. Likewise, previous findings on institutional effects show mixed results, with resource disparities historically favouring certain types of universities. This study indicates that these effects are significantly reduced within structured preparatory programmes like JUPEB.

Conclusion

Based on the results of this study, it is concluded that high-quality preparation reduces the impact of both gender and institutional variability on chemistry performance. The findings support the idea that fair access to curriculum, laboratory facilities, and assessment practices can lead to similar outcomes across different student groups, emphasising the value of preparatory programmes in fostering academic equality. This aligns with both Human Capital Theory and the I-E-O model, indicating that investment in structured learning and the quality of the educational environment can outweigh demographic and institutional differences in determining academic success.

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Recommendations

Given the findings of the study, the following recommendations were made:

1. Improve Fair Access to Resources Across Institutions: Although JUPEB offers standardised preparation, disparities in laboratory facilities, instructional materials, and learning technologies across universities may persist. Ensuring all affiliated institutions uphold consistent quality and access will further diminish any hidden performance gaps and promote academic parity among chemistry graduates.
2. Promote Inclusive Pedagogical Practices: Faculty development programmes should continue to emphasise student-centred, interactive teaching strategies that cater to diverse learning styles and gender dynamics. Encouraging collaborative laboratory work and problem-solving activities can maintain parity and enhance overall chemistry proficiency.
3. Expand Monitoring and Evaluation of Program Outcomes: Develop a systematic framework to assess student performance over time across entry pathways, universities, and class sizes. Ongoing feedback and data-informed adjustments will help uphold high standards, identify subtle gaps, and optimize the effectiveness of JUPEB preparatory programs in improving academic success.

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