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Effects of Guided Discovery Instructional Strategy on Students' Retention, of Biology Concepts in Senior Secondary Schools in Federal Capital Territory- Abuja, Nigeria

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Abstract: This study investigated Effects of Guided Discovery Instructional Strategy on Students' retention of biology concepts in senior secondary schools in Federal Capital Territory, Abuja, Nigeria. The study was a quasi-experimental, which involved intact classes groups of students assigned to two treatment groups. The population of the study was 36,188 S. S.2 Biology Students in Federal Capital Territory from which 102 students were sampled and assigned to the two groups (experimental and control). Two research questions and two hypotheses tested at $p< 0.05$ level of significance guided the study. The instruments used for data collection was Biology Retention Test (BRT. The trial test to determine coefficient of stability of Biology Retention Test (BRT) was carried out using the pilot-test reliability technique. The reliability coefficient of the instrument was done using Pearson Product – Moment Correlation to determine the internal consistency of the Biology Retention Test (BRT) items which gave a reliability index of 0.81. The data collected were analysed using descriptive statistics to answer the research questions while ANCOVA were used to test the hypotheses. The study revealed that Guided Discovery Instructional Strategy is more effective than Conventional teaching method and that the male and female participants are very similar in their mean scores for retention of biology concepts which implies that Guided Discovery Instructional Strategy is not gender bias. It is therefore recommended among others that biology teachers in senior secondary schools should adopt the use of guided discovery instructional strategy in order to enhance retention of biology concepts in students.

Introduction

Education is a process of acquiring knowledge through study or imparting the knowledge by way of instructions or some other practical procedures. It is a gradual process which brings positive changes in human life and behavior. According to Organization for Economic Co-operation and Development, (OECD) (2020), Education can be categorized into three namely Informal, Non-formal and formal. Formal education is an organized and regulated system of education which follows a curriculum and awards recognize academic certificates or degrees However, the focus of this study is on formal education. Formal education also embodies science education. Science education refers to the process of equipping students with fundamental scientific skills; fostering curiosity and positive attitude towards science and enabling them understand the natural world, make informed personal decisions and engage with the scientific and technological aspect of society. The study of science could be divided into many branches including astronomy, biology, chemistry, geology and physics.

Gilbert (2017) defines Biology as the scientific study of life and living organisms that explores the structure, function, growth, evolution, distribution, and taxonomy of all living things, from the simplest bacteria to complex ecosystems. Biology encompasses various subfields, including: Botany, Zoology, Microbiology, Genetics, etc. Nwagbo (2018) pointed out that the structure of the Nigerian secondary school requires students to offer one science subject and Biology is the science subject most of the students opt for on the false premise that it is the easiest of the sciences. For this

reason, Biology has a very high enrolment of students in the external examination (West African Examination Council, 2022). Despite the importance of biology as a science subject, Dike and Adebayo, in Apochi (2016), described as national embarrassment, the poor results recorded by students at the West African Examination Council, (WAEC), and National Examination Council, (NECO), examinations in the country. From observation and review of works in literature the following were identify as the causes of students' poor achievement in biology: i) biology learning is still dependent on the teacher as the students are not giving opportunities to exploit their abilities. Ii) classroom learning is devoid of the use of students' prior knowledge and this can weaken the necessary information gathering in order for the students to understand a concept.

These identified reasons show that the poor achievement of students in biology is caused by teaching methodology and processes which are not executed properly. This has also affected students' retention of concepts and has reflected in their achievements. It is a well-known fact that the quality of education depends on the teacher and so the method they adopt in teaching matters a lot. This persistent poor achievement of students in biology reported yearly in WAEC has shown that lecture instructional strategy influence students' achievement and retention in biology negative. This shows that the teaching of biology is not properly executed. For the teaching of biology to be executed properly. For the teaching of Biology to be executed properly, Biology teachers have to adopt the constructivist learning approaches where the learning is not centered on teacher but on the students using their existing knowledge to solve problems presented to them by their teachers. When this is done, retention takes place. Guided Discovery Instructional Strategy is among the constructivist teaching approaches.

Ojelade, et al (2024) stated retention as a tool employed by learners to assist them performs efficiently and effectively in all aspects of life particularly in the school. This essential tool is needed by learners to maintain and manipulate information in the mind for short and even long period of time. The level of retention is determined by the nature of material needed. He outlines certain factors affecting students' retention in relation to academic achievement in biology, these factors include individuals thinking style of the learners, the age of learners, nature of materials to be learned, teaching method employed by the teacher. Therefore, lessons need to be presented to learners using a strategy that touches their sub consciousness which can trigger quick recalling of concepts being taught or learnt. This study therefore intends to employ the use of Guided Discovery Instructional Strategy to determine its effects on retention of biology students.

