



Self-Esteem as a Predictor of Chemistry Performance among Secondary School Students in Kaduna State, Nigeria: The Moderating Role of Gender

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Abstract

Chemistry is central to scientific and technological development, yet students' performance in the subject remains a concern in Nigerian secondary schools. This study examined whether self-esteem predicts chemistry performance and whether gender moderates this relationship among Senior Secondary School II (SS II) Chemistry students in Giwa Educational Zone, Kaduna State, Nigeria. A correlational survey design was employed. From a population of 1,390 SS II Chemistry students in 14 public secondary schools, 346 students constituted the analytical sample following purposive and simple random sampling techniques. Data were collected using the Rosenberg Self-Esteem Scale and a researcher-adapted Chemistry Performance Test. The instruments were validated by experts. Reliability was .89 for the self-esteem scale and .86 for the Chemistry Performance Test based on test-retest method. Linear regression and moderation regression were conducted at $\alpha = .05$. Self-esteem significantly predicted chemistry performance, $B = 0.168$, $SE = 0.040$, $t(344) = 4.22$, $p < .001$, $R = .42$, $R^2 = .18$. Gender did not significantly predict performance, $B = 1.087$, $SE = 0.781$, $p = .165$, whereas the Self-Esteem $\times$ Gender interaction was significant, $B = -0.094$, $SE = 0.038$, $\beta = -.128$, $t = -2.47$, $p = .014$. The findings provide evidence of a statistically significant but modest moderation effect. Given the restricted sample and school-selection procedure, the findings should be regarded as context-specific evidence rather than definitive evidence of a general gender-contingent relationship.

Keywords: self-esteem, chemistry performance, gender, academic achievement, secondary school students, science education, moderation

1 Introduction

Science is recognized as a foundation for contemporary scientific and technological advancement because it provides the knowledge and skills required to understand and respond to developments in the natural and technological environment (Voulvoulis & Burgman, 2019). It is an organized body of knowledge derived from systematic observation of natural events and conditions for the purpose of discovering the laws and principles governing phenomena in the natural world (Poincaré, 2022). Science is also viewed as a complex human activity through which universal statements, including laws, theories and hypotheses, are developed to explain observable phenomena (Longino, 2020). In Nigeria, science education is expected to equip students with the knowledge and competencies necessary for effective participation in an increasingly scientific and technological society (Agboola, 2025). Science literacy is therefore considered essential to national development and can be promoted through effective science education (Osborne, 2023). Despite this importance, science education in Nigeria continues to experience challenges associated with inadequate funding, poor orientation and ineffective instructional practices (Marti & Muhammed, 2024). These challenges are reflected in students' learning outcomes across the major science subjects, including chemistry.

Chemistry occupies an important position in secondary school science because of its contribution to understanding the composition, properties and transformations of matter and its applications in several scientific and technological fields. Eilks et al. (2017) noted that chemistry is critical to understanding the natural world and addressing basic issues confronting society. The subject encompasses the study of atomic structure and behaviour, composition and structure of compounds, chemical reactions and associated energy changes, as well as the principles that integrate these phenomena into a coherent system (Kuhn et al., 2024). It also examines the changes that matter undergoes and the principles governing such changes. The relevance of chemistry extends to fields such as biochemistry, molecular biology, materials science and nanotechnology. Consequently, effective learning of chemistry at the secondary school level is important for students who

intend to pursue science-, technology-, engineering- and health-related careers. However, students' performance in chemistry at the senior secondary school level has remained a concern. Previous studies have reported unsatisfactory academic performance in chemistry (Guyah et al., 2022; Ikuejube, 2024; Umahaba et al., 2026), while reports of the West African Examinations Council have also documented persistent challenges in students' performance in chemistry examinations. The continued poor performance suggests that, in addition to instructional and curricular factors, students' psychological characteristics may play an important role in explaining variations in chemistry performance.

