DOI: https://doi.org/10.67203/jossme.2026.jrufrfb7

Journal of Studies in Science and Mathematics Education

ISSN: 2630-662x

Published: 20.11.2026

Volume (issue): 6(2)

Page: 348 – 360

Achievement Motivation and Locus of Control as Predictors of Secondary School Students' Academic Achievement in Chemistry

Bukar Alhaji Umate[1]*, Sa'adu Ibrahim[2]

[1]Department of Physical Sciences Education, Modibbo Adama University, Yola

[2]School of Science Education, Federal College of Education (Technical), Gombe, Nigeria

***Corresponding author:** bukaralhajiumate@gmail.com

Abstract

In this study, the predictive ability of Achievement motivation and locus of control on the science students' academic achievement in chemistry was explored. The study was carried out in Nsukka Local Government Area, Enugu State, Nigeria. Five research questions and five hypotheses tested at 0.05 level of significance guided the study. A correlational research design with a sample of 350 SSI students drawn using a multi-stage sampling procedure. The instruments for data collection were validated Chemistry Students' Achievement Motivation Scale (CSAMS), Chemistry Students' Locus of Control Scale (CSLOCS), and the Chemistry Achievement Test (CAT). The reliability coefficients of the instruments were 0.88, 0.78, and 0.72, respectively. Data analysis was carried out using Regression analysis, regression t-test, ANOVA and Hayes PROCESS Macro. The findings revealed that achievement motivation and locus of control had individual and joint significant positive predictive power on students' academic achievement in Chemistry. The moderating influence of gender on the predictive powers of achievement motivation and locus of control on students' academic achievement was not significant. The study recommends among others that educational stakeholders should integrate motivational and psychological support strategies into Chemistry teaching and learning to enhance students' achievement motivation and internal locus of control, thereby improving students' academic achievement.

Keywords: achievement motivation, locus of control, academic achievement, chemistry, gender, Hayes process macro

1 Introduction

Chemistry is a branch of science that deals with the composition, structure, properties, and transformations of matter. Chemistry education integrates theoretical instruction with practical laboratory experiences to develop students' understanding of chemical principles, experimental techniques, and the application of chemistry to everyday life and societal challenges (Ibrahim et al., 2025). The subject contributes significantly to scientific and technological advancement by supporting innovations in healthcare, agriculture, industrial production, energy, and environmental sustainability (Chi et al., 2024; Umate et al., 2025). Furthermore, chemistry education equips individuals with scientific awareness, logical thinking, and ability to proffer solutions to emerging problems (Taber, 2019). In the Nigerian educational system, Chemistry is one of the core science subjects at the senior secondary school level and is a prerequisite for admission into several science- and technology-related programmes, including medicine, pharmacy, engineering, agriculture, and environmental sciences (Federal Republic of Nigeria [FRN], 2014).

Despite its recognized importance, students' academic achievement in chemistry especially in developing countries such as Nigeria remain relatively poor. The WAEC Chief Examiners' reports from 2017 to 2024 reveal that senior secondary school students' performance in Chemistry has fluctuated continuously and remained consistently low, with credit pass rates (A1–C6) failing to cross the 50% threshold until 2024. Starting from a baseline of 41.00% in 2017, performance rose slightly to 49.73% in 2018 before dropping back to 45.67% in 2019 and further to 43.50% in 2020 amid widespread learning disruptions. Although 2021 saw a temporary rebound to 46.83%, the pass rate plummeted to a period-low of 36.00% in 2022. Despite a partial recovery to 43.70% in 2023, credit-level attainment only reached 50.00% in 2024, highlighting a persistent shortfall in chemistry achievement over the eight-year span.

This underachievement has remained a serious concern among educational stakeholders. Numerous studies have consistently identified various factors that influence students' academic achievement in chemistry. These factors include student-related variables such as attitude toward chemistry, prior knowledge, cognitive reasoning ability, problem-solving skills, motivation, self-efficacy, metacognitive skills, study habits, and academic engagement, as well as teacher- and school-related variables including teacher competence, instructional methods, classroom practices, learning resources,

classroom environment, curriculum relevance, and family background (Sibomana et al., 2021; Zhang et al., 2021; Musengimana et al., 2021; Umate et al., 2024; Chestnut & Johnson, 2025; Omwirhiren & Sa'idu, 2026). Despite these findings, students continue to perceive chemistry as a difficult and abstract subject, a perception that adversely affects their academic achievement (Umate et al., 2025). This suggests that additional learner-related constructs, such as achievement motivation, warrant further investigation to determine its contribution to students' academic achievement especially in chemistry.