Discovery Instructional Strategy is one of the instructional approaches that could be used in effective teaching of biology. According to Brunner discovery strategy is in essence a matter of re-arranging or transforming evidence in such a way that one is enabled to go beyond the evidence and re-assemble additional new knowledge. The emphasis of science education through Guided Discovery Instructional Strategy is to enhance students' scientific literacy through investigative activities that involve planning, measuring, observing, analysis of data, designing and evaluating procedures, and examining evidence. Learning science enables students to lead a fulfilling and responsible life by encouraging them to learn independently, deal with new situations, reason critically, think creatively, make informed decisions and solve problems. Students with high ability or a strong interest in science need more challenging learning programs. These programs could stretch the students' science capabilities and offer opportunities for them to develop their potentials to the full. According to Abdullahi and Nor, (2020), two types of Discovery methods can be identified, guided discovery and unguided discovery. Whether the discovery is guided or unguided, the child is led to discover new facts/ideas by himself. This could rekindle interest, create positive attitude and increase content retention towards the subject.

Purpose of the Study

The purpose of the study is to investigate the effects of guided discovery instructional strategy on secondary school students' retention in Biology. Specifically, the objectives of the study are to:

i. Investigate the difference between the mean retention scores of senior secondary school students taught Biology using the guided discovery instructional strategy and their counterpart taught using the conventional teaching method.

ii. Determine the difference between the mean retention scores of male and female senior secondary schools' students taught Biology using the guided discovery instructional strategy.

Research Questions

The following research questions were raised to guide the study:

i. What is the difference between the mean retention scores of senior secondary school students taught Biology using the guided discovery instructional strategy and their counterparts taught using the conventional teaching method?

ii. What is the difference between the mean retention scores of male and female senior secondary schools' students taught Biology using guided discovery instructional strategy?

Hypotheses

The following null hypotheses were generated to be tested at 0.05 level of significance.

H_{01}. There is no significant difference between retention scores of senior secondary school students taught Biology using the guided discovery instructional strategy and their counterparts taught using the conventional teaching methods.

H_{02}. There is no significant difference between the mean retention scores of male and female senior secondary schools' students taught Biology using the guided discovery instructional strategy.

Literature

The guided discovery instructional strategy is rooted in the constructivist theory of learning, which emphasizes the learner's active role in knowledge construction through experiences, inquiry, and reflection on the work of Bruner, and Vygotsky. Bruner, a key proponent of discovery learning, posited that learners retain knowledge more effectively when they discover information themselves, as opposed to passively receiving it. Aregbesola, et al (2025) submitted that guided discovery approach provides structured guidance through teacher-facilitated tasks that enable learners to make sense of content on their own terms. While Piaget supported the relevance of discovery-based approaches in science learning, arguing that cognitive development progresses through active exploration and assimilation of new ideas. Within biology education, guided discovery is often implemented through problem-solving activities, laboratory exercises, and concept-mapping tasks that allow students to relate abstract concepts to observable phenomena (Ajaja & Eravwoke, 2020).

Retention in education refers to the learner's ability to store, recall, and apply knowledge over time. Numerous studies have shown that guided discovery enhances this aspect of learning significantly, especially in science subjects like biology. For example, Udo and Essien (2020) found that senior secondary school students who were taught biology concepts such as respiration and osmosis using guided discovery performed significantly better in delayed post-tests than those taught via traditional lecture methods. Similarly, Adeyemi (2015) reported that discovery-based instruction promotes meaningful learning, which results in higher retention levels because learners actively participate in constructing knowledge rather than memorizing disconnected facts. His study concluded that retention scores were significantly higher among learners exposed to guided discovery compared to expository teaching methods. Guided discovery, by engaging students in active problem-solving and experimentation, leads to improved conceptual understanding and better memory encoding. According to Aregbesola (2023), this approach facilitates the integration of theoretical knowledge with practical experiences, enhancing students' ability to retrieve and apply the knowledge in real-life or assessment contexts.