One psychological variable that has attracted considerable attention in educational research is self-esteem. Self-esteem refers to an individual's evaluation of personal worth, competence and capability and reflects how individuals perceive and feel about themselves (AlHarbi, 2022). It has also been conceptualized as a person's global judgement of competence and self-worth (Birni & Eryilmaz, 2024). Students' experiences of academic success and failure can influence their perceptions of competence and consequently affect their self-esteem (Acosta-Gonzaga, 2023). Within the school environment, students continually receive academic and social feedback from teachers and peers, and these experiences may shape their perceptions of their abilities. A student who perceives himself or herself as competent may be more willing to participate in learning activities, persist when confronted with difficult tasks and approach academic challenges with greater confidence. Thus, self-esteem may constitute an important psychological factor associated with academic performance. Evidence concerning the relationship between self-esteem and academic achievement, however, is not entirely consistent. Some studies have reported a positive association between self-esteem and academic achievement (Golizadeh et al., 2024; Ejide & MCA, 2025; Gidado et al., 2025), while Zhang et al. (2025) associated positive self-perceptions with higher academic achievement. Acosta-Gonzaga (2023) further observed that academic achievement is influenced not only by cognitive factors but also by emotional, motivational and social variables, including self-esteem. Famolu (2025) suggested that self-esteem and competence may have a dynamic relationship in which improvement in one is accompanied by improvement in the other. Similarly, Chen et al. (2023) found that students with higher self-esteem participated more enthusiastically in learning activities. These findings suggest that students' perceptions of their worth and competence may have implications for their academic engagement and achievement.

Nevertheless, the extent to which self-esteem contributes to academic performance remains debatable. Orth and Robins (2022), for example, reported a relationship between self-esteem and school performance and noted that longitudinal evidence did not provide strong support for the assumption that high self-esteem necessarily produces improved academic performance. This suggests that an observed association between self-esteem and achievement should not automatically be interpreted as evidence that self-esteem is a strong predictor of academic performance. Rather, empirical analysis is required to establish the extent to which variations in students' self-esteem explain variations in their academic performance. Regression analysis is particularly appropriate for this purpose because it allows the predictive contribution of self-esteem to students' performance to be estimated rather than merely establishing whether the two variables are associated. The predictive relationship between self-esteem and academic performance may also be influenced by students' gender. Gender has been described as a socially ascribed attribute that differentiates masculine and feminine characteristics and roles (Agut et al., 2023). Research on gender differences in chemistry achievement has produced inconsistent findings. Some studies have reported that male students achieved significantly higher than female students in chemistry (Oladejo et al., 2023; Obikezie et al., 2023; Tijani, 2025; Aliyu, 2024), whereas other findings have indicated better achievement among female students (Onyi et al., 2022). van Leest et al. (2024) similarly observed that research findings concerning the influence of gender on students' academic performance have been inconsistent. These conflicting findings suggest that gender may require consideration not merely as a variable associated with achievement but also as a potential condition under which psychological factors such as self-esteem influence academic outcomes.

In particular, the question of whether gender moderates the relationship between self-esteem and chemistry performance remains insufficiently examined. Students' perceptions of competence may develop within different social and educational experiences, and these experiences may influence how self-esteem translates into academic engagement and achievement. Thus, even when male and female students report comparable levels of self-esteem, the contribution of self-esteem to chemistry performance may not necessarily be identical. Yu et al. (2022), for example, reported that gender and location did not moderate the predictive validity of self-esteem on students' academic achievement in science. This finding provides an important basis for further investigation because evidence from one context cannot necessarily be generalized to chemistry students in another educational setting. Moreover, much of the existing research in chemistry education has concentrated on instructional methods, attitudes and instructional resources, with comparatively less attention given to psychological predictors and the conditions under which their effects may vary across student groups.

The persistent concern about students' chemistry performance, together with the inconsistent evidence concerning self-esteem, academic achievement and gender, therefore creates a need for further empirical investigation. In particular, there is a need to establish whether self-esteem significantly predicts chemistry performance and whether gender changes the strength of this predictive relationship among secondary school students in Kaduna State, Nigeria. Addressing this gap is important because identifying psychological factors that predict chemistry performance may provide teachers, school counsellors and educational administrators with evidence for developing interventions aimed at improving students' academic functioning. Furthermore, determining whether gender moderates the relationship would establish whether such interventions should be designed differently for male and female students or applied similarly across gender groups. Accordingly, this study examined self-esteem as a predictor of academic performance in chemistry among secondary school students in Kaduna State, Nigeria, and investigated the moderating role of gender in the relationship between self-esteem and chemistry performance. Specifically, the study sought to answer two questions: (1) To what extent does self-esteem predict students' academic performance in chemistry? and (2) Does gender moderate the predictive relationship between self-esteem and students' academic performance in chemistry? The study contributes to the literature by moving beyond a simple examination of the association between self-esteem and achievement to test whether the predictive relationship is conditional on gender, thereby providing a more precise understanding of psychological factors associated with chemistry performance among secondary school students.

