

Effects of 7Es Teaching Model and Demonstration Method on SSS1 Students' Academic Performance and Retention on Chemical Behaviour of Gases

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Abstract

This study examined the effects of the 7Es Teaching Model and the Demonstration Method on the academic performance and retention ability of Senior Secondary School One (SSS1) students in Chemical Behaviour of Gases in Sokoto Metropolis, Nigeria. The study was prompted by the persistently weak performance of Nigerian secondary school students in chemistry, particularly on abstract topics such as gas behaviour, and by the absence of Sokoto-specific research examining how the 7Es model compares with the Demonstration Method on these two related outcomes. A quasi-experimental pretest-posttest-delayed-posttest, non-equivalent control group design was adopted. The population comprised 4,707 SSSI chemistry students across forty-eight public secondary schools in Sokoto Metropolis, from which a purposive sample of 109 students was drawn from two schools, comprising 51 students in the experimental group and 58 in the control group. Data were collected using a validated Academic Performance Test on Chemical Behaviour of Gases (APTCBG), administered as a post-test and, for the experimental group, as a delayed post-test two weeks later to assess retention, and analysed using Analysis of Variance and Repeated Measures Analysis of Variance at the 0.05 level of significance. Findings showed that students taught using the 7Es Teaching Model significantly outperformed those taught using the Demonstration Method in academic performance, $F(1,107) = 483.79$, $p = 0.001$, and that no significant difference existed between the experimental group's posttest and delayed posttest scores, $F(1,50) = 0.054$, $p = 0.817$, indicating that the knowledge gained under the 7Es model was retained over the two-week interval. The study concludes that the 7Es Teaching Model is more effective than the Demonstration Method for improving academic performance and is equally effective in supporting durable retention of Chemical Behaviour of Gases, and recommends its adoption in Sokoto Metropolis secondary schools.

Keywords: 7Es Teaching Model, Demonstration Method, Academic Performance, Retention, Chemical Behaviour of Gases

Cite this as (APA): Aliyu, M., Samaila, K., & Muhammad, R. (2026). Effects of 7Es Teaching Model and Demonstration Method on SSS1 Students' Academic Performance and Retention on Chemical Behaviour of Gases. *Rima International Journal of Education*, 5(6), 161—180. DOI: <https://doi.org/10.65760/rijessu.v5.6.10>

Introduction

Chemistry holds a particularly important position among the science subjects taught in Nigerian secondary schools: it underpins several fields of higher study, including medicine, agriculture, and engineering (Ngozi, 2021), and its mastery is widely regarded as vital to a nation's technological and economic advancement (Adeniyi *et al.*, 2021). Despite ongoing efforts by government bodies, researchers, and professional groups such as the Science Teachers' Association of Nigeria (STAN) to raise achievement levels, senior secondary students' chemistry results have stayed weak for years (Ikuejube, 2024). Several researchers link this poor academic outcome directly to instructional approach rather than to students' ability (Odukwe & Nwafor, 2022), and many students carry misconceptions into chemistry lessons that may themselves stem from the way teachers present the material (Kyado, Achor & Adah, 2021; Etokeren & Abosede, 2022).

This underperformance is visible nationally, with results from the West African Senior School Certificate Examination consistently falling short of expectations (Anthony, 2021). Under-equipped laboratories, limited exposure to inquiry-based teaching, and a shortage of adequately trained chemistry teachers (Badmus, 2023) make abstract topics especially hard for students to grasp, pushing many toward memorising facts rather than genuinely understanding them (Usman, 2021). Where laboratories are missing or under-used, teachers tend to rely on lecturing and demonstrating rather than involving students directly, and the resulting instruction often fails to build the kind of durable understanding that deeper learning requires (Usman, 2021).

Chemical Behaviour of Gases is one such abstract but foundational topic. It underlies students' later understanding of gas laws, molecular behaviour, and the interplay between temperature, pressure, and volume (Alabi *et al.*, 2023), concepts that matter greatly for anyone pursuing further study in science or technology. Because gases cannot be directly observed behaving the way solids and liquids can, students often struggle to connect the underlying theory to anything tangible. Zarei (2022) found that students could often manipulate gas law formulas to solve for an unknown variable without being able to explain what that variable meant conceptually, a sign that procedural fluency was outpacing real understanding. Research consistently shows that students learn more when actively involved in the learning process (Deslauriers *et al.*,

2019), a finding well aligned with constructivist theory, which holds that learners build understanding through direct experience with phenomena (Tobin, 2021).

