

Effect of Household Materials on Senior Secondary Schools Students' Academic Achievement in Chemistry, Osun State: A Comparative Study

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Abstract

The study explores the effect of household materials on senior secondary school students' academic achievement in chemistry in Ayedaade Local Government Area: Osun State: Three hypotheses guided the study at the 0.05 level of significance. A quasi-experimental design was employed with a sample size of 74 Senior Secondary II students. Two intact classes (experimental and control) were used, with 40 students in the experimental group and 34 in the control group. The experimental group was taught using household materials, while the control group was taught using the traditional (conventional) laboratory method. Data were collected using a validated Chemistry Achievement Test (CAT) with a reliability coefficient of KR-20 = 0.84 and analyzed using Analysis of Covariance (ANCOVA). The findings revealed that household materials significantly improved students' academic achievement compared to conventional laboratory methods, $F_{(1, 71)} = 130.09, p < 0.001, \eta^2 = .647$ while gender had no significant main effect, $F_{(1, 71)} = 0.115, p = .735, \eta^2 = 0.002$, and no significant interaction effect between gender and instructional strategy was observed, $F_{(1, 69)} = 2.33, p = 0.132, \eta^2 = 0.033$. The study concludes that the utilization of household materials constitutes a cost-effective and pedagogically inclusive intervention that significantly enhances students' achievement in chemistry, irrespective of gender. It recommends their systematic integration in resource-constrained schools as a means of addressing laboratory inadequacies and promoting equitable access to effective science instruction.

Keyword: Household materials, Laboratory methods, Chemistry achievement, Gender, Science education

Word Count: 230

Introduction

Chemistry is a fundamental science that is instrumental in explaining natural occurrences, technological advancement, and national development (National Academies of Sciences, Engineering, and Medicine, 2022). Its irreplaceability cuts across many disciplines and works such as medicine, agriculture, engineering, environmental sciences, and industry because it provides both conceptual understandings and empirical means with which one should solve a practical problem (Defista & Aznam, 2024). When taken at the level of senior secondary school, chemistry aims to improve the analytical and problem-solving abilities in learners, thus making them fit to continue further studies and career profiles in science-related disciplines (Kibga, Sentongo & Gakuba, 2022). However, most developing countries, including Nigeria, have not been able to perform well in chemistry among students (Shamsuddin, Arome, Aminu & Adamu, 2017)

Understanding of chemistry is generally measured by standardized tests, national tests, and classroom assessments. The empirical research has shown that a large percentage of Nigerian students underperform in chemistry practical and most of them cannot pass the West African Senior School Certificate Examination with credit grades (WAEC, 2023). In Osun State, recent statistics indicate that only about 41% of candidates obtained a credit pass in Chemistry in the May–June 2023 WASSCE, a figure that falls below the national average of approximately 45 percent (WAEC, 2023). Poor laboratory infrastructure, the abstract nature of chemical concepts by their nature, teacher-centred approaches to instruction, or even adverse affective attitudes toward the subject are among the factors linked to this underperformance (Chikendu & Ejesi, 2021). (Owan, 2022) highlighted the role of poor laboratory facilities and insufficient access to teaching resources to be the key factors in determining poor performance among students in chemistry.

To address these limitations, researchers have promoted the use of homemade teaching resources- especially home-based materials to replace or supplement traditional laboratory equipment in the context of resource constrained schools. Household products that can be used in teaching any chemical concept include vinegar, ash, charcoal, lime, and soda, among others, so that abstract knowledge of chemical reactions can be converted into economic and practical experiences of relatable value. Empirical studies have demonstrated that use of household materials does not only increase student engagement and participation, but also leads to greater

academic performance, compared to more traditional teacher-centred approaches (Nja, Obi & Anari, 2021). (Ngendabanga, Nkurunziza & Mugabo, 2025) reported that improvised household materials not only engage students actively but also improve their comprehension of abstract scientific concepts.

Although traditional laboratory devices provide researchers accuracy and consistency in laboratory activities, they are typically expensive to purchase and use, with a considerable level of necessity of the conditions to maintain the devices and with significant inaccessibility in low-budgeted institutions (Eduwa, Udeani, & Kareem, 2025). Household materials in contrast are cheap, known, and accessible to learners and therefore offer a good pedagogic tool in two-scarce resource environments (Naisiano, Koome, & Marima, 2020). They have an advantage over each other in demystifying straight-forward processes of learning science, building Self-esteem, and encouraging sustained knowledge, which together argue that a structured incorporation of domestic materials in chemistry courses can be employed as a productive attack towards achieving academic performance. (Kanwal, Shahid & Jabeen, 2022) found that using low-cost material to teach science positively affects students' learning.

