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Revisiting Guided Discovery: Evaluating Its Effect on Mathematics Performance among Secondary School Students in Kaduna State, Nigeria

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Abstract

This study examined the effect of the guided discovery instructional strategy on senior secondary school students' performance in mathematics in Kaduna State, Nigeria. Grounded in constructivist learning theory, the study adopted a quasi-experimental pretest, posttest non-equivalent control group design involving 204 SSII students. Participants were assigned to either an experimental group taught using guided discovery or a control group taught with conventional lecture methods. A researcher-designed Mathematics Performance Test (MPT) was administered before and after a four-week intervention. Descriptive statistics showed a higher mean score for the guided discovery group; however, analysis of covariance (ANCOVA) at $p \leq 0.05$ revealed no statistically significant difference between the groups after controlling for pre-test scores, $F(1, 139) = 0.043$, $p = .836$, $\eta^2 = .000$. Pre-test scores accounted for most of the variance in post-test performance ($\eta^2 = .936$), indicating that guided discovery played a major role in student outcomes. The findings recommend that while guided discovery promotes active engagement, its short-term impact on performance may be limited without sufficient scaffolding and prolonged

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exposure. The study underscores the need for sustained teacher training and future research on long-term effects and learner readiness for discovery-based learning.
Keywords: guided discovery, mathematics instruction, performance, constructivism, secondary education, Nigeria

Introduction

Mathematics is central to scientific and technological development because it fosters logical reasoning, problem-solving, and quantitative thinking (Santos-Trigo, 2024)). In Nigeria, mathematics is compulsory at the secondary school level (FRN, 2013), yet national examinations continue to show persistent underachievement, with over 60% of students failing to obtain credit passes (WAEC, 2021). Scholars attribute this trend largely to ineffective instructional practices and low learner engagement (Achor et al., 2009), underscoring the need for pedagogical approaches that promote meaningful learning and positive attitudes toward mathematics.

In many Nigerian schools, particularly in Kaduna State, mathematics teaching is still dominated by teacher-centred lecture methods that emphasise rote learning and limit students' active participation (Danlami et al., 2024). Such approaches have been linked to shallow understanding, mathematics anxiety, and reduced self-efficacy (Ablian & Parangat, 2022). Contemporary educational research, however, advocates learner-centred strategies that encourage exploration and conceptual understanding (Gravani & Hatzopoulos, 2021). One promising approach is the guided discovery strategy, which is grounded in constructivist theories and involves students in discovering mathematical ideas with teacher scaffolding (Bruner, 1961; Hmelo-Silver et al., 2007). International studies show that guided discovery can enhance problem-solving and long-term retention (Afridi & Hussain, 2025), but evidence of its effectiveness in Nigerian secondary school mathematics remains limited.

Given Kaduna State's persistent low performance in mathematics and ongoing efforts to improve instructional quality (Kaduna State Ministry of Education, 2019), evaluating the guided discovery strategy within this context is both timely and necessary. This study therefore examines the effect of guided discovery on students' mathematics achievement compared with the conventional lecture method. The aim is to provide context-relevant empirical evidence that can inform instructional practice, curriculum development, and policy decisions in Nigerian secondary schools.

Statement of the Problem

Mathematics is central to national development, but secondary school students in Nigeria have had a serious concern about sustaining poor performance (WAEC, 2021). The predominance of traditional methods of teaching, especially teacher-centred lectures, has led to the learning of mathematics resorting to passive ways of learning with poor conceptual understanding and limited skills in solving problems (Biong'Ahu & Ayuba, 2021; Danlami et al., 2024). This state of affairs seems to be worse in Kaduna State, where consistent years of poor performance in mathematics have fallen below the national average (Kaduna State Ministry of Education, 2022). International studies suggest that programs like guided discovery, which engage learners actively in constructing their understanding, lead to better outcomes when contrasted to teacher-centred paradigms (Afridi & Hussain, 2025). On the other hand, empirical studies dealing with the implementation and results of guided discovery in specific socio-educational contexts of Kaduna State are in short supply. Instructional reform grounded in non-empirical work could, therefore, remain simply on paper and nowhere near actual happenings in the classroom. Hence, this study intends to tackle the dire problem of dismal performance in mathematics through the examination of the effectiveness of guided discovery in bringing about a significant improvement in academic performance as opposed to conventional teaching method amongst secondary schools in Kaduna State.