One instructional response to this pattern is the learning cycle model. It originated as a three-phase (Exploration, Invention, Discovery) sequence developed by Atkin and Karplus in the 1960s. Between 1987 and 1989, the Biological Sciences Curriculum Study, led by Rodger Bybee, expanded this into the five-phase 5E model (Engage, Explore, Explain, Elaborate, Evaluate), grounded explicitly in constructivist learning theory. Eisenkraft (2003) subsequently extended the 5E model to seven phases by adding Elicit, to surface learners' prior conceptions before instruction begins, and extend, to support transfer of learning to new contexts, producing the 7Es model used in this study: Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend. Each phase serves a distinct instructional function, and the model's design specifically targets the kind of surface-level, examination-driven learning that is associated with poor retention in chemistry.

The Demonstration Method, by contrast, remains the dominant approach in many Nigerian chemistry classrooms because it requires fewer resources and less classroom-management complexity than fully learner-centred approaches. It has documented value for procedural and practical content (Okorafor *et al.*, 2023) but leaves the extent of learner cognitive engagement largely teacher-controlled. Comparing it directly against the 7Es model on the same topic, with the same students, allows a study to isolate the effect of instructional structure rather than resource availability alone, a comparison that had not previously been made for Chemical Behaviour of Gases in Sokoto Metropolis.

Academic performance in chemistry at the senior secondary level has long concerned Nigerian educators, researchers, and policymakers. It is generally understood as the measurable outcome of student learning, captured through tests and other assessment tools. WASSCE performance in chemistry has consistently fallen short of expectations despite repeated government interventions and curriculum reform, and Ikuejube (2024) found that a substantial share of Nigerian senior secondary students fails to secure credit passes in the subject, with abstract topics like gas laws contributing heavily to this outcome. Onunkwo *et al.* (2025) trace this persistent underperformance to a continued reliance on teacher-centred delivery that favours covering content

over building conceptual understanding, an approach that leaves students poorly equipped to develop the higher-order thinking gas laws require.

Performance is only part of the picture; how well students retain what they learn matters just as much. Retention refers to a learner's capacity to recall and apply previously acquired knowledge after time has passed since instruction, and in chemistry it carries particular weight because later topics build directly on earlier foundational ones such as gas laws; students who cannot retain earlier material will struggle to progress. Nigerian research consistently finds that conventional, lecture-based teaching produces weak retention, largely because students commit material to memory for the sake of passing an exam rather than genuinely internalising it (Okoli & Ibe, 2023). Salihu and Muhammad (2024), working with Nigerian secondary school students, found that more innovative instructional strategies markedly improved both performance and retention relative to conventional teaching, reinforcing the broader point that how a topic is taught shapes how long students remember it. Given that Chemical Behaviour of Gases requires learners to recall and combine multiple interconnected laws, weak retention here can snowball into wider knowledge gaps that damage overall achievement in science. Usman (2024) adds that teaching methods which deliberately connect new material to what students already know tend to produce stronger retention, since they help students build organised cognitive structures, which suggests the 7Es model, with its structured phases for eliciting prior knowledge and extending new learning, may be especially well suited to supporting retention among students in Sokoto Metropolis.

The 7Es Teaching Model

The 7Es Teaching Model is a constructivist, learner-centred instructional framework comprising seven sequential phases: Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend (Eisenkraft, 2003). The Elicit phase surfaces students' prior knowledge and misconceptions before formal instruction begins, allowing the teacher to build new understanding on an accurate foundation. The Engage phase captures learner interest through a problem, demonstration, or question that creates curiosity. The Explore phase allows students to investigate the concept hands-on, often in small groups, before formal explanation is given. The Explain phase introduces the formal vocabulary and theoretical structure needed to interpret what was explored. The Elaborate phase extends the concept to new situations, deepening

understanding through application. The Evaluate phase assesses whether learning objectives were achieved, and the Extend phase connects the concept to broader, real-world contexts. This cyclical, multi-phase structure is grounded in Constructivist Learning Theory, which holds that learners actively construct knowledge through direct experience rather than passively receiving it from the teacher (Piaget, 1972; Vygotsky, 1978).