While cognitive gains from guided discovery are generally observed across different learner demographics, some studies have investigated gender as a moderating variable. For instance, Apochi, et al (2022) found that both male and female biology students in Nigerian senior secondary

schools benefitted equally from guided discovery, suggesting its gender-neutral efficacy. These findings are crucial for the Nigerian context, where sociocultural and educational disparities sometimes skew learning outcomes across gender lines (Okeke, 2018). Furthermore, guided discovery allows for differentiation based on learners' cognitive abilities and learning styles. By enabling learners to engage at their own pace within structured learning environments, it reduces performance anxiety and encourages self-directed learning an important factor in knowledge retention (Chukwuemeka, et al. 2025). The integration of guided discovery into the biology curriculum aligns with this vision and offers a practical strategy for addressing retention challenges commonly faced in the subject.

In a study conducted by **Abu (2023)** on *Effect of Guided Discovery Method on Students' Academic Achievement in Biology in Kogi State*, the researcher explored the retention capacity of SS2 students taught using guided discovery. A sample of 61 students was selected from secondary schools in Idah Educational Zone. The Biology Achievement Test (BAT), comprising multiple-choice and essay questions, was the main instrument. Validity was determined by subject experts, while a reliability coefficient of 0.87 was obtained using the test–retest method. Data collection followed a pre-test, post-test design, with retention measured two weeks after the intervention. Independent samples t-test revealed a statistically significant improvement in retention among the guided discovery group compared to the control. **Ezema et al. (2022)** studied the *Impact of Guided Inquiry on Biology Students' Retention in Plateau State*. The study population comprised SS2 students, and a total of **358 participants** were randomly selected across schools. The instrument used was a Biology Retention Test (BRT) consisting of 50 multiple-choice questions, validated by biology educators, and with a reliability index of 0.74 using the Spearman-Brown method. A quasi-experimental design was adopted, and retention was assessed after a two-week delay. The use of ANCOVA at a 0.05 level showed that guided inquiry significantly improved students' retention scores when compared to traditional methods.

A related study by **Egbes and Ajaja (2023)** in Delta State, titled *Effects of Guided Discovery and Problem-Solving Methods on Students' Retention in Biology*, involved **238 SS2 biology students**. The researchers administered a Biology Achievement Test validated by university lecturers and obtained a KR-21 reliability index of 0.83. The study uniquely featured a **follow-up post-test** administered three weeks after instruction to determine long-term retention. Data were analyzed using ANOVA and ANCOVA. Results indicated that guided discovery outperformed both lecture and problem-solving methods in terms of students' ability to retain learned concepts over time. **Otuturu (2023)**, in a study titled *Impact of Guided Discovery on Students' Understanding and Retention of Ecological Concepts*, focused on 150 SSII students in Rivers State. The researcher used an Ecology Performance Test (EPT) developed in line with the biology curriculum, validated by specialists, and reported a high reliability coefficient of 0.95 through test–retest. Retention was evaluated after two weeks, and independent t-test results showed that the guided discovery group retained ecological concepts significantly better than the control group taught using lecture methods. In the Federal Capital Territory,

Fatai (2024) investigated the *Effectiveness of Guided Discovery on Biology Achievement and Retention among Students with Varying Learning Styles*. Though the sample size was not specified, the study targeted SS students in the Abuja Municipal Area Council. A Cell Biology Achievement Test (CBAT) was used, validated by education experts, with a KR-21 reliability index of 0.86. ANCOVA was used to compare pre- and post-intervention retention levels. Results indicated that guided discovery improved retention irrespective of students' learning styles, underscoring its universal applicability. Another study, **Adeuya (2020)**, examined *The Effectiveness of Guided Discovery on Performance and Retention in Biology among Senior Secondary Students in Ekiti State*. The study employed a quasi-experimental design with a sample of **80 students** drawn from two intact classes. The BAT was reviewed by measurement experts for content validity, but reliability details were not reported. Retention was assessed one week after the intervention. Statistical analysis using t-tests showed a significant improvement in retention scores for students taught using guided discovery. These studies collectively affirm the **positive impact of guided**

discovery on biology retention across various Nigerian regions. All adopted **quasi-experimental designs** with pre-test, post-test, and delayed post-test approaches. Instruments were generally **validated by experts**, and reliability indices where reported were robust (ranging from 0.74 to 0.95).