Objective of the Study

The objective of this study is to determine the impact of the guided discovery strategy on students' performance in mathematics at the senior secondary school level in Kaduna State, Nigeria.

Research Question

What is the impact of the guided discovery strategy on senior secondary students' academic performance scores in mathematics?

Research Hypothesis

H_0: There is no significant difference in the mathematics academic performance scores of students taught using the guided discovery strategy and those taught using the conventional lecture method.

Literature Review

Theoretical Framework

This study applies Constructivist Learning Theory, particularly work by Jean Piaget and Lev Vygotsky, as its major frame of reference. Piaget posited that cognitive development is a process by which learners actively build knowledge through interacting with their environments and assimilating and accommodating new experiences into pre-existing cognitive structures (Piaget, 1952). In this sense, Piaget's emphasis on the learner's active construction of his/her understanding gives credence to the guided discovery approach, which promotes explorations of mathematical concepts where students engage with hands-on activities instead of passively receiving information. In this setting, the students' journey from the concrete to the abstract allows for deeper conceptual understanding. Vygotsky's concept of ZPD complements the work of Piaget by emphasizing the importance of social interaction in the learning process. Vygotsky stated that learners achieve high levels of understanding when given appropriate scaffolding by a teacher or peer more knowledgeable than themselves (Vygotsky, 1978). Guided discovery, being teamwork on problem-solving, truly fits within this framework as students cooperate in sharing ideas and solutions under the guidance of their teacher. Another important aspect of this is the gradual reduction of support as the learner's competence increases, which is a key to successful guided discovery, thus promoting independence in mathematical thought.

Constructivist principles, thus, tie in with the goals of the guided discovery strategy, which fosters active, learner-centred activities. The emphasis on guided discovery and problem-solving not only allows students to connect their new knowledge to previous experiences but also encourages critical analysis of problems, testing hypotheses, and redefinition of the concept (Bruner, 1961). This Piagetian and Vygotskian based approach fosters in the students the

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cognitive and metacognitive skills they need to survive in mathematics and thus perfectly addresses the challenges of passive learning often characteristic of traditional classrooms.

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Empirical Studies

Other researchers have conducted investigations to establish how guided discovery teaching methods brought about mathematics performance improvement in Nigeria. For instance, David (2019) and Lasisi et al. (2019) revealed that students taught using guided discovery methods significantly outperformed their mathematically terrible counterparts taught using the conventional method. This finding seems to further validate that guided discovery fosters higher cognitive processing, which, in turn, aids students' problem-solving capabilities and understanding of mathematical concepts. In the same vein, Inyang et al. (2023) found that guided discovery had a positive effect on the academic achievement of secondary school students in Akwa Ibom State, Nigeria. The study established that students in the guided discovery sessions retained mathematical concepts better and understood them more than their peers in traditional-style classrooms. Arifin et al. (2020) conducted a study on the effect of guided discovery on algebraic reasoning skills of secondary school students. According to the study, students taking part in guided-discovery lessons made more connections between abstract algebraic concepts and practical applications, and this improved their performance in algebraic problem-solving tasks. The study concluded that guided discovery had the dual advantage of enhancing students' conceptual understanding and creating a positive attitude toward learning mathematics.

Despite the impressive positive results noted in different situations, there is a distinct gap in anything published on the guided discovery method in Kaduna State, Nigeria. The findings of studies carried out elsewhere across Nigeria and indeed abroad support improved mathematics achievement through the application of guided discovery-dependent methodologies; however, the specific problems and educational dynamics in Kaduna State, like large class sizes and inadequate resources, have not so far been well addressed. This gap begs for more localised research to authenticate the efficacy of guided discovery in the state. Also, while a lot of emphasis is put on the general advantages of active learning techniques in the already existing research, fewer studies have been conducted that explicitly connect the constructivist principles behind guided discovery to its productive outcomes in Nigeria.