There is however, lack of empirical study, comparing the effectiveness of household materials with that of conventional laboratory methods as far as the use of household materials in promoting the achievement of students in chemistry in the Osun State, Nigeria. The available literature is mainly based on anecdotal information or research-based studies that were not conducted within the Nigerian context, thus creating an evidentiary gap that hinders context-specific decision-making in the practitioners of the delivery process, or curriculum designers, and policymakers.

Besides that, gender is also a responsive factor in the sphere of science education, and studies present uneven results regarding differences in reactions by male and female learners to different teaching methods (Verdugo-Castro, Sánchez-Gómez, & García-Holgado, 2023). (Ajayi & Ogbaba, 2021) found that no gender disparities in chemistry performance when appropriate instructional strategies were adopted. (Aguillon, Siegmund, Petipas, Drake & Cotner, 2020) also argued that gender differences in science achievement are often minimized when active, student-centered teaching approaches are used. Marantika (2022) suggested that well-designed instructional methods can neutralize the often-assumed differences in learning outcomes between

male and female students. The aspects of the possible interaction of sex and employing household materials during drug pedagogies were not properly studied within the Nigerian context.

The possible consequences of addressing these gaps would be a continuation of a cycle of low achievement in the field of chemistry, thus it would impede the views of such a student in trying a science-based career and would discredit the further vision of Nigeria developing scientifically literate and technologically advanced workers. It is against this background that the current research will focus on empirically testing the relative impacts of household materials and conventional laboratory procedures on amassing achievement of senior secondary level school students in chemistry in Osun State, and at the same time testing the moderating role of gender.

Statement of the problem

Chemistry still maintains its relevance in terms of scientific literacy and technological advancements, but since its contents are also gained by secondary school learners, the subject in Osun State of Nigeria proves to be a challenge indeed as evident in the performance of students on their national assessment examination.

Recent data retrieved through the West African Examinations Council (WAEC, 2022) show that an average of only about 41 % of applicants in Osun State got credit passes in chemistry in the May/June WASSCE, which is a lower statistic compared to the national average. This sluggish performance has been attributed to a number of causes with a key issue being lack of proper facilities to teach and the lack of functionality of many chemistry labs as well as the lack of access to the standard laboratory equipment across a large number of state schools.

In response to those difficulties, some researchers proposed makeshift or low-cost options such as household materials, which are cheap, easily accessible and demonstrated their usefulness in increasing student engagement and achievement in similar low-resource environments such as Kenya and South Africa (Khan, Farooq, & Fleury, 2019). However, in Osun State, there is little or no empirical data that supports the suitability of the use of household materials as alternatives to the traditional laboratory materials in enhancing the performance of students in chemistry. The lack of evidence, based on this demonstration, leaves teachers, curriculum developers and policymakers with no viable road map in which they can apply content specific and economical teaching or learning methods.

Moreover, it has been discussed that gender is also a promising determinant in science education, and the research concluded mixed results regarding the ability of male and female students to perform differently in chemistry under the condition of different methods of teaching. It is also vital to consider the possibility of interaction between gender and use of household's materials as a teaching strategy, which has not been properly explored in the Nigerian settings. It is against this background that the current study attempts to examine how the household materials impact the achievement of the senior secondary school students at chemistry subjects in the case of Osun State, but focuses on the primary effects of instructions strategy and gender, and additional effects which are possible.

Aim and Objectives of the Study

The aim of this study is to investigate the effects of household materials on senior secondary schools students' achievement in chemistry, Osun State: Comparative study. The specific Objectives are to:

- i. determine the main effect of household materials on senior secondary school student's academic achievement in chemistry;
- ii. access the main effect of gender on senior secondary school student's academic achievement in chemistry;
- iii. examine the interaction effect of household materials and gender on senior secondary school student's academic achievement in chemistry.

Hypotheses

The following null hypotheses were tested at a 0.05 level of significance:

H₀1: There will be no significant main effect of household materials on students' academic achievement in Chemistry.

H₀2: There will be no significant main effect of gender on students' academic achievement in Chemistry.

