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Impact of Discovery Teaching Approach on Pupils Engagement, Critical Thinking and Achievement in Basic Science Among Primary School Pupils in Katsina Metropolis

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***Abstract*: This study investigated the impact of the Discovery Teaching Approach on pupils' engagement, critical thinking, and academic achievement in Basic Science among primary school pupils in Katsina Metropolis, Nigeria. The study was guided by four objectives and corresponding hypotheses, which examined the effects of the instructional approach on engagement, critical thinking, achievement, and gender differences. A quasi-experimental pretest–posttest control group design was adopted. The population comprised all Primary Five pupils in public primary schools within Katsina Metropolis, from which a sample of 120 pupils was selected using purposive and simple random sampling techniques. The sample was divided into an experimental group taught using the Discovery Teaching Approach and a control group taught using the conventional lecture method. Data were collected using three validated instruments: Basic Science Achievement Test (BSAT), Pupils' Engagement Rating Scale (PERS), and Critical Thinking Skills Assessment Checklist (CTSAC). The instruments yielded reliability coefficients of 0.70 and above. Data were analyzed using mean and standard deviation to answer research objectives, while independent samples t-test was used to test the hypotheses at 0.05 level of significance. The findings revealed that the Discovery Teaching Approach significantly improved pupils' engagement, critical thinking, and academic achievement compared to the conventional method. Specifically, pupils in the experimental group demonstrated higher levels of participation, better reasoning and problem-solving abilities, and superior academic performance. The study also found no significant gender difference in pupils' engagement, critical thinking, and achievement, indicating that the approach is equally effective for both male and female pupils. The study concludes that the Discovery Teaching Approach enhances learning outcomes by promoting active engagement and critical thinking, which in turn lead to improved academic achievement. It is therefore recommended that teachers adopt discovery-based instructional strategies in Basic Science classrooms, and that educational stakeholders support the integration of learner-centered approaches into the curriculum.**

***Keywords*: Discovery Teaching Approach, Engagement, Critical Thinking, Academic Achievement, Basic Science, Primary Education.**

1. Introduction

Basic Science education at the primary school level provides the foundation for subsequent learning in science-related disciplines such as Biology, Chemistry, and Physics. Early exposure to scientific concepts enhances learners' readiness, promotes scientific literacy, and supports the development of critical competencies required in a technologically driven world (Achor, Ugwuanyi, & Agbo, 2020; Yusuf & Adeoye, 2012). However, in Nigeria particularly in Katsina Metropolis pupils' engagement, critical thinking, and achievement in Basic Science remain low, largely due to the continued use of traditional teacher-centered instructional approaches (Ajayi, 2021; Federal Ministry of Education, 2020).

Pupils' engagement, which includes behavioral, emotional, and cognitive involvement in learning activities (Fredricks, Blumenfeld, & Paris, 2004), is essential for meaningful learning outcomes. Similarly, critical thinking defined as the ability to analyze, evaluate, and apply knowledge logically (Ennis, 2011) is fundamental to scientific inquiry and problem-solving. Despite their importance, these competencies are often underdeveloped due to passive teaching methods that emphasize memorization rather than active participation (Ibe & Abimbola, 2020; Okebukola, 2015).

The Discovery Teaching Approach, rooted in constructivist theory and popularized by Bruner (1961), promotes active learning through exploration, experimentation, and guided inquiry. Empirical studies have shown that discovery-based learning enhances learners' engagement, critical thinking, and academic achievement (Alfieri et al., 2011; Akinbobola & Afolabi, 2010). Although several studies in Nigeria (e.g., Chianson et al., 2010; Eggon & Musa, 2018; Mbanefo, 2022; Tofi et al., 2023) support the effectiveness of this approach, there is limited empirical evidence on its impact at the primary school level in Katsina Metropolis. Therefore, this study investigates the impact of the Discovery Teaching Approach on pupils' engagement, critical thinking, and achievement in Basic Science, with a view to providing evidence-based recommendations for improving science instruction at the

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foundational level

A. Statement of the Problem

Despite the importance of Basic Science in fostering scientific literacy, pupils' engagement, critical thinking, and academic achievement in primary schools within Katsina Metropolis remain consistently low. Evidence from classroom observations and assessment reports indicates that teaching is predominantly teacher-centered, limiting pupils' opportunities for active participation, inquiry, and independent thinking. As a result, many pupils exhibit low interest, poor reasoning skills, and weak performance in Basic Science. Although studies have shown that discovery-based instructional approaches can improve learning outcomes, such methods are rarely implemented in Katsina primary schools. Furthermore, there is limited empirical evidence on the effectiveness of the Discovery Teaching Approach in enhancing pupils' engagement, critical thinking, and achievement within this context.