2 Literature Review/Theoretical Framework

The present study is guided by Rosenberg's self-esteem perspective, which conceptualises self-esteem as an individual's overall evaluation of personal worth and competence. Within educational settings, self-esteem is relevant because students' perceptions of their own capabilities may influence how they approach academic tasks, respond to difficulties and persist in learning. Students who perceive themselves as competent may be more willing to engage with challenging tasks, whereas students with negative self-evaluations may be more likely to avoid difficult academic situations. This perspective provides a theoretical basis for examining self-esteem as a predictor of chemistry performance. The relationship between self-esteem and academic performance has received considerable empirical attention, but the evidence varies in context and strength. Golizadeh et al. (2024), in a meta-analytic review, reported an overall positive relationship between self-esteem and academic achievement, providing broad support for the relevance of self-evaluation to educational outcomes. Acosta-Gonzaga (2023), however, examined self-esteem alongside academic engagement and showed that self-esteem should be considered within a wider set of motivational and behavioural processes rather than as an isolated determinant of performance. Evidence from Nigeria is similarly supportive but context-dependent. Koki and Gambo (2025) reported higher academic achievement among public senior secondary students with higher self-esteem, while Jamiu (2025) found a significant relationship between self-esteem, school adjustment and academic performance. Bai and Liu (2026) further reported that self-esteem was part of a longitudinal network involving academic self-efficacy, physical activity and depression, suggesting that psychological variables may operate together rather than independently. Taken together, these studies support the relevance of self-esteem but also caution against treating it as a sufficient explanation of achievement differences. The present study therefore focuses specifically on chemistry performance, a subject requiring conceptual understanding, symbolic representation and problem-solving, and tests self-esteem as a predictor within that subject-specific context.

This inconsistency suggests that self-esteem should be empirically examined as a predictor rather than assumed to determine academic outcomes. It also indicates that the relationship may depend on contextual and student-related factors. The present study addresses this issue by focusing specifically on chemistry performance, rather than general academic achievement. Chemistry provides an important context for this investigation because learning the subject involves understanding abstract concepts, chemical representations, problem-solving and the interpretation of observable and theoretical phenomena. Students' perceptions of their competence may therefore influence their willingness to engage with difficult chemistry tasks and persist when they encounter conceptual difficulties. Nevertheless, much of the existing evidence on self-esteem has examined general academic achievement or science achievement, leaving comparatively limited evidence concerning self-esteem as a predictor of chemistry performance among secondary school students in Kaduna State. Gender provides an additional dimension to the relationship. Evidence on gender differences in science and chemistry achievement is mixed. Hagos and Andargie (2022) reported gender differences in motivation and conceptual knowledge in chemistry within a technology-integrated formative-assessment context, whereas Goulas et al. (2024) examined gender gaps in STEM more broadly and highlighted that observed differences can vary across educational and labour-market contexts. Yidana and Arthur (2024) found that gender did not moderate the predictive validity of self-esteem on science achievement, suggesting

that a direct gender difference or a gender interaction should not be assumed without empirical testing. These studies differ in subject focus, educational context and analytical approach, which may help explain why findings are not uniform. The present study therefore treats gender as a moderator rather than assuming that male and female students necessarily differ in mean chemistry performance. This approach permits examination of whether the strength of the self-esteem-performance relationship changes across gender groups even when gender itself is not a significant direct predictor.

Importantly, limited research has examined whether gender moderates the relationship between self-esteem and academic performance. Yidana and Arthur (2024) found that gender did not moderate the predictive validity of self-esteem on science achievement. However, this finding may not be generalisable to chemistry students in Kaduna State because differences in subject demands, educational context and student characteristics may produce different relationships. Thus, an important empirical gap remains concerning whether the predictive contribution of self-esteem to chemistry performance differs between male and female students. Based on the reviewed literature, the present study proposes that self-esteem predicts chemistry performance, while gender may alter the strength of this predictive relationship. The study therefore extends previous research beyond examining a simple association between self-esteem and achievement by testing both its predictive contribution and the possible moderating role of gender. This framework provides the basis for determining whether self-esteem is a significant predictor of chemistry performance and whether that prediction varies according to gender among secondary school students in Kaduna State, Nigeria.

3 Materials and Methods

3.1 Research Design and Participants

The study employed a correlational survey design to examine whether self-esteem predicts chemistry performance and whether gender moderates this predictive relationship. The design was appropriate because the study examined naturally occurring variables without manipulating participants or assigning them to experimental conditions. The study was conducted among Senior Secondary School II (SS II) students offering Chemistry in public secondary schools in Giwa Educational Zone, Kaduna State, Nigeria. The target population comprised 1,390 SS II Chemistry students from 14 public secondary schools, consisting of 640 males and 750 females. Three co-educational schools with a total sample size of 346 students were purposively selected from the 14 schools, followed by simple random sampling. Before the final study administration, a Chemistry Performance Test was used to examine whether the selected schools differed substantially in chemistry performance, and one-way ANOVA was used as the screening procedure. Schools with comparable performance were retained.