H₀3: There will be no significant interaction effect of household materials and gender on students' academic achievement in Chemistry

Methodology

The research adopted a Quasi-experimental research design. The study population consisted of the entire Population of SS two students that offer chemistry in Osun State Public Government Secondary Schools. Simple random technique was used to select one Local Government Area out of the 30 Local Governments in the state. Two public secondary schools (distant from each other) were purposively selected. Each school had qualified chemistry teacher and chemistry Laboratory. One intact SS 2 science class with 40 students was taken from each of the schools for experimental group and was taught chemistry concepts using household materials. The other intact SS2 science class with 34 students was taken from the other school for control and was taught chemistry concepts using the traditional laboratory materials. The validity of the instrument used was validated Chemistry Achievement Test (CAT) with reliability value $KR-20 = 0.84$. The CAT was first administered to the two groups as the pretest to identify the level of knowledge of both groups. Household materials (vinegar, lime juice, charcoal, and detergent) were used to teach experimental group while conventional laboratory equipments were used for teaching control group. After the teaching, a post test-test was administered (that is, after about four weeks of treatment), the scores were collected.

Inferential statistics were used to test the hypothesis. Specifically, analysis of covariance (ANCOVA) was employed to determine whether there was a statistically significant difference between the mean scores of students taught using household materials and those taught using conventional laboratory methods at the 0.05 level of significance.

Results

Table 1: Demographic Information of Respondents

Dependent Variable: posttest

Treatment	Gender		Total
	Male	Female	
Experimental	18	22	40
Control	15	19	34
Total	33	41	74

H₀₁: There is no significant main effect of household materials on students' academic achievement in Chemistry

Table 2: ANCOVA Result on Effect of Household Materials on Students Academic Achievement in Chemistry, Osun State

Dependent Variable: posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	66.171 ^a	2	33.086	65.048	0.000	0.647
Intercept	144.677	1	144.677	284.444	0.000	0.800
Pretest	0.133	1	0.133	0.261	0.611	0.004
Household materials	66.170	1	66.170	130.094	0.000	0.647
Error	36.113	71	0.509			
Total	4325.000	74				
Corrected Total	102.284	73				

a. R Squared = .647 (Adjusted R Squared = .637)

Source: Fieldwork, 2025

In the table 2, the ANCOVA result showed a statistically significant effect of household materials on student's academic achievement F- value [(1, 71) = 130.094 and the corresponding significant level (p= 0.000), which is less than 0.05 threshold. Hence H_{01} is rejected. This finding implies that household materials have a significant effect on student's academic achievement in chemistry. Furthermore, the effect represented by Partial Eta Squared ($\eta^2 = 0,647$), showed that 64.7% of the variance in students' posttest scores can be attributed to the use of household materials. The results demonstrate that household materials significantly enhanced students' academic achievement in chemistry in Osun State. The general model with R- squared of 0.647 (adjusted R squared= 0.637), further indicated that the model explained about 64.7% of the variance in the academic performance of students which included the pretest score and the treatment.

Table 3: Parameter Estimates of Effect Household Materials on Students' Academic Achievement in Osun State

Parameter Estimates

Dependent Variable: posttest

Parameter	B	Std. Error	T	Sig.	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
Intercept	6.312	0.443	14.247	0.000	5.428	7.195	0.741
Pretest	0.049	0.095	0.511	0.611	-.141	0.239	0.004
Household materials	1.899	0.166	11.406	0.000	1.567	2.231	0.647
Conventional laboratory	0 ^a	0.00	0.00	0.00	0.00	0.00	0.00

a. This parameter is set to zero because it is redundant.

Table 3 further provides insight into the specific contributions of each variable to the posttest scores, which represent students' academic achievement in chemistry. The intercept ($B = 6.312$, $p=0.000$) represents the predicted posttest score when other variables are held constant. It is statistically significant ($p < 0.05$), indicating that the baseline posttest score is not zero and is meaningfully different. Likewise, the pretest score ($B = 0.049$, $p = 0.05$) is a significant predictor of the posttest performance. The partial eta squared value of 0.04 indicates a moderate to strong contribution of the pretest to the final score.

The parameter representing the effect of household materials ($B = 1.899$, $p = 0.05$) compared to the reference category, which is the conventional laboratory method in the table was positive and statistically significant ($B = 6.312$, $p < 0.000$) indicating that students taught with household materials scored on average, 1.899 points higher on the posttest than those taught with the conventional laboratory method. The 95% confidence interval (1.567-2.231) confirms the precision and reliability of the estimate. The partial eta squared value of 0.647 also reflects a strong effect size, showing that the household materials accounts for 64.7% of the variance in posttest scores. Conventional laboratory method is set as the reference group with results affirming the positive significance of household materials on students' academic achievement in chemistry.