The Demonstration Method

The Demonstration Method is a teacher-centred instructional approach in which the teacher performs an experiment or procedure in front of the class while students observe, listen, and take notes (Okorafor, Akanwa & Ugwu, 2023). The method is valued for its efficiency and its relatively modest resource requirements, since it does not require every student to have access to individual laboratory equipment. However, because the demonstration is performed by the teacher rather than the student, the depth of learner cognitive engagement it produces is largely teacher-controlled, and it offers fewer natural opportunities for the kind of active, elaborative processing associated with durable learning.

The Concept of Retention in Chemistry Education

Retention ability refers to learners' capacity to remember, accurately recall, and meaningfully apply knowledge and skills they acquired earlier, after a period during which that material has not been actively rehearsed or reviewed (Usman, 2024). In chemistry education, retention is not simply a desirable outcome; it is a functional necessity, since chemistry builds cumulatively and understanding advanced topics depends directly on a secure grasp of foundational concepts introduced earlier in the curriculum. Gas laws, for instance, are prerequisite knowledge for later senior secondary topics such as thermodynamics, equilibrium, and electrochemistry, and students who fail to retain their understanding of gas behaviour will run into compounding difficulty as the curriculum advances. Educational psychology research consistently shows that knowledge acquired through active, meaningful, and elaborative processing is retained considerably longer than knowledge acquired through passive, surface-level exposure (Yusuf & Adamu, 2022). When learners actively engage with new information, connecting it to what they already know and reflecting on its meaning, the resulting memory traces are deeper, more interconnected, and more resistant to decay than those

formed through mere listening or observation. This principle underpins the expectation that the 7Es model, with its systematic engagement of multiple active-processing phases, will produce stronger retention outcomes than the Demonstration Method.

Empirical Studies on the 7Es Teaching Model, Academic Performance, and Retention

Several recent studies have examined the effect of the 7Es Teaching Model on academic performance across subjects. Adanu-Ogbole, Akinola and Hassan (2025), in a large-scale quasi-experimental study among Lagos State chemistry students, found that those exposed to the 7Es Learning Cycle recorded significantly higher achievement scores than those taught conventionally. Abdulrahim (2025) reported a similar pattern among biology students in Kwara State, and Akpan, Umanah, Udofia and Etim (2025) compared the 3E, 5E, and 7E learning cycle models on chemistry achievement in Akwa Ibom State and found the 7E model produced the highest achievement scores of the three.

With respect to retention specifically, Isma'il and Moriki (2023) found that students taught genetics using the 7Es model retained significantly more content after a four-week gap than those taught by demonstration, working within a chemistry-related context in Zamfara State that closely mirrors the design of the present study. Adam, Soladoye and Ayodele (2022) reported a comparable retention advantage for the 7E learning cycle model in ecology over a six-week period, while Usman and Ahmed (2023) and Adeyemi and Oloruntoba (2024) documented similar retention advantages for learner-centred instructional strategies in chemistry and basic science respectively. The consistency of this pattern across subjects, regions, and time intervals lends strong support to the expectation that the 7Es model's cyclical, multi-phase structure, which repeatedly requires students to explore, explain, elaborate on, and apply what they have learned, reinforces the underlying cognitive structures well beyond the point of initial instruction, producing more durable learning than the Demonstration Method's more passive, observational structure.

Theoretical Framework

This study is anchored on Constructivist Learning Theory, associated with the work of Piaget (1972) and later extended by Vygotsky (1978) and Bruner.