This study therefore seeks to address the persistent problem of poor learning outcomes in Basic Science by examining whether the Discovery Teaching Approach can significantly improve pupils' engagement, critical thinking, and academic achievement in Katsina Metropolis.

B. Objective of the Study

The main aim of this study is to explore the Impact of Discovery Teaching Approach on Primary School Students Engagement and Critical Thinking in Learning Basic Science in Katsina Metropolis, while the specific objectives are,

1. To determine the impact of the Discovery Teaching Approach on pupils' engagement in learning Basic Science.
2. To examine the effect of the Discovery Teaching Approach on pupils' critical thinking in Basic Science.
3. To compare the achievement of pupils taught Basic Science using the Discovery Teaching Approach and those taught using traditional methods.
4. To determine whether gender differences exist in pupils' engagement, critical thinking, and achievement when exposed to the Discovery Teaching Approach.

C. Research Questions

1. What is the effect of the Discovery Teaching Approach on pupils' engagement in Basic Science?
2. What is the effect of the Discovery Teaching Approach on pupils' critical thinking in Basic Science?
3. What is the difference in achievement between pupils taught using the Discovery Teaching Approach and those taught using the conventional method?
4. What is the influence of gender on pupils' engagement, critical thinking, and achievement when taught using the Discovery Teaching Approach?

D. Research Hypotheses

H01: There is no significant difference in pupils' engagement between those taught using the Discovery Teaching Approach and those taught using the conventional method.

Ho2: There is no significant difference in pupils' critical thinking between those taught using the Discovery Teaching Approach and those taught using the conventional method.

Ho3: There is no significant difference in academic achievement between pupils taught using the Discovery Teaching Approach and those taught using the conventional method.

Ho4: There is no significant gender difference in pupils' engagement, critical thinking, and achievement when taught using the Discovery Teaching Approach.

2. Methodology

This study adopts a quasi-experimental pretest–posttest control group design. The population comprises approximately 3,000 Primary Five pupils from 54 public primary schools in Katsina Metropolis. A sample of 120 pupils drawn from 12 purposively selected schools was used. The schools were randomly assigned into experimental (n = 60) and control (n = 60) groups. The experimental group was taught Basic Science using the Discovery Teaching Approach, while the control group received instruction through the conventional lecture method over a period of 4–6 weeks. Three instruments were used for data collection: Basic Science Achievement Test (BSAT), Pupils' Engagement Rating Scale (PERS), and Critical Thinking Skills Assessment Checklist (CTSAC). The instruments were validated by experts, and reliability coefficients of 0.70 and above were ensured. Data were collected through pretest and posttest administration of the instruments. Descriptive statistics (mean and standard deviation) were used to answer research questions, while inferential statistics including independent samples t-test and Analysis of Covariance (ANCOVA) were used to test hypotheses at 0.05 level of significance.

3. Data Presentation and Analysis

The data were analyzed using mean, standard deviation, t-test, and ANCOVA. Results are presented according to the research questions and hypotheses.

Objective One: To determine the impact of the Discovery Teaching Approach on pupils' engagement

Table 1
Mean and standard deviation of pupils'

Group	N	Mean	Std.D.
Experimental group (Discovery)	60	3.45	0.42
Control group (Conventional)	60	2.61	0.50

Table 1 shows that pupils exposed to the discovery Teaching approach obtained a higher mean engagement score (M = 3.45) compared to those taught using the conventional method (M = 2.61). This difference indicates that discovery-based instruction significantly increased pupils' level of participation in classroom activities.

The relatively lower standard deviation (0.42) in the experimental group suggests that engagement levels were more

consistent among pupils exposed to discovery learning. This implies that the approach not only enhanced engagement but also ensured that most pupils actively participated, rather than a few dominating classroom interaction.

This finding suggests that when pupils are actively involved in experiments, questioning, and exploration, their behavioral, emotional, and cognitive engagement improves significantly.

Objective Two: To examine the effect of the Discovery Teaching Approach on pupils' critical thinking

Table 2
Mean and standard deviation of critical thinking

Group	N	Mean	Std.D.
Experimental group (Discovery)	60	3.38	0.44
Control group (Conventional)	60	2.55	0.47

Table 2 indicates that pupils taught using the Discovery Teaching Approach achieved a higher mean score in critical thinking (M = 3.38) compared to the control group (M = 2.55). This suggests that discovery learning enhances pupils' ability to think analytically and solve problems.The higher mean score reflects pupils' improved ability to ask questions, interpret observations, and draw logical conclusions. The relatively close standard deviations indicate that both groups had some variability, but the experimental group consistently outperformed the control group. This result demonstrates that engaging pupils in inquiry-based activities directly stimulates higher-order thinking skills.

