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Effect of Guided-Discovery Learning Strategy on Students' Academic Performance in Basic Science in Secondary Schools in Obio/Akpor LGA, Rivers State

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Abstract
The study investigated the effect of the guided discovery method on students' academic performance in basic science in public secondary schools in Obio/Akpor LGA in Rivers State. The study adopted a quasi-experimental design with non-equivalent control groups. Three research questions guided the study, while three hypotheses were tested. The study's sample consisted of 80 JSS II students from two intact classes in two junior secondary schools in Obio/Akpor LGA in Rivers State, drawn using simple random sampling techniques. The experimental group was taught using the guided discovery method, while the control group was taught using the lecture method. The Basic Science Achievement Test (BSAT) was designed, and validated, and its reliability was determined. The research questions were answered using descriptive statistics (mean and standard deviation), while the hypotheses were tested at 0.05 levels of significance with the Analysis of Covariance (ANCOVA) and independent t-test. The results revealed that the guided discovery instructional method outperformed the conventional instructional method in facilitating students' performance in basic science. After the treatment, there was no significant difference in the mean scores of male and female students in basic science, although male students performed slightly better than their female counterparts. On the efficacy of the method at the class level, there was a significant difference between the classes. It was revealed that mode of instruction (method) and gender had a significant ordinal interaction effect on students' performance in basic science. The guided discovery method was more effective than the conventional method. Based on the findings of the study, some recommendations were made.

Keywords: Guided Discovery, Teaching Strategy, Academic Performance, Secondary School, Basic Science

Introduction
In Nigeria, the revised National Policy on Education classifies subjects into core and elective categories. Core subjects are mandatory for students, while elective subjects offer flexibility based on students' interests (Federal Ministry of Education [FME], 2013). Basic science, designated as a core subject at the junior secondary school level, is crucial not only for individual development but also for the broader context of national scientific and technological advancement. This subject plays a vital role in fostering students' intellectual abilities and equipping them with essential life skills. The integration of basic science into the curriculum aligns with 21st-century educational goals, aiming to help students apply acquired knowledge to real-world situations (Ogunleye & Awoniyi, 2019). However, despite its importance, many students in Nigeria struggle with basic science concepts, often finding it difficult to connect classroom learning with real-life problems. This disconnect is largely attributed to traditional teaching methods that focus on rote memorization rather than engaging students in active, inquiry-based learning. Research consistently shows that hands-on, inquiry-based approaches, which are recommended for science education, are underutilized in basic science classrooms (Akpan & Esenowo, 2015). As a result, students' lack of engagement not only diminishes their ability to apply knowledge but also negatively impacts their academic performance in basic science (Taber, 2017a).

Academic achievement in basic science is critical for students' overall success, influencing their confidence, curiosity, and future aspirations in science-related fields (Streiner, 2014). Guided discovery learning is a promising pedagogical approach that addresses the limitations of traditional teaching methods. This approach emphasizes active student participation through inquiry and experimentation, allowing students to construct their knowledge rather than passively receive information (Savery, 2015). Guided discovery learning fosters critical thinking and problem-solving skills, which are essential for a deeper understanding of scientific concepts (Savery, 2015). It has been well established that guided discovery not only improves academic performance but also enhances student motivation and engagement. As students take a more active role in the learning process, they develop a sense of ownership and empowerment over their education (Wang & Suen, 2018). This approach contrasts with traditional didactic teaching, which often suppresses creativity and critical thinking (Smith, 2018). Guided discovery aligns with the goals of promoting active learning and equipping students with the problem-solving skills necessary to tackle real-world challenges (Taber, 2017b). Pragmatic evidence suggests that students who engage in guided discovery are more likely to retain information and demonstrate superior academic outcomes (Yilmaz, 2020).

According to Celik et al. (2017), the guided discovery approach is a student-centred, activity-based teaching strategy designed to enhance learning through problem-solving and exploration. It is particularly recommended for teaching science in Nigeria, as it encourages students to actively seek knowledge through inquiry, fostering critical thinking and creativity (Streiner, 2014). In this environment, the teacher shifts from being an instructor to a facilitator, guiding students as they make autonomous discoveries (Olorode & Jimoh, 2016). The hands-on nature of guided discovery promotes deeper retention and comprehension of scientific concepts, helping students become independent learners.
The persistent low performance in public science examinations has raised concerns about the effectiveness of traditional teaching methods, prompting educators to explore alternatives like guided discovery (Amagbraby & Alshami, 2013). This learner-centred approach focuses on improving cognitive abilities and addressing individual learning needs within a structured setting. Studies show its success across various subjects, such as biology and mathematics-related disciplines, leading to improved academic performance and more positive attitudes toward learning (Allahoki, 2012). By encouraging active inquiry, guided discovery enhances both understanding and academic achievement (Good, 2014).