3.2 Instruments

Data was collected using two instruments: the Rosenberg Self-Esteem Scale (RSES) and a researcher-adapted Chemistry Performance Test (CPT). The RSES, originally developed by Rosenberg (1965), consists of 10 items measuring students' global self-evaluation and perceived self-worth. Responses were obtained using a four-point Likert scale ranging from strongly disagree to strongly agree, with negatively worded items reverse scored. Higher scores indicated higher levels of self-esteem. The CPT consisted of 40 multiple-choice items developed from the senior secondary school Chemistry curriculum and adapted from relevant Chemistry examination materials, including West African Examinations Council (WAEC), National Examinations Council (NECO), Joint Admissions and Matriculation Board (JAMB) past questions, and relevant secondary school Chemistry texts. The test covered major Chemistry concepts appropriate to the students' level. Each correct response attracted one mark, giving a maximum possible score of 40.

3.3 Validity and Reliability

The instruments were subjected to face and content validation by experts in Science Education, Chemistry, and Educational Psychology and Counselling at Ahmadu Bello University, Zaria. The experts assessed the relevance, clarity, appropriateness and coverage of the items in relation to the study variables and objectives. Their recommendations were incorporated before the final administration. A pilot study was conducted among 30 SS II Chemistry students from a public secondary school within the study population but outside the sampled schools. The pilot study was used to assess the clarity and administration of the instruments and to establish their reliability.

The CPT was subjected to a test–retest procedure, producing a reliability coefficient of .86, which was interpreted as evidence of satisfactory temporal stability. Internal-consistency analysis produced a coefficient of .89 for the self-esteem scale and .83 for the Chemistry Performance Test. Thus, .86 represents the CPT test-retest reliability, whereas .83 represents its internal-consistency reliability; these coefficients should not be treated as interchangeable. The reliability coefficients exceeded the commonly accepted threshold of .70 for educational research. Item analysis was conducted for the CPT using facility and discrimination indices. Items that did not meet the predetermined criteria were revised or removed. The final test comprised 40 items with acceptable psychometric properties.

3.4 Data Collection Procedure

Following approval from the relevant educational authorities and school administrators, the researcher visited the selected schools and administered the instruments to the sampled SS II Chemistry students. The purpose and procedures of the study were explained to the participants before administration. Participation was voluntary, and respondents were informed that the information provided would be used strictly for research purposes. The self-esteem scale and Chemistry Performance Test were administered under standardised conditions. Completed instruments were collected immediately after administration, checked for completeness, scored according to the established scoring procedures, and prepared for statistical analysis.

3.5 Data Analysis

Gender was coded categorically, with male students assigned a value of 1 and female students assigned a value of 2. The interaction term (Self-Esteem $\times$ Gender) was then entered into the regression model to determine whether the relationship between self-esteem and chemistry performance differed by gender. The moderation model was specified as:

$$CP = \beta_0 + \beta_1(SE) + \beta_2(G) + \beta_3(SE \times G) + \epsilon$$

Where;

CP represents Chemistry Performance, SE represents Self-Esteem, G represents Gender, SE $\times$ G represents the interaction between Self-Esteem and Gender, β_0 represents the intercept, β_1 – β_3 represent regression coefficients, and ϵ represents the error term. A statistically significant coefficient for the Self-Esteem $\times$ Gender interaction was interpreted as evidence that gender moderates the predictive relationship between self-esteem and Chemistry performance. Where significant moderation was detected, simple-slope analysis was used to determine the nature of the interaction for male and female students. Statistical significance was evaluated at $\alpha = .05$.

3.6 Ethical Considerations

Ethical principles governing educational research were observed throughout the study. Permission to conduct the research was obtained from the relevant educational authorities and participating schools. Students were informed about the purpose of the study, participation was voluntary, and confidentiality and anonymity of responses were maintained. Data were used solely for academic research purposes.

4 Results

4.1 Self-Esteem as a Predictor of Chemistry Performance

The first research question examined the extent to which self-esteem predicted chemistry performance among secondary school students. Descriptive statistics for the study variables are presented in Table 1.

Table 1

Descriptive statistics for self-esteem and chemistry performance

Variable	<i>N</i>	<i>M</i>	<i>SD</i>
Self-esteem	346	36.60	7.18
Chemistry performance	346	39.70	5.45

A simple linear regression analysis was conducted to examine whether self-esteem significantly predicted chemistry performance. The results are presented in Table 2.