H₀₂: There is no significant main effect of gender on students' academic achievement in Chemistry

Table 4: ANCOVA Result on Effect of Gender on Students Academic Achievement in Chemistry, Osun State

Tests of Between-Subjects Effects

Dependent Variable: posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	0.167 ^a	2	0.084	0.058	0.944	0.002
Intercept	154.385	1	154.385	107.341	0.000	0.602
Pretest	0.006	1	0.006	0.004	0.949	0.000
Gender	0.166	1	0.166	0.115	0.735	0.002
Error	102.117	71	1.438			
Total	4325.000	74				
Corrected Total	102.284	73				

Squared = .002 (Adjusted R Squared = -.026)

Source: Fieldwork, 2025

In the table 6, the ANCOVA result showed a statistically significant effect of gender on student's academic achievement F- value [(1; 71) = 0.115 and the corresponding significant level (p= 0.735), which is higher than 0.05 threshold. Hence H₀₂ is accepted. This finding implies that gender have no significant effect on student's academic achievement in chemistry. Furthermore, the effect represented by Partial Eta Squared ($\eta^2 = 0.02$). Therefore, the null hypothesis 2 is retained, affirming that gender does not significantly influence Students' academic achievement in Osun State.

Table 5: Parameter Estimates of Gender on Effect of Household Materials on Students' Academic Achievement of Chemistry, Osun State

Dependent Variable: posttest

Parameter	B	Std. Error	T	Sig.	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
Intercept	7.465	0.750	9.958	0.000	5.971	8.960	0.583
Pretest	0.010	0.161	0.065	0.949	-.310	0.331	0.000
male=1	0.096	0.282	0.340	0.735	-.466	0.658	0.002
female=2	0 ^a	0.00	0.00	0.00	0.00	0.00	0.00

a. This parameter is set to zero because it is redundant.

Table 5 further provides insight into the specific contributions of each variable to the posttest scores, which represent students' academic achievement in chemistry. The intercept (B = 7.465, p = 0.000) represents the predicted posttest score when other variables are held constant. It is statistically significant ($p < 0.05$), indicating that the baseline posttest score is not zero and is meaningfully different. Likewise, the pretest score (B = 0.010, $p = 0.05$) is a significant predictor of the posttest performance. The partial eta is 0.000.

H₀₃: There is no significant interaction effect of household materials and gender on students' academic achievement in Chemistry

Table 6: ANCOVA Result on Interaction Effect of Household Materials and Gender on Students Academic Achievement in Chemistry, Osun State

Tests of Between-Subjects Effects

Dependent Variable: posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	67.482 ^a	4	16.870	33.448	0.000	0.660
Intercept	143.659	1	143.659	284.825	0.000	0.805
Pretest	0.052	1	0.052	0.104	0.748	0.002
Treatment	63.208	1	63.208	125.319	0.000	0.645
Gender	0.195	1	0.195	0.386	0.536	0.006
treatment * gender	1.175	1	1.175	2.330	0.132	0.033
Error	34.802	69	0.504			
Total	4325.000	74				
Corrected Total	102.284	73				

a. R Squared = 0.660 (Adjusted R Squared = 0.640)

Source: Fieldwork, 2025

In table the 6 above ANCOVA result showed a statistically significant effect of household materials on student's academic achievement F- value [(1; 69) = 2.330 and the corresponding significant level (p= 0.132), which is higher than 0.05 threshold. Hence H₀₃ is accepted. This finding implies that household materials have no significant effect on student's academic

achievement in chemistry. Furthermore, the effect represented by Partial Eta Squared ($\eta^2 = 0.33$), R-squared value of 0.660 (adjusted R squared = 0.640). Thus, there was no significant interaction effect of household materials on students' academic achievement in Osun State.

Table 7: Parameter Estimates of Gender on Household Materials on Students' Academic Achievement, Osun State

Dependent Variable: posttest

Parameter	B	Std. Error	T	Sig.	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
Intercept	6.231	0.457	13.646	0.000	5.320	7.142	0.730
Pretest	0.031	0.096	0.323	0.748	-.161	0.224	0.002
[treatment=1]	2.126	0.223	9.534	0.000	1.681	2.571	0.568
[treatment=2]	0 ^a	.	.	.	.	.	.
[gender=1]	0.361	0.246	1.472	0.146	-.128	0.851	0.030
[gender=2]	0 ^a	.	.	.	.	.	.
[treatment=1] * [gender=1]	-.515	0.337	-1.526	0.132	-1.188	0.158	0.033
[treatment=1] * [gender=2]	0 ^a	0.00	0.00	0.00	0.00	0.00	0.00
[treatment=2] * [gender=1]	0 ^a	0.00	0.00	0.00	0.00	0.00	0.00
[treatment=2] * [gender=2]	0 ^a	.	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

The parameter estimates Table 7 provides further clarity on the nature and strength of the interaction effects between the instructional strategies and gender on students' academic achievement in Household Material. The intercept (B = 6.231, $p < 0.05$) represents the baseline

posttest score when all other variables are at zero. The pretest score is a strong positive predictor ($B = 0.031$, $p < 0.05$), indicating that higher pretest scores significantly contribute to better posttest outcomes. This suggests that prior knowledge plays an important role in determining final performance. The partial eta squared value of 0.002 confirms a large effect size.