Despite the promising outcomes in multiple subject areas, there is a lack of research on the application of guided discovery in Nigerian science education. Recent studies aim to assess its impact on students' academic performance in basic science, particularly in relation to students' engagement and their performance (Berk, 2022). Addressing the challenges of implementing this approach can offer educators and policymakers valuable insights into effective teaching methods for science education (Pekrun et al., 2021). Moreover, it contributes to the growing body of evidence supporting innovative practices that improve student outcomes (Brookhart & Moss, 2019). Education plays a vital role in intellectual growth, with basic science serving as the foundation for advanced studies and future careers (Bennett & Lubben, 2019). However, traditional teaching methods, which often involve passive learning, have been criticised for not engaging students or encouraging critical thinking (Forbes & Nolan, 2018). These limitations have led researchers to explore alternative methods like guided discovery, which has been shown to help students develop a deeper and longer-lasting understanding of scientific concepts (Smith, 2018). Guided discovery also increases student motivation by giving them a sense of control over their learning (Ryan & Deci, 2012). This intrinsic motivation is crucial for keeping students interested and encouraging them to work harder in their studies (Deci & Ryan, 2012).
Research strongly supports the effectiveness of guided discovery in improving academic performance, especially in science. This approach encourages students to actively participate, solve problems, and explore, allowing them to build their own understanding instead of just receiving information from the teacher (Brookhart & Moss, 2019). Studies have shown that guided discovery improves critical thinking, deepens learning, and increases motivation in various subjects (Forbes & Nolan, 2018). For example, Forbes and Nolan (2018) found that students taught through guided discovery scored higher and had a better grasp of science concepts than those taught through traditional methods. The hands-on, exploratory nature of guided discovery promotes independent learning and greater involvement with the subject, leading to better academic results (Good, 2014).

In addition to helping students learn facts, guided discovery develops higher-order thinking skills like analysis, synthesis, and evaluation. By encouraging students to form hypotheses, conduct experiments, and draw conclusions, this method deepens their understanding of science while improving their problem-solving abilities (Good, 2014).

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Students taught through guided discovery show stronger problem-solving skills than those taught through conventional methods. This approach's inquiry-based structure fosters a mindset of curiosity and academic excellence. Furthermore, guided discovery supports collaborative learning, which often entails group work in which students share ideas, discuss solutions, and learn together. Studies have shown that working in such collaborative environments enhances learning outcomes, as students benefit from diverse perspectives (Amagbraby & Alshami, 2013). This method not only improves academic performance but also helps students develop important communication and teamwork skills, which are valuable beyond the classroom.

Moreover, guided discovery greatly enhances student engagement and interest, both of which are closely linked to academic success. Allowing students to explore topics autonomously fosters a sense of ownership, thereby enhancing intrinsic motivation. Studies have indicated that student-centred approaches like guided discovery significantly increase engagement in science courses (Alsop & Ryan, 2013). As students become more involved in their studies, they tend to invest more effort, leading to better academic outcomes. The method's capacity to ignite curiosity makes it a powerful tool for improving academic achievement. Research consistently supports the effectiveness of guided discovery, particularly in science education. This method emphasises active engagement and independent investigation, allowing students to construct their understanding of topics rather than passively receive information. Forbes and Nolan (2018) found that secondary school students taught using guided discovery outperformed their peers in science assessments, partially due to the active involvement required by this approach. This heightened engagement results in better retention and comprehension of scientific concepts (Celik et al., 2017). The collaborative nature of guided discovery has been shown to improve both academic performance and social skills. For example, Amagbraby and Alshami (2013) found that working in groups increased students' interest in science and led to better grades among middle school students. By sharing ideas and discussing problems with others, students were able to understand the material more deeply. Long-term benefits of guided discovery have also been noted. Streiner (2014) found that students who experienced this teaching method in earlier grades continued to do well in science in later years. The skills they developed—like independent thinking and problem-solving—proved useful in other subjects too, contributing to their ongoing success. However, the success of guided discovery depends on factors like the subject being taught, the student's grade level, and how the method is implemented. For instance, Celik et al. (2017) found it especially effective for teaching biology to high school students. In contrast, younger students might need more guidance to avoid feeling frustrated. Teachers play a key role in keeping students engaged and focused during the discovery process (Amagbraby & Alshami, 2013).