Table 2

Simple linear regression predicting chemistry performance from self-esteem

Predictor	<i>B</i>	<i>SE</i>	<i>t</i>	<i>P</i>	<i>R</i>	<i>R</i> ²	Adjusted <i>R</i> ²
Self-esteem	0.168	0.040	4.22	<.001	.42	.18	.18
Constant	45.875	1.490	30.79	<.001			

Note. *N* = 346.

The regression model was statistically significant, $F(1, 344) = 17.83$, $p < .001$, with $R = .42$ and $R^2 = .18$. Self-esteem significantly predicted chemistry performance, $B = 0.168$, $SE = 0.040$, $t(344) = 4.22$, $p < .001$.

4.2 Moderating Role of Gender

The second research question examined whether gender moderates the relationship between self-esteem and chemistry performance. A moderation regression analysis was conducted by entering self-esteem, gender, and the Self-Esteem $\times$ Gender interaction term as predictors of chemistry performance.

Table 3

Moderation of the relationship between self-esteem and chemistry performance by gender

Predictor	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>p</i>
Constant	33.214	2.184	—	15.21	<.001
Self-esteem	0.176	0.051	.221	3.45	.001
Gender	1.087	0.781	.071	1.39	.165
Self-esteem $\times$ Gender	-0.094	0.038	-.128	-2.47	.014

The moderation analysis revealed that self-esteem significantly predicted chemistry performance, $B = 0.176$, $SE = 0.051$, $\beta = .221$, $t = 3.45$, $p = .001$. Gender was not a significant independent predictor of chemistry performance, $B = 1.087$, $SE = 0.781$, $\beta = .071$, $t = 1.39$, $p = .165$. However, the Self-Esteem $\times$ Gender interaction was statistically significant, $B = -0.094$, $SE = 0.038$, $\beta = -.128$, $t = -2.47$, $p = .014$. The interaction therefore indicates that the slope relating self-esteem to chemistry performance differs between the two gender groups. The standardised interaction effect ($\beta = -.128$) is small in magnitude, so its statistical significance should not be interpreted as evidence of a large practical effect. From the reported interaction *t* statistic and residual degrees of freedom, the corresponding partial R^2 is approximately .018, indicating that the interaction accounts for a small unique proportion of residual variance. Accordingly, the null hypothesis concerning moderation was rejected at $\alpha = .05$.

5 Discussion

The finding that self-esteem significantly predicted chemistry performance indicates that students' evaluations of their personal worth and competence were associated with their ability to perform in chemistry. The positive regression coefficient suggests that students with higher self-esteem tended to obtain higher chemistry performance scores. This finding is consistent with Achufusi et al. (2025) and Ezeanyagu et al. (2023), who reported significant relationships between self-esteem and academic achievement among secondary school students. It also agrees with Ojeleye et al. (2023), who found that self-esteem significantly predicted students' achievement in science. The finding provides further evidence that psychological characteristics can contribute to academic outcomes beyond the influence of instructional and curricular factors. The result is also theoretically consistent with Rosenberg's self-esteem perspective, which views self-esteem as an individual's evaluation of personal worth and competence. Students who hold more positive evaluations of themselves may approach academic tasks with greater confidence and persistence, particularly when learning requires sustained engagement with challenging concepts. Chemistry involves abstract representations, problem-solving and the interpretation of chemical phenomena; consequently, students' perceptions of their competence may influence their willingness to engage with these demands. The significant predictive effect observed in the present study therefore provides empirical support for applying

self-esteem perspective to chemistry learning in the secondary school context. However, the finding should not be interpreted as demonstrating that self-esteem alone determines chemistry performance. Although the relationship was statistically significant, the proportion of explained variance indicates that other factors also contribute to differences in students' performance. This interpretation is consistent with Ogwuegbu et al. (2026), who reported only a moderate relationship between self-esteem and school performance and questioned the assumption that high self-esteem necessarily produces superior academic achievement. The present finding therefore supports a predictive role for self-esteem while recognising the multifactorial nature of academic performance.