Discussion of Findings

This study investigated the effect of household materials and gender on students' academic achievement in chemistry in Osun State using a quasi-experimental design. The three null hypotheses tested were discussed in light of the findings and relevant literature.

Hypothesis one stated that there is no significant main effect of household materials on students' academic achievement in chemistry. The ANCOVA results revealed that household materials had a significant effect on students' achievement, $F_{(1, 71)} = 130.09$, $p < 0.001$, $\eta^2 = 0.647$, accounting for 64.7% of the variance in posttest scores. Students taught with household materials performed significantly better than those taught with conventional laboratory equipment. This finding aligns with the works of (Ngendabanga, Nkurunziza & Mugabo, 2025) who reported that improvised household materials not only engage students actively but also improve their comprehension of abstract scientific concepts. The result further corroborates (Kanwal, Shahid & Jabeen, 2022) who found that using low-cost material to teach science positively affects students' learning. Thus, this study has provided empirical evidence that the use of household materials is a cost-effective and pedagogically sound strategy that can substantially boost chemistry learning outcomes in Nigeria.

Hypothesis Two proposed that there is no significant main effect of gender on students' academic achievement in chemistry. The findings showed that gender had no significant effect, $F_{(1, 71)} = 0.115$, $p = 0.735$, $\eta^2 = 0.002$, indicating that male and female students performed comparably regardless of the teaching method employed. This agrees with (Ajayi & Ogbaba, 2021) who also found no gender disparities in chemistry performance when appropriate instructional strategies were adopted. It further supports (Aguillon, Siegmund, Petipas, Drake & Cotner, 2020), who argued that gender differences in science achievement are often minimized when active, student-centered teaching approaches are used. The implication is that the use of household materials benefits both male and female learners equally, and gender should not be a barrier in the design and implementation of innovative instructional strategies.

Hypothesis Three stated that there is no significant interaction effect of household materials and gender on students' academic achievement in chemistry. The results showed that the interaction was not significant, $F_{(1, 69)} = 2.33$, $p = .132$, $\eta^2 = .033$, suggesting that the effectiveness of household materials did not depend on students' gender. Both male and female students responded similarly to the instructional method, and no moderating effect of gender was observed. This finding aligns with previous studies by Marantika (2022), who suggested that well-designed instructional methods can neutralize the often-assumed differences in learning outcomes between male and female students.

Overall, the study demonstrates that the major determinant of achievement in chemistry is the instructional strategy rather than gender or prior knowledge. The use of household materials emerges as a highly effective, affordable, and contextually relevant method that can bridge the resource gap in underfunded schools while promoting meaningful learning. The lack of gender influence further underscores the inclusiveness of this strategy, making it a sustainable approach for achieving equity in science education

Conclusion

The study established that the use of household materials had a significant positive effect on students' academic achievement in chemistry, with those taught using improvised materials outperforming their counterparts taught with conventional laboratory equipment. Nevertheless, gender and gender-instructional strategy interaction were not in the limelight, which means that male and female students equally benefited when household materials were used. These results indicate that, in schools with limited resources, household material can provide a cheap and inclusive alternative to teach chemistry, and can result in better learning outcomes and reduce the divide posed by poor laboratory facilities without a gender-specific bias.

Recommendations

Based on the findings of this study, the following recommendations are made

- i. Chemistry teachers should adopt the use of locally available household materials such as vinegar, lime juice, charcoal, and detergent as substitutes for conventional laboratory equipment. This approach should be encouraged in schools with poorly

equipped laboratories, as it has been proven to be highly effective in enhancing students' academic performance.

- ii. Educational stakeholders should promote gender-inclusive instructional strategies without bias. Since both male and female students benefit equally from household materials, teachers should focus more on effective instructional methods rather than gender considerations. There should also be continued campaigns by government and the Non-Government Organization that both the boys and girls should study science subjects in equal measure.
- iii. Policymakers and curriculum developers should adopt the use of household materials as a universal instructional strategy in chemistry, knowing that it benefits both male and female learners equally. This offers an equitable, inexpensive, and non-discriminatory approach to augment science teaching free of the dread of increased gender disparities in achievement.

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