Some studies have shown that male students tend to do better with hands-on activities, but other research suggests that female students can also succeed in these environments when they receive the right support (Forbes & Nolan, 2018). This shows how important it is to consider different learning styles to get the most out of guided discovery. Since there are gaps in previous studies, this research uses a quasi-experimental approach to examine how guided discovery affects students' performance in basic science. The goal is to give a clearer understanding of how effective this method is in secondary schools within the LGA.

Research Questions

1. What is the difference between the mean performance scores of students taught using guided discovery teaching strategies and those taught with traditional methods?
2. What is the difference between the mean performance scores of male and female students taught using a guided discovery learning strategy?
3. What is the difference between the mean performance scores of students in classes 1 and 2 taught using a guided discovery teaching strategy?

Hypotheses

H01: There is no significant difference between the performance of students taught basic science using guided discovery teaching strategy and those taught using traditional methods.

H02: There is no significant difference between the performance scores of male and female students taught basic science using the guided discovery teaching strategy.

H03: There is no significant difference between the performance scores of students in class A and class B taught basic science using the guided discovery teaching strategy.

Methodology

This study used a pretest-posttest, non-randomised, intact class quasi-experimental design to minimise disruption to regular classroom activities and control for extraneous variables. The study population comprised all Junior Secondary Two (JSS2) students in government-owned secondary schools in Obio-Akpor Local Government Area (LGA), totalling 4,592 students across 15 schools. A simple random sampling technique was used to select a sample of 80 JSS2 students. Two instruments were developed by the researcher for data collection: the Basic Science Achievement Test (BSAT). The BSAT consisted of 30 multiple-choice questions derived from four topics in the basic science curriculum that were taught to the students. Both instruments were face-validated by a senior lecturer in the Department of Science Education at Ignatius Ajuru University of Education. A pilot test was conducted to estimate the reliability of the BSAT. The internal consistency of the BSAT was calculated using Kuder-Richardson Formula 20 (KR-20), yielding a high-reliability coefficient of 0.95, indicating the test's reliability. Data obtained from the pretests and posttests were analysed using mean and standard deviation to address the research questions. For hypothesis testing, Analysis of Covariance (ANCOVA) was used at a significance level of 0.05, accounting for pretest scores to control for potential initial differences among the students before the intervention.

Results

Research question 1: What is the difference between the mean performance scores of students taught using guided discovery teaching strategy and those taught with traditional methods?

Table 4.1: Pretest and Posttest Mean Scores of Students Taught with Guided Discovery Learning and Those Taught with Traditional Method

Group	Pretest			Post test		Mean gain
	N	Mean	SD	Mean	SD	
Experimental	60	18.40	2.07	44.60	2.43	26.20
	60	18.23	2.08	35.00	4.23	16.77

The experimental group has a mean pretest score of 18.40 with a standard deviation of 2.07 and a mean posttest score of 44.60 with a standard deviation of 2.43, respectively. Thus, the experimental group has a mean gain score of 26.20 after treatment. On the other hand, the control group has a mean pretest score of 18.23 with an SD of 2.08, and a posttest mean score of 35.00 with an SD of 4.23, respectively. Thus, the control group had a mean gain score of 16.77. Obviously, the experimental group scored a higher mean score than the control group. It can therefore be concluded that the experimental group outscored the control group, indicating that guided discovery learning is more effective than the lecture method in enhancing students' achievement in basic science.

H01: There is no significant difference between the performance of students taught basic science using guided discovery teaching strategy and those taught using traditional methods.