The second major finding was that gender significantly moderates the relationship between self-esteem and chemistry performance. Although gender itself was not a significant independent predictor of performance, the significant Self-Esteem $\times$ Gender interaction demonstrates that the contribution of self-esteem to chemistry performance differed according to gender. Importantly, the interaction coefficient was small ($\beta = -.128$), and the derived partial R^2 of approximately .018 indicates a limited unique contribution beyond the other terms represented in the model. The significant interaction extends previous research that has primarily examined gender differences in achievement as a direct effect. The inconsistent findings across these studies may partly reflect differences in how gender is conceptualised and analysed. The present study suggests that examining gender only as a difference between male and female achievement may overlook a more important possibility: gender may influence how students' psychological resources translate into academic performance. This discrepancy may reflect differences in subject context, sample characteristics, educational environment or measurement procedures. Whereas the earlier study considered science achievement more broadly, the present study focused specifically on chemistry performance among secondary school students in Kaduna State. Chemistry may place distinctive cognitive and affective demands on learners, particularly through its combination of theoretical concepts, symbolic representations and quantitative problem-solving. Such characteristics may contribute to differences in how self-perceptions are translated into academic performance across gender groups.

The findings have implications for educational practice. The significant predictive contribution of self-esteem suggests that efforts to improve chemistry achievement should not focus exclusively on content delivery and instructional methods. Teachers and school counsellors may also consider approaches that strengthen students' academic self-perceptions, confidence and willingness to persist with challenging chemistry tasks. However, the significant moderation effect indicates that such interventions should be sensitive to differences in students' experiences rather than assuming that the same relationship operates identically for all learners. Gender-responsive support may therefore be useful where evidence indicates that students differ in how self-esteem relates to their chemistry learning outcomes. The study also contributes to the literature by shifting attention from whether male and female students differ in chemistry achievement to whether gender changes the predictive relationship between a psychological variable and achievement. This provides a more nuanced interpretation of gender in science education research. From a theoretical perspective, the findings suggest that Rosenberg's self-esteem perspective can be extended by considering the social and contextual conditions under which self-evaluations are translated into academic outcomes.

Several limitations should nevertheless be considered. First, correlational design limits causal interpretation; therefore, the significant predictive relationships should not be interpreted as proof that increasing self-esteem will necessarily cause improved chemistry performance. Second, the analytic sample comprised 346 students drawn from only three schools within Giwa Educational Zone, and the schools were screened for comparable chemistry performance before the final analysis. This purposive pre-screening may have restricted between-school and performance variance and therefore limits external validity and may affect the magnitude of the observed predictive relationship. Third, self-esteem was measured through self-report, making the findings potentially susceptible to response and social-desirability biases. Finally, the absence of reported simple-slope tests, exact ΔR^2 , and gender-coding information limits interpretation of the moderation effect. Future studies should address these limitations through broader probability-based sampling, transparent reporting of exclusions, larger and more geographically diverse samples, and complete moderation diagnostics. Future research should also examine the mechanisms through which gender influences the self-esteem-chemistry performance relationship. Variables such as academic self-efficacy, motivation, classroom climate, teacher expectations, parental support and students' prior achievement may help explain why the predictive contribution of self-esteem varies across genders. Such investigations would provide a more comprehensive account of the psychological and contextual processes underlying chemistry achievement among secondary school students.

6 Conclusion

The study found that self-esteem significantly predicted chemistry performance among secondary school students in Kaduna State, Nigeria, and that the relationship varied significantly by gender. However, the moderation effect was small, and the available results do not justify interpreting it as a large practical difference between male and female students. Because the analytic sample was restricted to 346 students from three purposively selected schools whose performance was screened for comparability, the findings should be regarded as context-specific evidence rather than definitive evidence that gender generally changes the self-esteem–chemistry–performance relationship. Future research should use more representative sampling, report complete conditional-effect statistics, and examine the contextual mechanisms that may account for differences in the self-esteem–performance relationship across gender groups.

7 Declarations

Ethical Statements: Ethical approval for the study was obtained from the relevant educational authorities and the participating secondary schools in Kaduna State, Nigeria, before commencement of data collection. Permission was also obtained from the administrators of the selected schools. The participants were informed about the purpose and procedures of the study, and participation was voluntary. Appropriate informed consent was obtained from the participants before administration of the research instruments. Participants were informed that they could withdraw from the study at any time without penalty. Confidentiality and anonymity were maintained throughout the study, and no personally identifying information was included in the dataset or reported in the manuscript. The data were used solely for academic research purposes.

Conflict of Interest: The authors declare neither financial nor non-financial conflict of interest.

Author Contributions: P.G. conceived and designed the study, developed the instruments, coordinated data collection, analysed and interpreted the data, and drafted the manuscript, while M.M. and H.M. contributed to data collection, interpretation of findings, and critical revision of the manuscript, and all authors approved the final version and accepted accountability for the integrity of the work.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgments: The author acknowledges the educational authorities, school administrators, teachers, and students who facilitated and participated in the study. The author also appreciates the experts who contributed to the validation of the research instruments and provided valuable feedback during the development of the study.