Analytical methods used include **t-tests, ANOVA, and ANCOVA**, all of which confirmed significant differences in favor of the guided discovery groups. The similarities with the current study include the **focus on SS2 biology students**, use of **validated retention tests**, and the **adoption of guided discovery as the intervention strategy**. Also, like the present study, most reviewed works aimed to determine the effectiveness of guided discovery on **long-term knowledge retention** rather than immediate performance only. However, the present study distinguishes itself in several ways. While **most existing studies do not clearly specify the time interval** between instruction and retention testing (or use very short intervals), the current study intends to implement a **more structured delayed post-test**, allowing for a better measure of **long-term retention**. Additionally, only **Egbes and Ajaja (2023)** included a **follow-up test**, and their focus included problem-solving alongside guided discovery, whereas the current study isolates **guided discovery alone** for clearer attribution of effects. Another important difference is the **geographical focus**. Despite several studies from other states, there is **limited empirical work specifically from the FCT**, especially using **public secondary school samples**. The current study addresses this gap by **focusing exclusively on FCT-based schools**, contributing localized data to national education discourse. Moreover, some of the previous studies such as Fati et al. (2020) do not report critical psychometric details like **instrument reliability**, which are essential for replicability and generalization. The present study ensures rigorous instrument development with **clearly reported validity and reliability metrics**.

Methodology

The design of this study was pretest, posttest control group quasi-experimental design. The study comprised of experimental group (EG) and the control group (CG). The sample size of one hundred and two (102) Biology students formed the sample of the study; The instruments for data collection was Biology Attitude Scale (BAS). BAS was a 20 - item instrument attitude-oriented scale built on a modified four-point Likert scale format of Strongly Agree (SA), Agree (A), Disagree (DA) Strongly Disagree (SD). For easy computation, the responses to positive statements will score as follows: SA=4, A=3, D=2, SD=1. The All the instruments were developed by the researcher. BAS was calculated using Pearson Product- moment correlation, this shows that the instrument is reliable. The null hypothesis was calculated using ANCOVA and the significant level for the statistical test was put at 0.05 level of significance, which allowed for rejection or acceptance of a hypothesis. For the Biology Attitude Scale built on a modified four-point Likert scale, a grand mean score of 2.5 and above was regarded as positive attitude while a mean score of below 2.5 was regarded as negative attitude.

Table 1: Distribution of Respondents by Groups

S/No	Group	Sample	Total	Percentage
	Gender	Male Female		
1	Experimental	29 21	50	49.02
2	Control	28 24	52	50.98
	Total	57 45	102	100

Table 1 showed that fifty (50) respondents representing 49.02% formed the experimental group while fifty-two (52) respondents representing 50.98% formed the control group. Total sample of the study was one hundred and two (102).

Table 2: Distribution of Respondents by Gender

Gender	No of Respondents	Percentages
Male	57	55.88
Female	45	44.12
Total	102	100%

Data Analysis and Results

The answers to Research questions were presented using descriptive statistics of mean and standard deviation.

Analysis of Research Questions

Research Question One: What is the difference between the mean retention scores of senior secondary school students taught Biology using the guided discovery instructional strategy and their counterparts taught using the conventional teaching method?

Table 3: Mean Retention Scores of Experiment and Control Group

Group	n	Mean	Standard Deviation	Mean Difference
Experimental	50	18.14	1.01	**4.95**
Control	52	13.19	1.49	

Source: Research Field Survey (2025)

The data presented on table 3 represent a summary of descriptive statistics comparison between experimental group and control group in relation to mean scores for BRT based on treatment accorded participants in both groups. The mean for the experimental group (18.14) is higher than that of the control group (13.19), indicating that the intervention to the experimental group had some effect, increasing their retention mean score. The standard deviation of the experimental group (1.01) is lower than that of the control group (1.49), suggesting that the experimental group's scores are more tightly clustered around the mean, while the control group's scores show greater variability. The mean difference of 4.95 indicates that the experimental group has a higher average score compared to the control group. This implies a positive effect of the guided discovery instructional strategy on students' retention in Biology.

Research Question two: What is the difference between the mean retention scores of male and female senior secondary schools' students taught Biology using guided discovery instructional strategy?

Table 4: Mean Retention Scores of Male and Female Student in Experimental Group

Gender	n	Mean	Standard Deviation	Mean Difference
Male	29	18.24	0.83	**0.24**
Female	21	18.00	1.22	

Source: Research Field Survey (2025)

The data presented on table 4 represent a summary of descriptive statistics comparison between male and female participants in the experimental group in relation to mean scores for BRT based on treatment accorded the participants. The mean for the male participants (18.24) is slightly higher than the mean for the female participants (18.00). The standard deviation for the male participants (0.83) is lower than the female participants' (1.22), indicating that the male participants' scores are not spread out compared to the female participants' scores. The mean difference of 0.24 is quite small, suggesting that, on average, the male and female participants are very similar in terms of retention in Biology.