Achievement motivation refers to the inner drive that reflects a learner's willingness to set meaningful goals, overcome obstacles, and continuously improve academic achievement. Elliot and Hulleman (2017) explained achievement motivation as the psychological processes that direct individuals toward developing competence and attaining success in achievement-related activities. Similarly, Schunk (2023) views achievement motivation as a tool that initiates, directs, and sustains students' effort, persistence, and self-regulated learning in the pursuit of academic goals. In the same vein, Eccles and Wigfield (2024) argued that students are motivated to achieve when they believe they can succeed and perceive learning tasks as valuable and worthwhile. These perspectives suggest that achievement motivation is an essential psychological construct that may influence students' academic achievement. Empirical studies conducted outside Nigeria generally reveal that achievement motivation is an important predictor of students' academic performance. Studies conducted in Kenya and India have consistently reported that achievement motivation positively influenced students' academic achievement, although the strength of the relationship varied according to demographic characteristics such as gender and parental socioeconomic status (Karari et al., 2022; Kumar & Sangeetha, 2019). Likewise, Chebrolu (2024) observed that female students demonstrated higher levels of achievement motivation than their male counterparts in a post-COVID-19 comparative study, suggesting that demographic factors may influence students' motivation and, consequently, their academic achievement.

Within Nigeria, findings on the association between achievement motivation and academic performance are generally positive but not entirely consistent. Several studies reported that achievement motivation significantly predicted or positively influenced students' academic performance across different educational levels and subject areas (Erhuvwu & Adeyemi, 2019; Oribhabor, 2022; Sani & Inuwa, 2025). Similarly, Mas'ud et al. (2026) observed significant gender differences in achievement motivation and academic performance among senior secondary school students. However, Attahiru et al. (2026) reported that achievement motivation neither significantly correlated with nor predicted students' academic performance. Overall, these findings demonstrate that although achievement motivation is an important determinant of students' academic achievement, the inconsistent evidence indicates that it may not operate in isolation. Consequently, there is a need to examine achievement motivation alongside other learner-related psychological variables, such as locus of control, to provide a more comprehensive explanation of students' academic achievement. Locus of control refers to an individuals' beliefs about the extent to which they can be influenced by internal or external force. Rotter (1966) originally conceptualized locus of control as the extent to which individuals feel that the consequences of their doings are dependent upon their own behaviour rather than external forces. Many scholars described it as a generalized expectancy or personality trait that reflects individuals' beliefs about whether life outcomes are determined by their own actions or by circumstances beyond their control (Nowicki et al., 2021; Nießen et al., 2022; Terry, 2022). Locus of control refers to individuals' beliefs about whether academic and life outcomes are as a result of their own efforts or by external factors. Some studies report that the predictive power of locus of control on students' academic performance does not depend on gender (Bilesanmi-Awoderu, 2002; Deora, 2015; Chalak & Nasri, 2015; Ossai & Amedu, 2023). This implies that the effects of locus of control on students are independent of their sex.

From the global context, several studies have reported inconsistent findings regarding the relationship between locus of control and academic achievement. Some studies found that locus of control significantly influenced students' academic achievement, (Mohamed et al., 2018). In contrast, other studies reported that locus of control had no significant relationship with or predictive influence on academic achievement among university students (Choudhury & Borooah, 2017; Merkine et al., 2019; Villa & Sebastian, 2021; Yadav, 2023). These conflicting findings suggest that the influence of locus of control on academic achievement may depend on factors such as educational level, discipline, and socio-cultural context. Additionally, empirical evidence from Nigerian studies also presents diverse findings concerning the prediction of students' academic achievement by locus of control. The studies reported that locus of control significantly influenced or predicted students' academic achievement across different subject areas, including Physics and Mathematics, and among senior secondary school students (Chinedu & Nwizuzu, 2021; Okeke & Ukoh, 2020; Ogar et al., 2024; Chukwuma et al., 2025). However, other studies found either a significant negative relationship or only weak predictive effects of locus of control on students' academic achievement (Christian-Ike & Okoli, 2021; Nwokolo & Nneka, 2025).