Data Availability Statement: The dataset generated and analysed during the current study is not publicly available because it contains educational research data collected from school students and is subject to confidentiality and ethical considerations. However, the data may be made available from the corresponding author upon reasonable request, subject to appropriate ethical and institutional restrictions.

8 References

- Achufusi, N., Okwuchukwu, A. A., & Enebechi, R. I. (2025). Interest and self-esteem as correlates of secondary school students' academic achievement in chemistry in Ogidi education zone. *UNIZIK Journal of Educational Research and Policy Studies*, 19(2).
- Acosta-Gonzaga, E. (2023). The effects of self-esteem and academic engagement on university students' performance. *Behavioral Sciences*, 13(4), 348.
- Agboola, O. S. (2025). Science education in Nigeria: The emergence, challenges and expectations. An inaugural lecture delivered at Oduduwa hall, Obafemi Awolowo University, Ile-Ife Nigeria.
- Agut, S., Martín-Hernández, P., Soto, G., & Arahuate, L. (2023). Understanding the relationships among self-ascribed gender traits, social desirability, and ambivalent sexism. *Current Psychology*, 42(29), 25793–25806.
- AlHarbi, N. (2022). Self-Esteem: A concept analysis. *Nursing science quarterly*, 35(3), 327–331.
- Aliyu, A. (2024). Effect of Cooperative Learning Strategy on Students' Academic Achievement in Chemistry in Calabar Municipality, Cross River State, Nigeria. Cross River State, Nigeria (June 22, 2024).

- Bai, D., & Liu, X. (2026). Longitudinal associations between physical activity, academic self-efficacy, self-esteem, and depression in Chinese junior high school students. *Acta Psychologica*, 265, 106688.
- Birni, G., & Eryilmaz, A. (2024). Conceptual and theoretical review of self-worth. *Psikiyatride Güncel Yaklaşımlar*, 16(2), 327–346.
- Chen, C., Shen, Y., Zhu, Y., Xiao, F., Zhang, J., & Ni, J. (2023). The effect of academic adaptability on learning burnout among college students: The mediating effect of self-esteem and the moderating effect of self-efficacy. *Psychology Research and Behavior Management*, 1615–1629.
- Eilks, I., Sjöström, J., & Zuin, V. (2017). The responsibility of chemists for a better world: challenges and potentialities beyond the lab. *Revista Brasileira de Ensino de Química*, 12(1), 97–105.
- Ejide, B., & MCA, O. O. (2025). Relationship Between Self-Esteem and Academic Achievement among Public Secondary School Students in Anambra State. *International Journal of Innovative Psychology and Social Development*, 13(2), 313–321.
- Ezeanyagu, N. D., Opara, F. M., & Okafor, T. U. (2023). Motivation and self-esteem as predictors of secondary school students' achievement in Biology in Awka educational zone of Anambra state. *UNIZIK Journal of Educational Research and Policy Studies*, 16(2), 219–228.
- Famolu, F. (2025). Exploring the Correlation Between Self-Esteem and Academic Success Among Special Needs Students in Kwara State, Nigeria. *Jurnal Kajian Bimbingan dan Konseling*, 10(1), 55–68.
- Gidado, B. K., Apeh, H. A., & Akinjobi, F. N. (2025). Relationship between self-esteem and academic achievement of senior secondary school students in North-central, Nigeria. *Asian Journal of Education and Social Studies*, 51(2), 99–110.
- Golizadeh, Z., Mirzaei, L., & Mirzaei, M. (2024). Meta-analysis of the relationship between self-esteem and academic achievement. *Educational Psychology*, 19(70), 200–226.
- Goulas, S., Griselda, S., & Megalokonomou, R. (2024). Comparative advantage and gender gap in STEM. *Journal of Human Resources*, 59(6), 1937-1980.
- Guyah, P., Mari, J.S., & Umahaba, R.E. (2022). Effect of Personalized learning Strategy on Self- Efficacy and Performance in Mole Concept among secondary school students, Zaria Education zonal, Kaduna state, Nigeria. *Nigerian Educational Forum*, 31(1&2), 107–118
- Hagos, T., & Andargie, D. (2022). Gender Differences in Students' Motivation and Conceptual Knowledge in Chemistry Using Technology-Integrated Formative Assessment. *Asian Journal of Assessment in Teaching and Learning*, 12(1), 10–22.
- Ikuejube, B. A. (2024). Assessment of chemistry teachers' scientific attitudes on the academic performance in chemistry among senior secondary school students in Ondo city. *Journal of Education Innovation and Practice*, 8(1), 60–67.
- Jamiu, M. S. (2025). Relationship among Self Esteem, School Adjustment and Academic Performance of Students in College of Education Ilorin, Kawara State, Nigeria. *Journal of Educational Studies Trends and Practice*, 8(8), 166–176.
- Koki, A. T. A., & Gambo, M. H. (2025). Influence of self-esteem on academic achievement of public senior secondary school students in Potiskum education zone, Yobe state, Nigeria. *International Journal of Assessment and Evaluation in Education*, 10(8), 1–16.
- Kuhn, H., Waldeck, D. H., & Försterling, H. D. (2024). Principles of physical chemistry. John Wiley & Sons.
- Longino, H. E. (2020). Science as social knowledge: Values and objectivity in scientific inquiry.
- Marti, D. M., & Muhammed, K. (2024). Challenges facing the development of science education in Nigeria and the way forward: A review. *Journal of Education Research and Library Practice*.
- Obikezie, M. C., Nwuba, I. S., & Ibe, F. N. (2023). Influence of school location and gender on generative learning model on secondary school students' academic achievement in chemistry. *Eureka: Journal of Educational Research*, 2(1), 51–59.