Studies conducted earlier indicate that the guided-discovery approach is effective in enhancing the performance of students in mathematics however, several gaps can be found in the literature that this study intends to address. First, although more studies are being conducted into active learning methods in different settings, particularly few studies deal with the application of guided discovery methods in Kaduna State. The peculiarities of the educational context in Kaduna State mix of urban and rural schools, with different levels of infrastructure and huge classes-need to be investigated to ascertain how the strategy will be adapted to suit local needs. Second, while the theoretical underpinning of guided discovery stands on constructivism, few empirical studies exist that directly correlate the constructivist principles with guided discovery outcomes in Nigeria's secondary schools. Much of the literature remains stuck in theoretical abstraction, not considering how guided discovery could fit within a larger conceptualisation of constructivism.

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Therefore, further studies need to analyze the effectiveness of guided discovery and investigate how constructivist learning theories are applied in the classroom to affect students' cognitive and metacognitive growth in mathematics. Moreover, considering several studies focus primarily on student outcomes and neglect some other equally important outcomes, such as attitudes toward mathematics and motivation, attention, and attitude, are the bedrocks of effective learning (Bruner, 1961; Mayer, 2004b). These factors are indeed seldom the focus of investigation in guided discovery. The neglect is highly pertinent in Nigeria, where students with a poor attitude towards mathematics usually perform poorly in academics.

Methodology

This study applied a quasi-experimental design employing pre-test-post-test non-equivalent control groups. It aimed at investigating the effectiveness of the guided disbelief strategy on students' mathematics performance. This design contained two groups, that is, the control group and the experimental group. The pre- and post-tests measured baseline and post-intervention performance to compare the effects of the two instructional strategies. While the control group received traditional lecture-based instruction, the experimental group was exposed to the guided discovery strategy. The primary objective is to assess the change students were able to make in their pre-test and post-test learning outcomes in both groups. Guided discovery is a student-oriented strategy of instruction that actively involves students in learning activities, inquiry, and exploration. In a guided discovery class, students solve problems with very limited direct instruction from the teacher. With structured exploration, self-reflection, and collaborative discussions, students discover a mathematical concept in very subtle ways. The teacher only guides the learning by asking guiding questions, giving hints, and encouraging critical thinking. It is this belief that students learn by constructing their understandings from interaction and reflection that makes this approach appropriate under constructivism theory (Bruner, 1961; Vygotsky, 1978).

The target population of the study included 42,121 senior secondary school students of public secondary schools in Kaduna State, Nigeria, as reported by the Kaduna State Ministry of Education (2023). This population was selected since it directly represents the wider student population in the region and is the perfect setting for looking into the effect of teaching methods on mathematics performance. The senior secondary students, especially in Senior Secondary School II (SSS II), were selected because they are at such an important level in their education, with mathematics being a very significant subject for pursuing further education and opening up career opportunities.

The sampling strategy adopted was multi-stage sampling. First, public secondary schools were stratified according to senatorial zones so that there would be proportional representation across the region. All the schools in each of the zones were then selected randomly. Finally, intact classes of SSS II were selected because they had by then covered the mathematics curriculum. Two classes- one for the experimental group that received the guided discovery strategy and the other for the control group subjected to the traditional lecture method- were selected. There were 204 numbers of subjects (102 students in each group) for proper statistical analysis.

This Mathematics Performance Test (MPT) was designed by the researcher as the principal instrument of data collection. The test consisted of multiple-choice and short-answer questions drawn from the SSS II mathematics curriculum. The MPT was purposely set to evaluate students' conceptual understanding and problem-solving competence. This required not only the establishment of content validity through expert reviews by mathematics educators and measurement experts but also the establishment of reliability. A pilot study conducted with yet another set of students gave a high reliability measure of 0.918, as indicated by Cronbach's Alpha.