The review of the literature indicates that previous studies have examined achievement motivation (Karari et al., 2022; Senthil Kumar & Sangeetha, 2019; Erhuvwu & Adeyemi, 2019; Oribhabor, 2022; Sani & Inuwa, 2025; Attahiru et al., 2026) and locus of control (Chinedu & Nwizuzu, 2021; Christian-Ike & Okoli, 2021; Ogar et al., 2024; Bini & Idehen, 2023; Nwokolo & Nneka, 2025; Chukwuma et al., 2025). Most of these studies involved foreign samples whose findings are difficult to generalize to the present study. Furthermore, several existing studies focused on subjects other than chemistry, yielded contradictory results, or analyzed these constructs separately in relation to academic achievement. Additionally, few studies examined whether gender influences these relationships, as explored in this research. Crucially, there is limited empirical evidence regarding the joint influence of these variables (achievement motivation, locus of control) on students' academic achievement, particularly in chemistry. In this study, these research gaps were addressed by examining the predictive power of achievement motivation and locus of control on chemistry achievement among senior secondary school students in Nsukka Local Government Area of Enugu State, Nigeria

1.1 Objectives of the Study

The study sought to determine:

1. The predictive power of achievement motivation on the students' academic achievement in chemistry.
2. The moderating influence of gender on predictive power of achievement motivation on the students' academic achievement in chemistry.
3. The predictive power of locus of control on the students' academic achievement in chemistry
4. The moderating influence of gender on predictive power of locus of control on the students' academic achievement in chemistry
5. The Joint predictive power of achievement motivation and locus of control on the students' academic achievement in chemistry

1.2 Research Questions

The following research questions guided the study;

1. What is the predictive power of achievement motivation on the students' academic achievement in chemistry?
2. What is the moderating influence of gender on the predictive power of achievement motivation on the students' academic achievement in chemistry?
3. What is the predictive power of locus of control on the students' academic achievement in chemistry?
4. What is the moderating influence of gender on the predictive power of locus of control on the students' academic achievement in chemistry?
5. What is the Joint predictive validity of achievement motivation and locus of control on the students' academic achievement in chemistry?

1.3 Hypothesis

The null hypothesis was tested at 0.05 alpha level of significance.

H_{O1}: the predictive power of achievement motivation on the students' academic achievement in chemistry is not significant

H_{O2}: Gender does not moderate the predictive power of achievement motivation on the students' academic achievement in chemistry

H_{O3}: The predictive power of locus of control on the students' academic achievement in chemistry is not significant

H_{O4}: Gender does not moderate the predictive power of locus of control on the students' academic achievement in chemistry

H_{O5}: the Joint predictive power of achievement motivation and locus of control on the students' academic achievement in chemistry is not significant

2 Theoretical Framework

This study is grounded in two theories: Atkinson's Expectancy-Value Theory (1957) and Weiner's Attribution Theory (1974). Atkinson's Expectancy-Value Theory state that achievement motivation is determined by a person's expectation of success and the value placed on that success. It has three key tenets: motive (stable traits driving goal pursuit), expectation (perceived probability of achieving a goal), and incentive (the value assigned to goal attainment, positive or negative). This theory is used in this study because learners who expect success and value it is more likely to work hard and demonstrate high achievement motivation. Weiner's Attribution Theory concerned with how individuals interpret situations and how this influences thinking and behavior. The theory Postulate that individuals attribute causes to behavior through a three stages: observing the behavior, believing it was intentional, and determining whether it was situationally forced or internally driven. Its key dimensions are locus of control (internal vs. external), stability (whether causes change over time), and controllability (whether causes can be controlled). This theory is relevant because locus of control shapes attributions for academic success or failure, and individuals' beliefs about what controls their destiny influence their attitudes toward life events aligning with the core definition of attribution theory. Together, these theories explain how expectations, values, and causal attributions influence students' motivation and achievement-related behaviors.

3 Methods

A Correlational research design was employed in this study. A Correlational research design seeks to establish prediction of one or two variables by one or two variables (Nworgu, 2015). The population of the study comprised of 2626 (1240 Male, 1386 female) senior secondary school one (SS I) students in the 32 public schools of Nsukka LGA, Enugu State. (Post Primary School Management Board [ESPPSMB], 2025). The sample involved 350 (170 males, and 180 females). This is based on recommendation of Cohen et al. (2007) which state that for a population between 2500-3000, the minimum sample at 95 percent confidence interval and 5 percent margin of error is 333. AA multi-stage sampling procedure was employed. At first stage, simple random sampling technique was used to draw secondary schools that offer chemistry. At second stage, purposive sampling technique was used to select coeducational secondary schools on the basis that gender is a variable in this study. At third stage, simple random sampling technique was used to draw intact classes from the sampled coeducational schools and sampled intact classes were used for the study.