Constructivist theory holds that learners actively construct meaning rather than passively absorb information transmitted to them, building new understanding by connecting new experience to existing knowledge structures. The 7Es Teaching Model, spanning Elicit through Extend, follows a clearly constructivist orientation, since it pushes students to build knowledge actively through inquiry, exploration, and reflection at each stage. This theoretical grounding supports the expectation that the 7Es model, relative to the more teacher-centred Demonstration Method, would produce both stronger academic performance and more durable retention, since constructivist engagement is associated with deeper, more interconnected memory traces that resist decay over time (Hodson & Wong, 2022).

Statement of the Problem

Senior secondary chemistry performance in Nigeria has stayed persistently weak, and Chemical Behaviour of Gases is among the topics hit hardest, since it requires students to reason about invisible particulate behaviour using several interrelated mathematical laws (Onunkwo, 2025). In Sokoto Metropolis, this difficulty is worsened by classrooms with limited resources and a continuing reliance on lecture- and demonstration-based delivery (Alhassan, 2019). Existing research shows that shifting toward active, learner-centred instruction improves both achievement and retention in chemistry (Muhammad & Yusuf, 2025; Ramatu, 2025), yet none of this work has tested a complete learning-cycle model specifically on Chemical Behaviour of Gases, and none has been carried out within Sokoto Metropolis. Existing comparisons are also narrow in what they measure: most examine only academic performance in isolation, despite evidence that performance and retention are closely interdependent, since weak retention undermines later performance (Musengimana *et al.*, 2021).

It is this combination of gaps, geographic, topical, and methodological, that motivated the present study. Without Sokoto-specific evidence covering both outcomes together, teachers and curriculum planners in the state have no basis for judging whether adopting the 7Es model justifies the added preparation and training investment relative to the Demonstration Method already in use. This study therefore compared the 7Es Teaching Model with the Demonstration Method on senior secondary school students' academic performance and examined the retention ability of students taught using the 7Es Teaching Model in Chemical Behaviour of Gases in Sokoto Metropolis.

Objectives of the Study

The objectives of the study are:

1. To examine the difference in academic performance between students exposed to the 7Es Teaching Model and those exposed to the Demonstration Method on Chemical Behaviour of Gases in Sokoto Metropolis.
2. To examine the difference in retention ability of students exposed to the 7Es Teaching Model on Chemical Behaviour of Gases in Sokoto Metropolis.

Research Questions

The research questions of this study are:

1. Is there any significant difference in the academic performance of students exposed to the 7Es Teaching Model and those exposed to the Demonstration Method on Chemical Behaviour of Gases in Sokoto Metropolis schools?
2. Is there any significant difference in the retention ability of students exposed to the 7Es Teaching Model on Chemical Behaviour of Gases in Sokoto Metropolis schools?

Hypothesis

The hypothesis are

- H_{o1}: There is no significant difference in the academic performance of students exposed to the 7Es Teaching Model and those exposed to the Demonstration Method on Chemical Behaviour of Gases in Sokoto Metropolis schools.
- H_{o2}: There is no significant difference in the retention ability of students exposed to the 7Es Teaching Model on Chemical Behaviour of Gases in Sokoto Metropolis schools.

Research Methodology

This study adopted a quasi-experimental pretest-posttest-delayed-posttest, non-equivalent control group design. Quasi-experimental designs are appropriate where random assignment of participants to groups is not feasible but the researcher nonetheless seeks to establish cause-and-effect relationships (Janssen & Kollar, 2021). The design involved two groups, experimental and control, formed from intact classes of Senior Secondary School One (SSS I) students in Sokoto Metropolis. The experimental group was taught using the 7Es Teaching Model, while the control group was taught using the Demonstration Method. After a six-week treatment period, a post-test was administered to measure academic performance, followed by a delayed post-test two weeks later, administered to the experimental group, to assess retention.

The population of this study comprised all Senior Secondary School One chemistry students across the 48 public secondary schools in Sokoto Metropolis, numbering 4,707 students. A purposive sampling technique was used to select two public secondary schools considered suitable for the study, based on the availability of SSSI chemistry students, qualified chemistry teachers, and comparable learning environments. From each selected school, one intact chemistry class was drawn, producing a total sample of 109 students: 51 in the experimental group (Sani Dingyadi Unity Secondary School, Sokoto) and 58 in the control group (Sokoto Science College, Sokoto). Using intact classes was appropriate given the study's quasi-experimental design, since randomly assigning individual students to treatment conditions was not feasible; existing classes were therefore retained, preserving the schools' normal instructional arrangements (Creswell & Creswell, 2023).