The process of data collection began with a pre-test administered to both experimental and control groups to establish students' baseline mathematics performance. After this, the experimental group was taught using a guided discovery strategy, wherein the teacher acted more as a facilitator, stimulating critical thinking through guiding questions, and helping students while they explored mathematical concepts. The process encourages active participation and collaborative learning, with the ultimate aim of enhancing deep conceptual understanding and independent problem-solving paradigms. On the other hand, the control group was subjected to traditional lecture-based instruction where mathematical concepts were explained by the teacher, and their students were passive recipients of the information. After the experimental period, both groups took an identical post-test to determine the extent to which the teaching strategies had influenced student performance. Data analysis involved both descriptive and inferential statistics. Before and after the intervention, descriptive statistics (means and standard deviations) summarise students' performance. The null hypothesis was tested using Analysis of Covariance (ANCOVA). ANCOVA was chosen since it adjusts for any differences in scores before treatment, thus making a more balanced comparison of post-test performance between experimental and control groups. The significance level is set at 0.05 to ensure the statistical soundness of the findings.

Results

What is the impact of the guided discovery strategy on students’ performance in mathematics?

The descriptive statistics for students’ performance scores on the Mathematics Performance Test (MPT) under the conventional teaching method and the guided discovery strategy are presented in Figure 1

Figure 1

Descriptive Statistics for Students' Performance in the Conventional and Guided Discovery Groups

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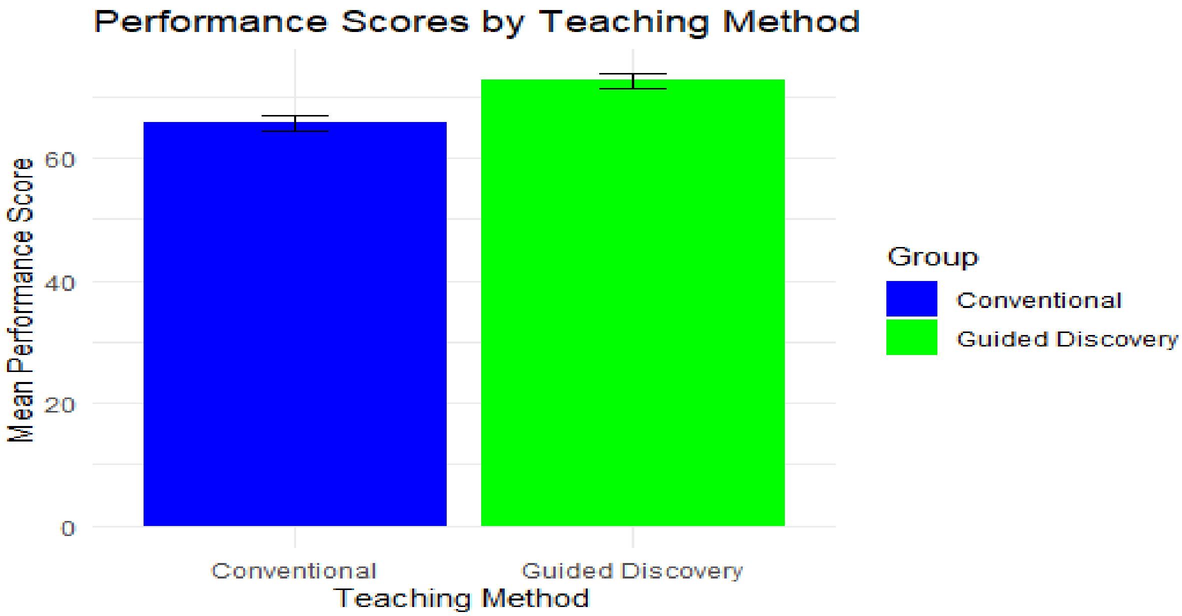

The analysis revealed that students taught using the guided discovery strategy had a higher mean score (M = 68.45, SD = 7.92) than those taught using the conventional method (M = 60.34, SD = 9.11). The error bars represent the standard error of the mean, illustrating the variability of the data. Students in the guided discovery group achieved higher mean scores compared to those in the conventional teaching group, indicating a potential difference in performance. Additionally, the guided discovery group exhibited slightly less variability in performance as indicated by the standard deviations, suggesting more consistent outcomes within this group.