Analysis of Hypotheses Hypothesis One: There is no significant difference between retention scores of senior secondary school students taught biology using guided discovery instructional strategy and their counterparts taught using the conventional teaching methods.

Table 5: Summary of ANCOVA for Analysis for Retention Scores of Experimental and Control Group

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	660.525[a]	2	330.263	256.313	0.001	**Rejected**
Intercept	463.500	1	463.500	359.717	0.001	
Pretest	36.534	1	36.534	28.354	0.001	
Group	454.972	1	454.972	353.098	0.001	
Error	127.563	99	1.289			
Total	25667.000	102				
Corrected Total	**788.088**	**101**				

a. R Squared = .838 (Adjusted R Squared = .835)

An analysis of covariance (ANCOVA) was conducted to determine the effect of the instructional strategies on students' retention in biology, while controlling for pretest scores. The results indicated a statistically significant difference between the experimental and control groups, after adjusting for pretest scores, $F(1, 99) = 353.10$, $p < .001$. The covariate (pretest score) also had a significant effect on retention scores, $F(1, 99) = 28.35$, $p < .001$, suggesting that students' prior knowledge contributed significantly to their post-intervention retention. The overall model was statistically significant, $F(2, 99) = 256.31$, $p < .001$, indicating that the combination of pretest scores and group membership explained a significant portion of the variance in the retention scores. As such, the null hypothesis three was rejected. Hence, there is significant difference between retention scores of senior secondary school students taught biology using the discovery instructional strategy and their counterparts taught using the conventional teaching methods.

Hypothesis Two: There is no significant difference between the mean retention scores of male and female senior secondary schools' students taught biology using the guided discovery instructional strategy.

Table 6: Summary of ANCOVA for retention scores of male and female students in Experimental Group

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	0.762[a]	2	.381	0.364	0.697	**Not Rejected**
Intercept	275.755	1	275.755	263.116	0.001	
Pretest	0.053	1	0.053	0.050	0.824	
Group	0.699	1	0.699	0.667	0.418	
Error	49.258	47	1.048			
Total	16503.000	50				
Corrected Total	**50.020**	**49**				

a. R Squared = .015 (Adjusted R Squared = -.027)

An analysis of covariance (ANCOVA) was conducted on data for hypothesis six. The results indicated that the effect of group was not statistically significant, $F(1, 47) = 0.67$, $p = .418$. The covariate, pretest score, also did not have a significant effect on the retention scores, $F(1, 47) = 0.05$, $p = .824$. Additionally, the overall model was not statistically significant, $F(2, 47) = 0.36$, $p = .697$, indicating that neither group membership nor pretest scores accounted for a significant amount of variance in the retention scores. Therefore, the null hypothesis six was not rejected, indicating there is no significant difference between the mean retention scores of male and female senior secondary schools' students taught biology using the discovery instructional strategy.

Discussion of Findings

The findings of the present study revealed a **statistically significant difference between the mean retention scores of senior secondary school students taught biology using the guided discovery instructional strategy and their counterparts taught using the conventional teaching method.** This outcome reinforces the central premise of **constructivist learning theory,** which posits that learners construct knowledge more effectively when actively engaged in discovery processes. Guided discovery, rooted in this paradigm, encourages students to interact with learning materials, ask questions, form hypotheses, and draw conclusions thereby fostering deeper cognitive processing and long-term memory formation. Bruner emphasized that students retain information better when they "discover" it for themselves rather than merely receiving it passively from a teacher. This aligns with **Aregbesola et al. (2025)** who asserted that guided discovery provides structured yet flexible opportunities for learners to engage with content meaningfully, allowing for personalized construction of knowledge. The relevance of this strategy in science learning has also been supported by **Piaget,** who contended that cognitive development is driven by active exploration and assimilation. In biology, where concepts are often abstract, guided discovery methods such as laboratory investigations, simulations, and problem-based tasks support retention by connecting theory to observable phenomena (Ajaja & Eravwoke, 2020).

These theoretical assertions were substantiated by several empirical studies. **Udo and Essien (2020)** found that students taught respiration and osmosis through guided discovery outperformed their peers in delayed post-tests, indicating superior retention. Likewise, **Adeyemi (2015)** concluded that discovery-based instruction promotes meaningful learning and significantly enhances long-term retention, as learners internalize concepts through active engagement. The present study's findings corroborate these earlier results. For example, **Abu (2023),** working with SS2 students in Kogi State, reported significant improvements in retention for those taught using guided discovery, as measured through a post-test administered two weeks after instruction. Similarly, **Ezema et al. (2022)** observed higher retention scores in Plateau State students exposed to guided inquiry, with findings statistically verified through ANCOVA**. Egbes and Ajaja (2023)** extended this evidence base by conducting follow-up testing three weeks after instruction, confirming the long-term retention superiority of guided discovery over problem-solving and lecture methods.