Chemistry students' Achievement Motivation Scale (CSAMS), Chemistry Students Locus of Control Scale (CSLOCS) and Chemistry Achievement Test (CAT) were used as measures in this study. The CSAMS and CSLOCS made up of 15 items each to measures students' achievement Motivation and locus of control respectively, using a 4- Points Likert Scale: Very often (VO) =4, Often (O) =3, Sometimes (S) =2, and Never (N) =1. The CAT consisted of 20 multiple choice items based on Kinetics theory of matter, Gas laws and Acids, Bases and Salts developed by the researchers. These measures were validated by a panel of four experts: two experts are from chemistry education unit, and one expert from measurement and evaluation unit, Department of Science Education, and one expert from Educational Psychology unit, Department of Educational Foundation, university of Nigeria, Nsukka.

To establish the internal consistency reliability of the instruments CSAMS, CSLOCS and the CAT were administered to 20 SS I students that are not part of the sample for the study. The internal consistency reliability indices of CSAMS and CSLOCS are 0.88 and 0.78 respectively determined using Cronbach alpha Method. The reliability index of the CAT was 0.72 which was determined using Kuder- Richardson formula (K-R20). The data collected for the study were analyzed using Regression Analysis and Hayes Process Macro version 5.x. Coefficient of determination was used to answer research questions Regression t-test, ANOVA and Hayes process were used to test hypotheses at 0.05 level of significance. The strength of the correlation coefficient was interpreted according to the thresholds outlined by Schober et al. (2018), where values of .10–.39, .40–.69, and .70–.89 indicate weak, moderate, and strong relationships, respectively .

4 Results

Research Question One: What is the predictive power of achievement motivation on the students' academic achievement in chemistry?

Table **1**

Regression analysis of the predictive validity of achievement motivation on the students' academic achievement in chemistry

Model	N	R	R Square	Adjusted R Square
1	350	.740[a]	.548	.547

Table 1 displays regression analysis showing the predictive power of achievement motivation for students' academic achievement in chemistry. It reveals an R value of 0.740 and an R square of 0.548, implying a strong and positive predictive power of achievement motivation on students' academic achievement in chemistry. The coefficient of determination (R^2) indicates that 58.8% of the variation in chemistry students' academic achievement is explained by their achievement motivation, while the remaining 42.2% is attributed to other factors not considered in this study.

Hypothesis one: the predictive power of achievement motivation on the students' academic achievement in chemistry is not significant

Table **2**

Regression t-test for the predictive power of achievement motivation on the students' academic achievement in chemistry

Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t-value**	**p-value**
	B	Std. Error	Beta		
(Constant)	17.411	1.720		10.125	<.001
Achievement Motivation	.872	.042	.740	20.544	<.001

Table 2 displays a regression t-test results for predictive power of achievement motivation for students' academic achievement in chemistry. It reveals a $t(350) = 20.544$ and an associated p-value $p < 0.001$. Because associated p-value is less than the chosen level of significance p-value ($\alpha = 0.05$), the null hypothesis is rejected. Therefore, the predictive power of achievement motivation for students' academic achievement in chemistry is significant.

Research Question Two: what is the moderating influence of gender on the predictive power of achievement motivation on the students' academic achievement in chemistry?

Table **3**

Regression Analysis for the moderating influence of gender on the predictive power of achievement motivation on the students' academic achievement in chemistry

Gender	**R**	**R Square**	**Adjusted R Square**
Male	.744[a]	.554	.551
Female	.736[a]	.542	.539

Table 3 displays the regression analysis of the moderating influence of gender on the predictive power of achievement motivation on the students' academic achievement in chemistry. For male students, the analysis reveals an R value of .744 and an R^2 value of .554, while for female students, the R value is .736 and the R^2 value is .542. This indicates a strong, positive predictive power of achievement motivation on academic achievement for both genders. Specifically, achievement motivation accounts for 54.4% and 54.2% of the variance in academic achievement for male and female students, respectively. Thus, the relationship between achievement motivation and academic performance is slightly stronger among male students than female students.