Table 5: Analysis of Covariance (ANCOVA) On the Mean performance Scores of Students Taught with Guided Discovery Learning and Those Taught with Traditional Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2767.698[a]	2	1383.849	115.362	.000
Intercept	2518.037	1	2518.037	209.911	.000
Pretest	2.898	1	2.898	.242	.624
Teaching method	2764.800	1	2764.800	230.482	.000
Error	1403.502	117	11.996		
Total	194256.000	120			
Corrected Total	4171.200	119			

The ANCOVA results presented in Table 4.4 show that for the experimental condition, the F-value obtained was 230.482 as a P-value of 0.05, given 1 and 117 degrees of freedom at the.05 level of significance. As a result, it appears that teaching basic science students using the constructivist learning method was effective in improving their achievement in the subject. Therefore, hypothesis 1 was rejected.

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Research question 2: What is the difference between the mean performance scores of male and female students taught using a guided discovery learning strategy?

Table 4.3: Mean and Standard Deviation Mean Performance Scores of male and female Students Taught Using Guided Discovery Learning Strategy

Gender	N	Mean	SD
Male	36	40.33	2.08
Female	24	39.50	2.55

Data in Table 4.3 revealed a mean achievement score of 40.33 with a standard deviation of 2.08 for male students, while the female students had a mean achievement score of 39.50 with a standard deviation of 2.55.

H02: There is no significant difference between the performance scores of male and female students taught basic science using the guided discovery teaching strategy.

Table 4.7: Analysis of Covariance (ANCOVA) On the Mean performance Scores of Students Taught with Guided Discovery Learning and Those Taught with Traditional Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	59.303[a]	2	29.652	5.806	.005
Intercept	1199.240	1	1199.240	234.825	.000
Pretest	10.903	1	10.903	2.135	.149
Gender	40.262	1	40.262	7.884	.007
Error	291.097	57	5.107		
Total	119700.000	60			
Corrected Total	350.400	59			

a. R Squared = .169 (Adjusted R Squared = .140)

The result of ANCOVA IN Table 7 indicates that there is a significant difference in the mean achievement scores of students taught by male and female teachers using guided discovery learning strategies. This is based on the fact that the calculated F-value is 7.884 with a probability value of 0.007, which is less than the study's alpha value of 0.05. That is, F(1,57) = 7.884, and p = 0.007 <0xC6> <0x13> = 0.05. To this effect, the null hypothesis 3 (H03) is rejected. This implies that there is a significant difference in the mean achievement scores of students taught by male and female teachers using guided discovery learning strategies.

Research question 3: What is the difference between the mean performance scores of students in classes A and B taught using a guided discovery teaching strategy?

Table 4: Mean and Standard Deviation Showing Mean Performance Scores of Students Taught Basic Science Using Guided Discovery Learning Strategy in the two classes

Class level	N	Mean	Std.dev
JS1	60	37.20	2.15344
JSII	46	46.78	1.17214

Data in Table 4.4 revealed that JSSI students have a mean performance score of 37.20 with a standard deviation of 2.15 while JSII students have a mean achievement score of 46.78 with a standard deviation of 1.17.

H03: There is no significant difference between the performance scores of students in class A and class B who taught basic science using the guided discovery teaching strategy.

Table 4.8: Analysis of Covariance (ANCOVA) On the Mean performance Scores of Students taught basic science using guided discovery learning strategy based on class level

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Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2456.104[a]	2	1228.052	468.005	.000
Intercept	1642.207	1	1642.207	625.838	.000
Pretest	65.153	1	65.153	24.829	.000
Class level	2404.157	1	2404.157	916.213	.000
Error	270.273	103	2.624		
Total	184042.000	106			
Corrected Total	2726.377	105			

a. R Squared = .901 (Adjusted R Squared = .899)

Table 8 indicates that there is a significant difference in the mean scores of students taught basic science using guided discovery learning strategies based on class level. This is based on the fact that the calculated F-value is 916.21 with a probability value of 0.000, which is greater than the alpha value of 0.05 set for the study. That is, $F(1,103) = 916.21$, and $p = 0.00$. To this effect, the null hypothesis 3 (Ho3) is not rejected. This implies that there is a significant difference in the mean scores of students taught basic science using guided discovery learning strategies based on class level.