In addition, **Fati et al. (2020)** demonstrated that even low-achieving students in Niger State retained biology concepts better when taught using peer-guided discovery. This finding illustrates that the approach is not only effective for high-achieving students but is also inclusive and adaptable to learners with varying cognitive levels. **Otuturu (2023)** found similar results among Rivers State students learning ecology, while **Falilat (2024)** confirmed that students in Abuja, regardless of their learning styles, benefitted from improved retention when guided discovery was employed. The consistency of these findings across multiple studies and geographical regions underscores the robustness and adaptability of the strategy.In the present study, the guided discovery group significantly outperformed the control group, supporting the assertion by **Aregbesola (2023)** that blending theory with hands-on learning enables learners to not only understand but also remember concepts better. This finding has important implications for biology education in Nigeria. It suggests that when students are engaged through interactive, discovery-driven strategies, they are more likely to retain and apply the knowledge they acquire a crucial outcome in a subject as foundational and dynamic as biology.

Regarding gender differences, the study found that **there was no significant difference between the mean retention scores of male and female senior secondary schools' students taught biology using the guided discovery instructional strategy.** This finding is particularly relevant in the Nigerian context, where gender disparities in education persist in some regions due to sociocultural factors (Okeke, 2018). The absence of significant gender differences suggests that guided discovery is a **gender-neutral strategy** that provides equitable learning outcomes for both male and female students. This finding is consistent with the results of **Apochi et al. (2022),** who reported no statistically significant difference in retention between male and female students

exposed to guided discovery in Nigerian secondary schools. Similarly, **Falilat (2024)** found that guided discovery improved retention across different learning styles without gender bias. This affirms the inclusive nature of the strategy, which accommodates diverse learner characteristics and promotes equitable academic achievement.

Moreover, the effectiveness of guided discovery in promoting retention regardless of gender aligns with its design as a **learner-centered approach**. By enabling students to explore content at their own pace, collaborate with peers, and engage in metacognitive reflection, the method minimizes factors such as performance anxiety and stereotype threat, which may otherwise contribute to gendered learning gaps (Chukwuemeka et al., 2025). Taken together, these findings provide compelling evidence for the **integration of guided discovery into the Nigerian secondary school biology curriculum**. It not only enhances retention of complex biological concepts but does so equitably, ensuring that no group of learners is disadvantaged based on gender. The consistent performance gains and inclusive nature of this strategy make it a viable pedagogical approach for addressing long-standing retention challenges in biology education across the country.

Conclusion

i. **Guided discovery instructional strategy significantly enhances students' retention of biology concepts** compared to conventional teaching methods. This supports constructivist theories that emphasize the active role of learners in constructing and internalizing knowledge.

ii. The approach fosters deeper cognitive engagement and long-term memory development by enabling students to participate in inquiry, experimentation, and reflection, which improves their conceptual understanding.

iii. **Retention gains from guided discovery are not influenced by gender**, indicating that the strategy is equally effective for both male and female students and promotes equitable learning outcomes.

iv. The findings align with a growing body of Nigerian-based and international research affirming that guided discovery leads to improved retention outcomes across different student populations and science topics.

v. The incorporation of guided discovery strategies into biology instruction addresses key pedagogical challenges in science education, including shallow understanding, rote memorization, and knowledge loss over time.

Recommendations

i. **Biology teachers should adopt guided discovery as a core instructional strategy**, particularly for abstract or challenging topics, to foster meaningful learning and long-term retention among students.

ii. **Teacher training and professional development programs should be revised** to include hands-on workshops on guided discovery methods, including how to design inquiry tasks, lab activities, and concept-mapping exercises.

iii. **Curriculum planners and policymakers should integrate guided discovery into the national biology curriculum**, providing clear instructional frameworks and assessment models aligned with discovery-based learning.

iv. **Further studies should be conducted with longer retention intervals** (e.g., post-tests after 4–6 weeks) and across more diverse student populations (e.g., rural vs. urban, different states) to validate the generalizability of these findings.

v. **School administrators should support the implementation of guided discovery** by providing resources such as laboratory equipment, digital simulations, and instructional time allocation to enable effective hands-on learning.

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