- Ogwuegbu, L. C., Molokwu, A. N., Ojokheta, P., Yekinni, L. O., & Oladimeji, O. O. (2026). Self-esteem and parental counselling as predictors of academic achievement among students with hearing impairment in Oyo state. *International Journal of Studies in Psychology*, 6(2), 52–56.
- Ojeleye, C. I., Adegbile, O. N., & Apanpa, T. (2023). Academic resilience and self-esteem as determinant of students' academic performance in Zamfara State. *Milestone: Journal of Strategic Management*, 3(2), 68–78.
- Oladejo, A. I., Nwaboku, N. C., Okebukola, P. A., & Ademola, I. A. (2023). Gender difference in students' performance in chemistry—can computer simulation bridge the gap? *Research in Science & Technological Education*, 41(3), 1031–1050.
- Onyi, I. E., Njoku, Z. C., & Nwafor, S. C. (2022). Efficacy of problem-based learning in promoting high achievement of students in chemistry. *Journal of critical reviews*, 9(01), 49–57.
- Orth, U., & Robins, R. W. (2022). Is high self-esteem beneficial? Revisiting a classic question. *American Psychologist*, 77(1), 5.
- Osborne, J. (2023). Science, scientific literacy, and science education. In Handbook of research on science education (pp. 785-816). Routledge.
- Poincaré, H. (2022). The Foundations of Science: Science and Hypothesis, The Value of Science, Science and Method: Enriched edition. DigiCat.
- Rosenberg, M. (1965). Rosenberg self-esteem scale (RSE). Acceptance and commitment therapy. *Measures Package*, 61(52), 18.
- Tijani, B. E. (2025). Impact of open inquiry instructional strategy on secondary school students' academic achievement and conceptual knowledge in Chemistry across genders in Osun state, Nigeria. *African Journal of Teacher Education*, 14(1), 120–141.
- Umahaba, R. E., Gambari, A. I., Thomas, G., & Asaph, R. R. (2026). Effect of process oriented guided inquiry learning strategy on students' academic performance in organic chemistry in Kwami Local Government Area of Gombe State Nigeria. *Discover Education*, 5(1), 370.
- van Leest, A., van de Pol, J., van Tartwijk, J., & Hornstra, L. (2024). Inconsistency in student achievement across subject domains: Examination of associations with students' gender, socioeconomic status, and teachers' track recommendations. *Educational Research and Evaluation*, 29(5-6), 274–298.
- Voulvoulis, N., & Burgman, M. A. (2019). The contrasting roles of science and technology in environmental challenges. *Critical Reviews in Environmental Science and Technology*, 49(12), 1079–1106.
- Yidana, M. B., & Arthur, F. (2024). Influence of economics students' self-esteem on their academic engagement: The moderating role of gender. *Heliyon*, 10(4).
- Yu, W., Qian, Y., Abbey, C., Wang, H., Rozelle, S., Stoffel, L. A., & Dai, C. (2022). The role of self-esteem in the academic performance of rural students in China. *International Journal of Environmental Research and Public Health*, 19(20), 13317.
- Zhang, Y., Dong, Q., Xiao, B., Coplan, R. J., Wang, J., & Ding, X. (2025). Relations between dimensions of self-perceptions and academic achievement in Chinese children: A cross-lagged panel analysis. *School Psychology*, 40(4), 524.

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