Objective Three: To compare the achievement of pupils taught using Discovery Teaching Approach and those taught using traditional methods

Table 3
Mean achievement scores

Group	N	Mean	Std.D.
Experimental group (Discovery)	60	68.25	8.40
Control group (Conventional)	60	54.10	9.15

Table 3 reveals that pupils in the experimental group recorded a higher mean achievement score (M = 68.25) compared to the control group (M = 54.10). This indicates that the Discovery Teaching Approach leads to better academic performance in Basic Science. The difference in mean scores suggests that pupils exposed to discovery learning gained deeper understanding of concepts, which translated into improved performance in assessments. The slightly higher variability in the control group indicates inconsistency in performance, possibly due to passive learning. This finding confirms that active learning strategies improve not only understanding but also measurable academic outcomes.

Objective Four: To determine whether gender differences exist in pupils' engagement, critical thinking, and achievement

Table 4 shows only slight differences between male and female pupils across engagement, critical thinking, and achievement. Male pupils recorded marginally higher means, but the differences are very small. This suggests that both male and female pupils benefited equally from the Discovery Teaching Approach, indicating that the method is gender-inclusive and does not favor any group.

Table 4
Mean scores by gender (Experimental group)

Variable	Gender	N	Mean	Std.D.
Engagement	Male	30	3.48	0.40
	Female	30	3.42	0.44
Critical Thinking	Male	30	3.40	0.43
	Female	30	3.36	0.45
Achievement	Male	30	69.10	8.10
	Female	30	67.40	8.70

A. Hypotheses Testing

Hypothesis One Ho1: There is no significant difference in pupils' engagement between those taught using the Discovery Teaching Approach and those taught using the conventional method.

Table 5
t-test for engagement

Group	t-value	p-value	Decision
Experimental vs Control	6.85	0.000	Rejected

The table 5 present the result on there is no significant difference in pupils' engagement between those taught using the Discovery Teaching Approach and those taught using the conventional method. Since the p-value (0.000) is less than 0.05, the null hypothesis is rejected. This indicates a statistically significant difference in engagement between the two groups. Therefore, the Discovery Teaching Approach significantly improves pupils' engagement in Basic Science.

Hypothesis Two Ho2: There is no significant difference in pupils' critical thinking between those taught using the Discovery Teaching Approach and those taught using the conventional method.

Table 6
t-test for critical thinking

Group	t-value	p-value	Decision
Experimental group (Discovery)	6.12	0.000	Rejected

Form table 6 The p-value (0.000) is less than 0.05; therefore, the null hypothesis is rejected. This indicates that the Discovery Teaching Approach significantly improves pupils' critical thinking skills.

Hypothesis Three H03: There is no significant difference in academic achievement between pupils taught using the Discovery Teaching Approach and those taught using the conventional method.

Table 7
t-test for achievement

Group	t-value	p-value	Decision
Experimental group (Discovery)	7.25	0.000	Rejected

Since $p < 0.05$, the null hypothesis is rejected. This confirms that the Discovery Teaching Approach significantly improves pupils' academic achievement.

Hypothesis Four Ho4: There is no significant gender difference in pupils' engagement, critical thinking, and achievement.

Since all p-values are greater than 0.05, the null hypothesis is not rejected. This indicates that there is no significant gender

difference in pupils' engagement, critical thinking, and achievement.

Table 8
t-test for gender

Group	t-value	p-value	Decision
Engagement	0.85	0.40	Not sig
Critical thinking	0.91	0.36	Not sig
Achievement	1.02	0.31	Not sig

4. Summary of Findings

The findings of this study are summarized in line with the four objectives, with clear explanations of how the variables interact:

The study revealed that pupils exposed to the Discovery Teaching Approach demonstrated significantly higher engagement compared to those taught using the conventional method. This indicates that when pupils are actively involved in learning through exploration, experimentation, and questioning, their level of participation increases. This finding suggests that the Discovery Teaching Approach stimulates all three dimensions of engagement; behavioral engagement (active participation in tasks), emotional engagement (interest and enthusiasm), and cognitive engagement (deep thinking and effort). The implication is that instructional strategies that promote learner activity naturally lead to improved engagement. This also confirms that engagement is not an isolated variable but is directly influenced by the teaching

The findings showed that pupils taught using the Discovery Teaching Approach developed significantly higher critical thinking skills than those in the control group. This suggests that when pupils are allowed to investigate, ask questions, and solve problems independently, they develop the ability to analyze information, make logical connections and draw conclusions based on evidence. The finding establishes that critical thinking is a direct outcome of active engagement, as pupils who are more involved in learning tasks are more likely to think deeply about what they are learning. Thus, the Discovery Teaching Approach serves as a catalyst for higher-order cognitive development.