The Academic Performance Test on Chemical Behaviour of Gases (APTCBG) was used to collect data for both outcomes examined in this study. It was designed by the researcher in collaboration with experienced secondary school chemistry teachers, based on the SSSI chemistry syllabus, and consists of 30 multiple-choice items with options A to D. The same instrument was used as the post-test to measure academic performance and, for the experimental group only, as a delayed post-test administered two weeks later to measure retention. The instrument was reviewed for validity by three experts from the Department of Science Education, Sokoto State University, and two experienced secondary school chemistry teachers, and was piloted with 40

SSS I students from a school outside the main sample. Reliability was established using the test-retest approach, yielding a coefficient of 0.89.

In Week 1, the researcher introduced the study to the students in both schools and administered a pretest using the APTCBG to establish baseline equivalence between the two groups. During Weeks 2 to 7, the instructional treatment was carried out. The experimental group received chemistry lessons on Chemical Behaviour of Gases using the 7Es Teaching Model across its seven sequential phases, while the control group received lessons on the same content using the Demonstration Method. Both groups covered the same topics, including the properties of gases, Boyle's Law, Charles' Law, Gay-Lussac's Law, the combined and ideal gas laws, and kinetic molecular theory, with equal instructional time maintained across both groups. At the end of Week 7, a post-test using the APTCBG was administered to both groups to measure academic performance. In Week 9, two weeks after the post-test, a delayed post-test was administered to the experimental group using the same APTCBG instrument, to assess the extent to which the concepts learned had been retained; during this two-week interval, students received no further instruction on Chemical Behaviour of Gases.

Data were analysed using descriptive statistics (mean and standard deviation) to answer the research questions. Null Hypothesis One was tested using Analysis of Variance (ANOVA) at the 0.05 level of significance, while Null Hypothesis Two, which examined the difference between the experimental group's posttest and delayed posttest scores, was tested using Repeated Measures Analysis of Variance. The Shapiro-Wilk test was used to assess the normality of the posttest and delay posttest score distributions; although several distributions showed departures from strict normality, sample sizes were sufficiently large and reasonably balanced across groups, and ANOVA is generally robust to moderate violations of normality under such conditions (Knief & Forstmeier, 2021; Blanca et al., 2024). ANOVA and Repeated Measures ANOVA were accordingly retained as the appropriate tests for the two hypotheses.

Results

Baseline Equivalence

Before treatment, an independent samples t-test on pretest APTCBG scores confirmed that the two groups were statistically equivalent, $t(107) = 0.130$, $p =$

0.897, with the experimental group recording a mean pretest score of 12.12 (SD = 1.87) and the control group recording a mean pretest score of 12.07 (SD = 2.02). This confirmed that students in both groups had comparable prior knowledge of Chemical Behaviour of Gases before treatment.

Answering Research Question One and Null Hypothesis One: Academic Performance

Research Question One: Is there any significant difference in the academic performance of students exposed to the 7Es Teaching Model and those exposed to the Demonstration Method on Chemical Behaviour of Gases in Sokoto Metropolis schools?

To answer Research Question One, posttest scores from the APTCBG were analysed using descriptive statistics, presented in Table 1.

Table 1

Descriptive Statistics of Posttest Scores of Students Exposed to the 7Es Teaching Model and Control Groups

Group	N	Mean	SD
Experimental	51	24.29	2.19
Control	58	16.24	1.61

Table 1 shows that the experimental group recorded a mean posttest score of 24.29 (SD = 2.19), while the control group obtained a mean posttest score of 16.24 (SD = 1.61), a mean difference of 8.05 points between the groups.

Null Hypothesis One

HO₁: There is no significant difference in the academic performance of students exposed to the 7Es Teaching Model and those exposed to the Demonstration Method on the Chemical Behaviour of Gases in Sokoto Metropolis schools.

To test this hypothesis, the posttest data from the APTCBG were subjected to Analysis of Variance (ANOVA) at $\alpha = 0.05$. The result is presented in Table 2.