Null Hypothesis One

There is no significant difference in the mathematics performance of students taught using the guided discovery strategy and those taught using the conventional lecture method.

To test this hypothesis, A one-way analysis of covariance (ANCOVA) was conducted to examine the effect of the teaching method (Guided Discovery vs. Conventional) on students' mathematics performance while controlling for pre-test scores. The results are shown in Table 1.1.

Table 1.1

Analysis of Covariance (ANCOVA) for Performance by Teaching Method (Guided Discovery vs Conventional)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	16851.372[a]	2	8425.686	1121.953	.000	.942
Intercept	847.832	1	847.832	112.896	.000	.448
Pre_Test	15148.895	1	15148.895	2017.207	.000	.936
Group	.322	1	.322	.043	.836	.000
Error	1043.867	139	7.510			
Total	697550.000	142				
Corrected Total	17895.239	141				

a. R Squared = .942 (Adjusted R Squared = .941)

The univariate ANCOVA results in Table 4.2 show that the instructional method (Guided Discovery vs. Conventional) did not significantly affect students' performance after controlling

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for pre-test scores: $F(1, 139) = 0.043$, $p = .836$, $\eta^2 = .000$. The p-value ($p = .836$) is greater than .05, indicating that there is no sufficient evidence to reject the null hypothesis. This result suggests that students taught using the Guided Discovery strategy did not perform significantly better than those taught using the Conventional method when accounting for prior knowledge. Additionally, the partial eta squared value ($\eta^2 = .000$) indicates that the effect size of the instructional method on performance was negligible, meaning that it accounted for almost none of the variance in post-test scores. The corrected model was significant, $F(2, 139) = 1121.95$, $p < .001$, primarily due toc the strong influence of pre-test scores on students' performance ($F(1, 139) = 2017.21$, $p < .001$, $\eta^2 = .936$). The R-squared value ($R^2 = .942$, adjusted $R^2 = .941$) suggests that the model explained 94.2% of the variance in post-test scores, with pre-test scores contributing the most to this variance. However, the instructional method did not have a meaningful impact on students' final performance after accounting for prior knowledge.

To ensure the validity of the ANCOVA results, Levene's test of equality of error variances was conducted to assess the assumption of homogeneity of variances. The test results were $F(1, 140) = 0.271$, $p = .604$, indicating that the assumption was met. Since the p-value ($p = .604$) is greater than the commonly accepted significance level of .05, it can be concluded that the variances in performance scores between the two instructional groups were not significantly different.

These findings suggest that while students in the Guided Discovery group had a higher mean post-test score, this difference was largely attributable to pre-existing differences rather than the instructional method itself. The strong predictive power of pre-test scores highlights the importance of prior knowledge in determining students' academic performance.

Discussion of Results

The result of this study indicates that while students taught using the guided discovery strategy had a higher mean post-test score than those taught using the conventional method, the difference was not significant ($F(1, 139) = 0.043$, $p = .836$). This finding would imply that guided discovery does confer some benefits on students; however, these benefits on mathematics performance are not significantly greater than those offered by the traditional method of teaching, which focuses more on previous knowledge. The guided discovery strategy is an instructional model which centres on the students and promotes the enhancement of active learning through inquiry, exploration, and self-directed problem-solving (Bruner, 1961). It allows students to create their understanding of mathematical concepts through engaging with problems, exploring solutions, and reflecting on their learning. Bruner (1960) posits that learning by discovery permits deeper understanding, as students interact with the processes of learning. The success of this approach, however, depends a great deal on students' abilities to engage in inquiry learning and prior experience with self-directed learning strategies.