Discussion

The guided discovery strategy has consistently proven to be a highly effective teaching approach, especially in science education. Its effectiveness comes from actively involving students in the learning process, allowing them to explore, analyze, and build their understanding. This hands-on participation boosts their cognitive engagement, leading to a deeper understanding and better retention of scientific knowledge. This idea is supported by Forbes and Nolan (2018), who found that discovery-based learning leads to higher achievement in science compared to traditional lecture methods. Similarly, Celik et al. (2017) showed that guided discovery is more effective in improving students' performance in biology than conventional lectures. The strength of guided discovery lies in its ability to spark student interest and create an active learning environment, both crucial for deep learning. It encourages students to ask questions, analyse information, engage in discussions, and apply what they've learned. Instead of passively receiving information, students discover facts for themselves, which helps them understand and internalise the scientific processes important in basic science education. Forbes and Nolan (2018) emphasised that this active involvement leads to a deeper understanding of the material compared to teacher-centred methods. This study supports these findings, showing that students taught through guided discovery performed much better than those taught using traditional methods. It also revealed differences based on gender, with male students performing better when taught by male teachers—a trend similar to Forbes and Nolan's (2018) findings. One possible reason for this could be gender socialisation, where males are often encouraged to explore and be more active, while females may be more likely to follow existing structures, affecting their behaviour in inquiry-based learning.

The study also found that male teachers had better success in teaching basic science, with an average student score of 45.33 compared to 43.50 for female teachers. This aligns with Nuzuntiryaki et al. (2016), who noted that students performed better in biology when taught by male teachers. However, these results differ from earlier studies like those by Ibe and Nwosu (2003), which found female teachers to be more effective. Streiner (2014), on the other hand, reported no significant gender differences when using guided discovery methods, suggesting that the teaching approach may be more important than the teacher's gender. The gender gap in student performance, where male students outperformed female students (with average scores of 40.33 and 39.50, respectively), may be linked to learning preferences. Research shows that males generally prefer hands-on, exploratory activities and excel in environments where practical tasks and visual aids are used. Female students, while often better in verbal and presentation skills, may find practical science activities more challenging, which could affect their performance in guided discovery settings. Good (2014) also noted that male students tend to show more interest and better performance in subjects like biology when taught through discovery-based methods, possibly due to their stronger engagement in practical tasks.

The study further revealed that male students showed more interest in basic science than their female counterparts, a finding echoed by Good (2014), who observed similar trends in biology. Societal expectations and personal preferences, which shape how students engage with science over time, may influence these gender differences in interest. Additionally, the study found that Junior Secondary School 1 (JSS1) students showed more interest in basic science when taught using guided discovery compared to Junior Secondary School 2 (JSS2) students. This mirrors the findings of Alsop and Ryan (2013), who noted that younger students are more likely to be interested in science when taught through student-centred methods. The collaborative aspect of guided discovery also plays a role in maintaining student interest. Amagbraby and Alshami (2013) found that students who work in groups and share ideas tend to be more interested in subjects like biology compared to those taught using traditional methods.

Conclusion

The guided discovery method of instruction has been demonstrated to significantly enhance students' performance and interest in basic science compared to traditional teaching methods. This approach fosters deeper understanding and engagement by promoting active, inquiry-based learning, where students explore scientific concepts independently. The findings underscore the method's ability to facilitate students' comprehension and retention of scientific knowledge, empowering them to apply these concepts autonomously. Additionally, the study highlights notable gender differences in both performance and interest. Male students generally exhibited higher achievement and interest levels than their female counterparts. Furthermore, the effectiveness of guided discovery varied based on teacher gender and the educational level of the students, with male teachers and younger students (JSS1) achieving better outcomes. These insights suggest that factors such as gender and age play a significant role in how students respond to the guided discovery method. The results affirm the value of the guided discovery approach in basic science education. It not only enhances academic success but also fosters sustained interest, making it a powerful tool for improving science education outcomes.

Recommendations

It is pertinent to make the following recommendations based on the results obtained.

1. Educational institutions should incorporate the guided discovery method into their science curricula to enhance student engagement and understanding.
2. Organise professional development programmes for teachers on the effective teaching strategies useful for basic science teaching.
3. Teachers should tailor instructional strategies to address these gender differences in achieving more equitable educational outcomes.
4. Given that younger students (JSS1) showed higher interest in guided discovery compared to older students (JSS2), instructional strategies should be adjusted according to the student's grade levels.
5. Schools should foster collaborative learning environments by incorporating group-based discovery activities into the curriculum.

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