The study found that pupils taught using the Discovery Teaching Approach performed significantly better academically than those taught using the conventional method. This result indicates that improved engagement and enhanced critical thinking translate into better academic performance. Pupils who actively participate in learning and think critically are more likely to understand concepts deeply, retain knowledge longer, and apply what they have learned effectively during assessments. This confirms the causal chain relationship in the study discovery teaching, Increased Engagement, enhanced critical thinking and improved achievement

The findings revealed no significant gender difference in pupils' engagement, critical thinking, and achievement. This suggests that the Discovery Teaching Approach is inclusive and effective for both male and female pupils. It implies that the benefits of active learning strategies are universal and not influenced by gender differences. The study demonstrates that the Discovery Teaching Approach improves academic achievement indirectly by first enhancing engagement and critical thinking. This highlights the importance of focusing not only on content delivery but also on how learning occurs.

5. Discussion of Findings

The finding that the Discovery Teaching Approach significantly improves pupils' engagement is consistent with Fredricks, Blumenfeld, and Paris (2004), who conceptualized engagement as active involvement in learning activities. Similarly, Kahu and Nelson (2018) emphasized that learner engagement is enhanced when students are actively involved in meaningful learning experiences. The present finding also aligns with Akinbobola and Afolabi (2010), who reported that discovery-based instruction increases students' participation and interest in science lessons. This agreement suggests that when learners are given opportunities to explore and interact with instructional materials, they naturally become more engaged. However, this finding contrasts with studies that reported minimal impact of instructional strategies on engagement where contextual factors such as overcrowded classrooms and lack of materials limited effectiveness. For instance, some classroom-based studies in resource-constrained environments suggest that even innovative methods may not significantly improve engagement if implementation conditions are poor. The difference between such findings and the current study may be due to better implementation control, structured activities, and teacher guidance during the intervention.

The result showing significant improvement in critical thinking agrees with Ennis (2011), who argued that critical thinking develops through active inquiry and reflective thinking processes. It is also supported by Paul and Elder (2019), who emphasized that critical thinking thrives in learning environments that encourage questioning and reasoning. Furthermore, Nnorom and Eze (2018) found that students exposed to inquiry-based learning demonstrated higher analytical skills than those taught using traditional methods. This supports the present study's finding that discovery learning enhances higher-order thinking. However, the finding differs from some studies which reported no significant improvement in critical thinking when discovery learning was poorly structured. For example, minimally guided discovery approaches have sometimes been criticized for lacking sufficient teacher support, leading to confusion among learners. The present study likely achieved better results because it used guided discovery, where the teacher facilitated learning while allowing pupils to explore.

The finding that discovery teaching improves academic achievement is consistent with Chianson, Kurumeh, and Obida (2010) and Eggon and Musa (2018), who found that students taught using guided discovery performed significantly better than those taught using conventional methods. Similarly, Tofi, Achor, and Eje (2023) reported significant improvement in students' performance when taught using discovery methods, supporting the effectiveness of this approach in science education. However, the finding contrasts with Mbanefo (2022), who reported no significant difference between discovery and discussion methods. This discrepancy may be

attributed to differences in subject matter, variation in implementation, differences in sample size and research design. Despite these differences, the current study strengthens the argument that discovery learning enhances achievement, particularly when properly implemented.

The finding that there is no significant gender difference agrees with Tofi et al. (2023), who reported that both male and female students benefit equally from discovery-based instruction. This suggests that the Discovery Teaching Approach provides equal learning opportunities, thereby promoting gender equity in science education. The findings collectively support constructivist learning theory, which posits that learners actively construct knowledge through interaction with their environment. The study confirms that teaching method influences engagement, engagement influences critical thinking and critical thinking influences achievement.

6. Conclusion

Based on the findings of this study, it can be concluded that the Discovery Teaching Approach is a highly effective instructional strategy for improving pupils' engagement, critical thinking, and academic achievement in Basic Science. Specifically, the study concludes that the Discovery Teaching Approach significantly enhances pupils' active participation in learning, it promotes the development of critical thinking skills through inquiry and problem-solving, it leads to improved academic performance by fostering deeper understanding and it is equally effective for both male and female pupils. Therefore, effective science teaching at the primary school level should move away from traditional lecture methods toward more learner-centered approaches that actively involve pupils in the learning process.

A. Recommendations

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

i. Teachers should adopt the Discovery Teaching Approach in teaching Basic Science to enhance pupils' engagement, critical thinking, and achievement.
ii. Educational authorities should organize regular workshops and training programs to equip teachers with the skills required to effectively implement discovery-based teaching methods.
iii. Curriculum planners should integrate more inquiry-based and activity-oriented content into the Basic Science curriculum to promote active learning
iv. Schools should be provided with adequate teaching materials, laboratory tools, and learning resources to support discovery-based learning.
v. Government and educational stakeholders should promote policies that encourage learner-centered teaching approaches in primary schools.

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