It was found that the guided-discovery teaching method, although for the theory able to give several advantages, fails to have a direct and strong effect on students' mathematics ability, as reflected in the results of this study. Similar to what was found by Kibirige and Maake (2021) and Yusuf (2020), the conclusion was that while guided discovery will promote students' conceptual understanding, its effects on performance are mediated by factors such as students' learning backgrounds and the complexity of the topics being taught. For students in an environment of low exposure to independent or inquiry-based learning, this directly affects their ability to engage with the process at hand and the absence of gains observed from it. In this regard, the lack of statistically significant differences between the two groups in the present study implies that the effects of the guided discovery strategy on student performance require more time to manifest. The short-term effects of this method may be hampered by students' prior exposure to a teacher-centered classroom environment and by students' proficiency in managing self-guided aspects of learning. As Yusuf (2020) has confirmed, students used to passive, teacher-directed learning might have difficulty adjusting to an active, student-directed approach. Such problems, especially with complex mathematics concepts, might impede the effectiveness of guided discovery in its initial stages.

According to the findings, prior knowledge plays a significant role in determining student performance, as shown by the large effect of pre-test scores in the ANCOVA results. Pre-test scores had a major influence on the variance in post-test performance, $F(1, 139) = 2017.21$, $p < .001$, $\eta^2 = .936$. This underlines the importance of initial knowledge that students possessed in mathematics and was, therefore, likely to have influenced their ability to profit from the teaching techniques employed in this study. The guided discovery approach appeared to hold some merit for improved post-test scores, but these may have measured the relative limitation of the strategy due to prior knowledge of the students and their ability to engage with the strategy.

Overall, although the guided discovery strategy showed promise in fostering students' conceptual understanding of mathematics, the fact that there was no statistically significant difference with the traditional methods calls for further investigations into optimising the strategy (Abari & Ikyule, 2021). Future studies could look into how prior knowledge and length of exposure to the strategy may affect its success. It would also be useful to study how students' readiness for self-directed learning and the nature of the difficulty of the mathematical content being taught would affect the efficacy of the guided discovery strategy. Looking into the future, however, although guided discovery fosters active learning and conceptual understanding, it appears to have little immediate impact on mathematics performance compared to traditional teaching methods or prior knowledge. It becomes apparent from this study that, owing to the importance of their background for students, student-centred teaching can only be phased in, even if this maximises the potential benefits. More studies on long-term effects are necessary to investigate the conditions under which guided discovery is most effective in improving academic performance.

Conclusion

The findings of this study suggest that while the **guided discovery strategy** showed a slight advantage in improving students' mathematics performance compared to the **conventional teaching method**, this difference was not statistically significant. The analysis indicated that prior knowledge played a crucial role in students' performance outcomes, with pre-test scores explaining a significant portion of the variance in post-test performance. Despite the promising theoretical benefits of the guided discovery approach, particularly in fostering deeper conceptual understanding and active learning, its immediate impact on performance was not significantly greater than that of traditional instruction. The lack of a statistically significant difference can be attributed to several factors, including students' initial familiarity with teacher-centred methods and the time required for them to fully adapt to and benefit from inquiry-based learning.

Therefore, while guided discovery has the potential to enhance students' mathematical understanding over the long term, its short-term impact may be limited, especially for students who are more accustomed to passive learning approaches.

Recommendations

1. To fully harness the benefits of the guided discovery strategy, students should be exposed to it over a longer period. Continuous engagement in self-directed learning can enhance their problem-solving abilities. Future research should adopt a longitudinal approach to assess the long-term impact of guided discovery on student performance.
2. Teachers should receive adequate training in implementing the guided discovery strategy to ensure its success. Professional development programs should focus on equipping educators with the necessary skills to facilitate inquiry-based learning and provide effective support for students during problem-solving tasks.
3. Future studies should investigate factors such as students' prior knowledge, learning styles, and the complexity of content, which may influence the effectiveness of guided discovery. Additionally, exploring the role of technology in supporting guided discovery could provide valuable insights into enhancing active learning and engagement in mathematics education.

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