Hypothesis two: The predictive power of achievement motivation on the students' academic achievement in chemistry as moderated by gender is not significant.

Table **4**

Hayes Process of the moderating influence of gender on the predictive power of achievement motivation on the students' academic achievement

Predictor	B	SE	t-value	p-value
Constant	18.6237	5.4020	3.4476	.0006
Achievement Motivation	.8361	.1345	6.2157	0.001
Gender	-.8123	3.4520	-.2353	.8141
Achievement Motivation * Gender	.0241	.0853	.2828	.7775

Model Summary = $R^2 = 0.5248$, $F(3, 346) = 139.9481$, $p < 0.001$. ΔR^2 for interaction = 0.0001, $F(1, 346) = 0.080$, $p < 0.7775$

Table 4 displays the Hayes Process Macro for the moderating influence of gender on the predictive power of achievement motivation on students' academic achievement in chemistry. The overall model is significant $R^2 = 0.5248$, $F(3, 346) = 139.9481$, $p < 0.001$. the interaction effect of gender on the predictive powers of achievement motivation on the students' academic performance is not significant (β= -0.0241 SE =0.0853, t=0.2828, p> 0.7775). Therefore, the null hypothesis is not rejected. Hence, the inference drawn is that the moderating influence of gender on the predictive power of achievement motivation on the students' academic achievement is not significant.

Research Question Three: What is the predictive power of locus of control on the students' academic achievement in chemistry?

Table **5**

Regression analysis of the predictive power of locus of control on the students' academic achievement in chemistry

Model	N	R	R Square	Adjusted R Square
1	350	.673[a]	.453	.452

Table 5 displays regression analysis to show the predictive validity of locus of control on the students' academic achievement in chemistry. It reveals an R value of 0.673 and an R square of 0.453. This implies that there is a moderate and positive predictive power of locus of control on the students' academic achievement in chemistry. The coefficient of determination (R square) indicates that 45.3% of the variation in chemistry students' academic achievement is explained by their locus of control, while the remaining 54.7% could be attributed to other factors this study did not consider.

Hypothesis three: The predictive power of locus of control on the students' academic achievement in chemistry is not significant

Table **6**

Regression t-test for the predictive power of locus of control on the students' academic achievement in chemistry

Model		Unstandardized Coefficients		Standardized Coefficients	t-value	p-value
		B	Std. Error	Beta		
1	(Constant)	20.903	1.865		11.210	.001
	Locus of Control	.798	.047	.673	16.990	.001

Table 6 displays a regression t-test for the predictive power of locus of control on the students' academic achievement in chemistry. It reveals a t (1, 349) value of 16.990 and an associated p-value of 0.001. The associated p-value is less than the level of significance p-value (0.05). Therefore, the null hypothesis is not accepted. Hence, it can be concluded that the predictive power of locus of control on the students' academic achievement in chemistry is significant.

Research Question four: what is the moderating influence of gender on the predictive power of locus of control on the students' academic achievement in chemistry?

Table **7**

Regression Analysis for the moderating influence of gender on the predictive power of locus of control on the students' academic achievement in chemistry

Gender	R	R Square	Adjusted R Square
Male	.655[a]	.429	.425
Female	.694[a]	.482	.479

Table 7 displays a regression analysis of the predictive power of locus of control on the students' academic achievement in chemistry as moderated by gender. It reveals an R value of 0.659 and an R square value of 0.429 for male chemistry students and an R value of 0.694 and an R square value of 0.482 for female chemistry students. This implies a moderate and positive predictive power of locus of control on the academic achievement for male and female chemistry students. The results further reveal that 42.9% and 48.2% of the variation in the academic achievement of male and female chemistry students is accounted for by their locus of control. The predictive ability of the locus of control on the students' academic achievement in chemistry is slightly higher for female than male students.