Table 2

Analysis of Variance (ANOVA) of Posttest Scores of Students Exposed to the 7Es Teaching Model and Demonstration Method

Source of Variation	SS	Df	MS	F	Sig.	Decision
Between Groups	1759.782	1	1759.782	483.793	0.001	HO ₁ Rejected
Within Groups	389.209	107	3.637			
Total	2148.991	108				

The ANOVA results in Table 2 revealed a statistically significant difference in the academic performance of students exposed to the 7Es Teaching Model and those exposed to the Demonstration Method on Chemical Behaviour of Gases, $F(1,107) = 483.793$, $p = .000$. Since the obtained p-value was less than 0.05, the null hypothesis was rejected. The descriptive statistics further showed that students taught using the 7Es Teaching Model obtained a higher mean score ($M = 24.29$, $SD = 2.19$) than those taught using the Demonstration Method ($M = 16.24$, $SD = 1.61$), indicating that the 7Es Teaching Model was more effective in improving students' academic performance on Chemical Behaviour of Gases than the Demonstration Method.

Answering Research Question Two and Null Hypothesis Two: Retention

Research Question Two: Is there any significant difference in the retention ability of students exposed to the 7Es Teaching Model on Chemical Behaviour of Gases in Sokoto Metropolis schools?

To answer Research Question Two, delay posttest scores from the APTCBG, re-administered two weeks after the instructional treatment ended, were analysed using descriptive statistics. The delay posttest served as the measure of students' retention ability, assessing the extent to which they had maintained their knowledge of Chemical Behaviour of Gases following a period of non-instruction. The results are presented in Table 3.

Table 3

Descriptive Statistics of Posttest and Delay Posttest Scores of Students Exposed to the 7Es Teaching Model

Test	N	Mean	Standard Deviation	Mean Difference
Posttest	51	24.29	2.19	0.10
Delay Posttest	51	24.39	1.84	

Table 3 presents the descriptive statistics of the posttest and delayed posttest scores of students exposed to the 7Es Teaching Model. The results revealed a posttest mean score of 24.29 (SD = 2.19) and a delayed posttest mean score of 24.39 (SD = 1.84), with the delayed posttest score being slightly higher than the posttest mean by 0.10. This finding suggests that students retained the concepts taught on Chemical Behaviour of Gases after the treatment period, indicating that the 7Es Teaching Model was effective in supporting students' retention of the learned concepts.

Null Hypothesis Two

HO₂: There is no significant difference in the retention ability of students exposed to the 7Es Teaching Model on the Chemical Behaviour of Gases in Sokoto Metropolis schools.

To test this hypothesis, the delay posttest data from the APTCBG were subjected to Repeated Measures ANOVA at $\alpha = 0.05$. The result is presented in Table 4.

Table 4

Repeated Measures ANOVA Showing the Difference Between Posttest and Delay Posttest Scores of Students Exposed to the 7Es Teaching Model

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Squared	Eta
Test	0.245	1	0.245	0.054	0.817	0.001	
Error (Test)	225.255	50	4.505				

Table 4 presents the results of the repeated measures ANOVA comparing students' posttest and delayed posttest scores after exposure to the 7Es Teaching Model on Chemical Behaviour of Gases. The results show that there was no statistically significant difference between the students' posttest and delayed posttest scores, $F(1,50) = 0.054$, $p = 0.817$, partial $\eta^2 = 0.001$. Since the significance value of 0.817 is greater than the 0.05 level of significance, the null hypothesis, which states that there is no significant difference in the retention ability of students exposed to the 7Es Teaching Model on the Chemical Behaviour of Gases, is not rejected. This indicates that students' performance did not change significantly between the posttest and delay posttest, suggesting that the students were able to retain the concepts learned after the treatment period. The very small effect size (partial $\eta^2 = 0.001$) further indicates that the difference between the two testing occasions was negligible.