Hypothesis four: Gender does not moderate the predictive power of locus of control on the students' academic achievement in chemistry

Table **8**

Hayes Process of the moderating influence of gender on the predictive power of locus of control on the students' academic achievement

Predictor	B	SE	t-value	p-value
Constant	21.9314	5.9408	3.6917	0.001
Locus of Control	-0.7021	-01490	4.7130	.0001
Gender	-0.7210	3.7299	-0.1933	.8468
Locos of Control * Gender	0.0648	0.0940	0.6899	0.4907

Model Summary = $R^2 = 0.4570$, $F(3, 346) = 97.0677$, $p < 0.001$. ΔR^2 for interaction = 0.0007, $F(1, 346) = 0.4760$, $p > 0.05$

Table 8 displays the Hayes Macro Process for the moderating influence of gender on the predictive power of locus of control on the students' academic achievement. The overall model is significant $R^2 = 0.4570$, $F(3, 346) = 97.0677$, $p > 0.05$. The interaction effect between gender and locus of control was not significant ($\beta = -0.0648$, SE =0.0940, t= 0.6899, $p > 0.05$). ΔR^2 for interaction = 0.0007, $F(1, 346) = 0.4760$, $p > 0.05$. The predictive power of locus of control on students' academic achievement in chemistry is not significant. Therefore, the null hypothesis is not rejected. Hence, the inference drawn is that the moderating influence of gender on the predictive power of locus of control on the students' academic achievement in chemistry is not significant.

Research Question five: What is the Joint predictive power of achievement motivation and locus of control on the students' academic achievement in chemistry?

Table **9**

Joint and Individual Predictive power of Achievement Motivation and Locus of Control on Academic Performance in Chemistry

Predictor Variable	Unstandardized Coefficients (B)	Multiple Correlation (R)	Coefficient of Determination (R^2)	Standardized Coefficients (β)
Joint Predictors		0.977	0.954	
Achievement Motivation	0.834	-	-	0.708
Locus of Control	0.756	-	-	0.638

Table 9 presents the Joint predictive power of achievement motivation and locus of control on the students' academic achievement in chemistry. The table yielded a multiple correlation coefficient of 0.977 and a coefficient of determination (R^2) of 0.954. This indicates a strong and positive joint predictive power of achievement motivation and locus of control on the students' academic achievement in chemistry. The table also indicate that 95.4% of the total variation in students' academic performance in chemistry is jointly accounted for by achievement motivation and locus of control. In terms of individual contributions, achievement motivation (B = 0.708, β = 0.834) proved to be the stronger predictor of chemistry performance compared to locus of control (B = 0.638, β = 0.756). Both predictors contributed significantly and positively to academic achievement in chemistry

Hypothesis five: The Joint predictive powers of achievement motivation and locus of control on the students' academic achievement in chemistry is not significant.

Table **10**

Regression ANOVA of the joint predictive powers of achievement motivation and locus of control on the students' academic achievement in chemistry

Model	Sum of Squares	Df	Mean Square	F	p-value
Regression	84205.330	2	42102.665	3566.685	<.001[b]
Residual	4096.136	347	11.804		
Total	88301.466	349			

a. Dependent Variable: Academic Achievement

b. Predictors: (Constant), Locus of Control, Achievement Motivation

The result in Table 8 shows that F (2, 347) = 42.985, p = 0.001 < 0.05 for the Joint predictive power of achievement motivation and locus of control on the students' academic achievement in chemistry. The associated p-value is less than the level of significance p-value (0.05). Therefore, the null hypothesis is rejected. Hence, the inference drawn is that the joint predictive power of achievement motivation and locus of control on the students' academic achievement in chemistry is significant

5 Discussions

The study found a strong, positive, and significant predictive power of achievement motivation on students' academic achievement in Chemistry. This implies that students with higher achievement motivation are more likely to perform better academically. This may be because students with high achievement motivation will be energetic to participate in learning activities. This in turn, deepen their conceptual understanding thereby lead to improve in their academic achievement. The finding agrees with Karari et al. (2022), Kumar and Sangeetha (2019), Chebrolu (2024), Erhuvwu and Adeyemi (2019), Oribhabor (2022), and Sani and Inuwa (2025), who reported that achievement motivation significantly enhances students' academic performance. However, the finding contradicts Attahiru et al. (2026), who found no significant relationship between achievement motivation and academic performance. The difference may be attributed to variations in study location and sample characteristics. The study further found that gender did not significantly moderate the predictive power of achievement motivation on students' academic achievement. This indicates that achievement motivation predicts academic performance consistently across genders. The finding is consistent with Parker et al. (2020), who reported the structural relationship between achievement motivation and academic success remains invariant. However, it disagrees with Chebrolu (2024), who found higher achievement motivation among female students. The disparity may be due to differences in socio-cultural and educational settings.

The study also revealed a moderate, positive, and significant predictive power of locus of control on students' academic achievement in Chemistry. This indicates that students with a stronger locus of control are more likely to achieve better academic outcomes. The finding agrees with Mohamed et al. (2018), Okeke and Ukoh (2020), Chinedu and Nwizuzu (2021), Ogar et al. (2024), and Chukwuma et al. (2025), who reported significant positive relationships between locus of control and academic performance. However, it contradicts Choudhury and Borooah (2017), Merkine et al. (2019), Villa and Sebastian (2021), Yadav (2023), Christian-Ike and Okoli (2021), and Nwokolo and Nneka (2025), who found weak or insignificant relationships. These differences may be due to the variations of locations and educational level of the students.

The finding further showed that gender does not moderates the predictive power of locus of control on students' academic achievement. This implies that gender influences on the predictive power of locus of control on academic performance have the same effect for both male and female students. The finding supports the studies of Bilesanmi-Awoderu (2002), Deora, (2015). Chalak, and Nasri, (2015), Ossai and Amedu,(2023). Finally, the study found that achievement motivation and locus of control jointly had a moderate, positive, and significant predictive validity on students' academic achievement in Chemistry. This indicates that the combined influence of these psychological variables provides a stronger explanation of academic achievement than either variable alone. Both predictors contributed significantly and positively to academic achievement in chemistry. This finding emphasizes the importance of considering multiple psychological factors in explaining students' academic achievement.

6 Conclusion

The study concluded that achievement motivation and locus of control are significant psychological factors influencing students' academic achievement in Chemistry. Individually, achievement motivation and locus of control demonstrated strong and moderate positive predictive powers, respectively, while gender showed no moderating effect. Furthermore, their joint influence significantly predicted performance, indicating that students with higher motivation and an internal locus of control achieve better academic outcomes. Consequently, enhancing achievement motivation and fostering an internal locus of control represent essential strategies for improving Chemistry performance among senior secondary school students.

7 Recommendations

Based on the findings of the study, the following recommendations are appropriate:

1. Chemistry teachers, school counselors, and parents should implement strategies that enhance students' achievement motivation through regular encouragement, goal setting, recognition of academic excellence, and the use of engaging instructional methods.
2. School administrators and educators should deploy universal, gender-neutral motivational programs to boost academic performance.
3. Teachers and guidance counselors should help students develop an internal locus of control by encouraging self-discipline, personal responsibility, problem-solving skills, and confidence in their ability to influence their academic achievement.
4. School administrators and educators should implement universal, gender-neutral interventions aimed at strengthening students' internal locus of control.
5. Educational stakeholders, including curriculum planners, school administrators, and teachers, should integrate motivational and psychological support strategies into Chemistry teaching and learning to simultaneously enhance students' achievement motivation and internal locus of control for improved academic achievement.

8 Limitation of the Study

1. The Chemistry Achievement Test (CAT) used in this study 20 multiple-choice items covering a limited portion of the chemistry curriculum. A 20-item multiple-choice test may not fully capture a student's comprehensive mastery or practical laboratory capabilities in chemistry.
2. The study employed a correlational research design. While this design can establish associations and predictive power, it does not establish cause-and-effect. A high score in achievement motivation or locus of control correlates with better chemistry grades, but it cannot definitively prove that one *causes* the other.
3. The sampling technique involved purposive sampling to select co-educational secondary schools because gender was a moderating variable. This excludes single-sex schools (all-boys or all-girls schools), which might exhibit different behavioral, motivational, or gender-related academic dynamics.

4. Simple random sampling was used to draw intact classes. Using pre-existing classes rather than completely randomized individual student sampling can introduce classroom-level confounding variables (such as specific teacher qualities or classroom environment dynamics) that affect achievement scores. This might have affected the results of this study

9 Declarations

Ethical Considerations: This study was conducted in compliance with the ethical principles outlined in the Declaration of Helsinki. All participants provided informed consent after being fully briefed on the study's objectives, procedures, and the voluntary nature of their participation. To protect participant privacy and confidentiality, all identifying information was removed, and data were anonymized prior to analysis and stored in a secure location. The authors declare no conflicts of interest, financial or otherwise, that could have influenced the outcomes or interpretation of this work. Furthermore, the artificial intelligence tools Gemini and DeepSeek were used solely for language refinement and proofreading, with all scientific content, analysis, and conclusions generated and verified independently by the authors.

Funding Status: No funding was secured for this study

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