Discussion

The findings revealed that before treatment was introduced, there was no significant difference between the academic abilities of students in the experimental and control groups, confirming that both groups were academically homogeneous at the commencement of the study. Following the six-week instructional treatment, students taught using the 7Es Teaching Model recorded significantly higher academic performance than those taught using the Demonstration Method. This result agrees with the work of Adanu-Ogbole *et al.* (2025), whose Lagos State study found that students exposed to the 7Es Learning Cycle recorded significantly higher chemistry achievement than those taught conventionally. The superior performance of the experimental group in this study can reasonably be attributed to the interactive, activity-driven, and learner-centred structure of the 7Es model, which guided students through eliciting prior knowledge, exploring gas concepts collaboratively, explaining their reasoning, and extending their understanding to practical situations, a process the Demonstration Method's more passive, observational structure does not replicate.

With respect to retention, students exposed to the 7Es Teaching Model recorded a delayed posttest mean score slightly above their immediate posttest mean, and the Repeated Measures ANOVA found no statistically significant difference between the two. Rather than indicating a weakness in the design, this non-significant result is the desired outcome: it shows that the knowledge

students gained through the 7Es approach was firmly retained over the two-week interval rather than fading. This finding is consistent with Isma'il and Moriki (2023), who found that students taught genetics using the 7Es model retained significantly more content after a four-week gap than those taught by demonstration. Adam *et al.* (2022) reported a comparable pattern in ecology over six weeks, while Usman and Ahmed (2023) and Adeyemi and Oloruntoba (2024) documented similar retention advantages in chemistry and basic science respectively. The consistency of this pattern across subjects, regions, and time intervals strengthens confidence in the present result. The durability of learning under the 7Es model may be explained by its cyclical, multi-phase structure, which repeatedly requires students to explore, explain, elaborate on, and apply what they have learned, thereby reinforcing the underlying cognitive structures well beyond the point of initial instruction.

Taken together, the rejection of Ho1 and the retention of learning gains reflected in the non-rejection of Ho2 provide converging empirical support for the effectiveness of the 7Es Teaching Model, relative to the Demonstration Method, in producing both stronger academic performance and more durable learning of Chemical Behaviour of Gases. These findings affirm the value of structured, constructivist, inquiry-based instruction for teaching abstract chemistry concepts within the Sokoto Metropolis context, and align closely with the broader pattern of findings reported across similar studies conducted in other Nigerian states.

Conclusion

This study compared the effects of the 7Es Teaching Model and the Demonstration Method on the academic performance of SSS I students and examined the retention ability of students taught using the 7Es Teaching Model in Chemical Behaviour of Gases in Sokoto Metropolis. Findings showed that students taught using the 7Es Teaching Model significantly outperformed those taught using the Demonstration Method in academic performance, and that the knowledge gained under the 7Es model was retained over a two-week interval without significant decline. The study concludes that the 7Es Teaching Model is a more effective instructional approach than the Demonstration Method for teaching abstract chemistry topics such as Chemical Behaviour of Gases, producing both stronger immediate academic performance and durable, lasting understanding, owing to its learner-centred,

constructivist design, which actively engages students in knowledge construction through inquiry, exploration, elaboration, and evaluation.

Recommendations

1. Chemistry teachers in Sokoto Metropolis and northern Nigeria should adopt the 7Es Teaching Model when teaching abstract and conceptually demanding topics such as Chemical Behaviour of Gases, given its demonstrated effectiveness in improving both academic performance and retention.
2. School administrators and chemistry departments should organise regular in-service training workshops to equip serving chemistry teachers with the skills required to implement the 7Es Teaching Model effectively in their classrooms.
3. Curriculum developers and the National Educational Research and Development Council (NERDC) should consider formally integrating constructivist instructional frameworks such as the 7Es model into national chemistry curriculum guidelines, particularly for cumulative topics where retention of foundational concepts is essential.
4. Where laboratory resources are limited, chemistry teachers should combine the Demonstration Method with structured learner-centred activities drawn from the 7Es framework, such as group inquiry and guided elaboration exercises, to strengthen retention of teacher-led demonstrations.
5. Policymakers at the Sokoto State Ministry of Education should invest in instructional materials and teacher training that support the implementation of active, inquiry-based learning models capable of producing durable, lasting learning in chemistry classrooms across the state.

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