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Effect of Model-Aided Inquiry-Based Learning on Academic Performance in Basic Science among Students with Varied Reasoning abilities in Benue State, Nigeria

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Abstract

Persistent poor academic performance in Basic Science among Junior Secondary School students in Benue State, Nigeria, has been linked to the abstract nature of scientific concepts and continued reliance on teacher-centred instruction that limits active investigation. To address this problem, this study examined the effect of Model-Aided Inquiry-Based Learning (MAIBL) on the academic performance of students with varied reasoning abilities in Basic Science. The population comprised 18,420 JSS II students in 62 public co-educational schools in Zone B, Benue State, during the 2024/2025 session. A sample of 88 students was drawn from two intact classes in two co-educational schools in Makurdi Local Government Area using purposive sampling. A quasi-experimental, pre-test post-test non-equivalent control group design was adopted, with one school ($n = 42$) assigned to MAIBL and the other ($n = 46$) to the Conventional Discussion Method. Two research questions were answered, and two null hypotheses tested at 0.05 significance. Data were collected using the Basic Science Performance Test (BSPT) and Reasoning Ability Test (RAT), which classified students into high, moderate, and low reasoning categories. Both instruments were validated by three experts and yielded reliability coefficients of 0.82 and 0.79 respectively, using KR-20. Data were analysed using Mean, Standard Deviation, and ANCOVA. Results showed a significant difference in performance between students taught using MAIBL and CDM, $F(1, 85) = 80.075$, $p < .001$, partial $\eta^2 = .485$, favouring MAIBL. A significant difference was also found across reasoning ability levels under MAIBL, $F(2, 39) = 10.033$, $p < .001$, partial $\eta^2 = .340$, with high-reasoning students gaining most. It was recommended that Basic Science teachers integrate models into inquiry-based lessons to enhance performance across all reasoning levels.

Key Words: Model-aided inquiry-based learning, Performance, reasoning ability, Basic Science.

Introduction

Basic Science occupies a central position in the Nigerian Junior Secondary School curriculum, providing an integrated foundation in science and preparing learners for specialised study in Biology, Chemistry, and Physics at the senior secondary level. Beyond content knowledge, the subject cultivates inquiry skills, scientific thinking, problem-solving ability, and the application of scientific knowledge to everyday life (Mardonov, 2019; Ode & Fakaa, 2023). Despite this importance, students in Benue State continue to record inconsistent academic performance in Basic Science examinations (Benue State Teaching Service Board, 2023), a pattern consistent with broader challenges in Nigerian science education, even at the senior secondary level, where learning difficulties are attributed to the abstract nature of scientific concepts and the persistence of teacher-centred instruction (WAEC, 2022). This worries stakeholders in science education and requires research to find instructional strategies that actively engage learners while providing adequate cognitive support. The growing emphasis on learner-centred pedagogy has positioned Inquiry-Based Learning (IBL) as a key strategy in science teaching and learning. According to Abdi (2014), IBL engages learners in questioning, investigating, gathering and interpreting evidence, and constructing explanations, positioning them



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as active participants in knowledge construction rather than passive recipients of information. Empirical evidence supports the value of inquiry-oriented instruction, particularly when appropriately guided (Abdi, 2014; Furtak et al., 2012). In Nigeria, Enemarie et al. (2025) found that students taught Basic Science through guided inquiry outperformed those taught through demonstration. In other contexts, structured learner-centred approaches have similarly improved performance (Omaga & Kpiranyam, 2024). However, inquiry can impose considerable cognitive demands when complex concepts are explored without adequate support (Etobro & Fabinu, 2017), highlighting the need for adoption of a strategy that preserve inquiry's active features while offering concrete or visual scaffolding, with the use of models.

Model-Aided Inquiry-Based Learning (MAIBL) is a strategy that integrates models, physical, pictorial, symbolic, mathematical, or conceptual representations, into inquiry activities, helping learners visualise and explain phenomena that are otherwise difficult to observe directly (Griskevica & Iltner, 2021). Within MAIBL, learners interact with models, investigate questions, interpret evidence, and apply emerging understanding to new situations, consistent with constructivist principles of active, meaningful knowledge construction and promoting both hands-on and mind-on engagement (Achor et al., 2015; Etobro & Fabinu, 2017). Related studies reinforce the value of representational, cognitively engaging instruction. Kpiranyam et al. (2023) found that Biology students taught using a Graphic Advance Organizer achieved higher performance and retention than those taught through discussion, while Kpiranyam et al. (2024) reported that concept mapping enhanced students' critical thinking relative to conventional instruction. Although these findings support the value of representational structures in organising and connecting information, they do not establish whether embedding models directly within an inquiry process yields comparable benefits in Basic Science, or whether such benefits vary with learners' reasoning ability, which Achor and Musa (2021) describe as the capacity to think logically, relate ideas, draw conclusions, and apply information to solve problems. Since Basic Science requires learners to interpret observations, identify relationships, and explain phenomena, differences in reasoning ability may shape how effectively learners engage with inquiry and use models to construct explanations.

While related Benue State research links cognitively engaging strategies to improved critical thinking and performance (Samba & Kpiranyam, 2021; Kpiranyam et al., 2021), critical thinking and reasoning ability remain distinct constructs, leaving open whether reasoning ability moderates instructional effectiveness. This potential interaction can be understood through Piagetian theory, which holds that learners progressively develop capacities for abstract, hypothetical, and logical reasoning (Piaget, 1964). At the secondary level, learners vary in their readiness for independent abstract reasoning; models embedded in inquiry may bridge this variation by offering concrete representations through which learners can explore relationships before advancing to abstract explanation. Reasoning ability may therefore influence how learners respond to MAIBL during the learning process and, consequently, their resulting academic performance in Basic Science.

The present study uses the Conventional Discussion Method (CDM) as its comparison condition. The CDM is teacher-directed, involving presentation of subject matter followed by teacher-led questioning, and offers fewer opportunities for sustained investigation or model-supported representation than MAIBL. Demirçali and Selvi (2022) reported that model-based teaching produced significantly higher performance than conventional instruction, and Alqawasmi et al. (2024) reported comparable gains for inquiry-based instruction. Within Nigeria, Abdullahi et al. (2021) similarly



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found that secondary school Biology students taught using the 7E instructional strategy achieved and retained more than those taught through traditional, teacher-centred methods. Comparing MAIBL with CDM thus helps clarify whether performance differences arise from the combined inquiry-and-model-based support that characterises MAIBL, rather than mere exposure to instruction generally. Although evidence generally favours inquiry-based and model-supported strategies, guided inquiry (Furtak et al., 2012) and model-supported instruction (Gee & Wong, 2012; Ronoh et al., 2020) having both improved outcomes, findings are not uniformly consistent; Jerrim et al. (2019), for instance, found limited association between inquiry frequency and science performance, suggesting that effectiveness depends on how inquiry is structured and on learner characteristics. Despite growing evidence on inquiry-based and model-supported instruction, limited research has examined whether MAIBL differentially affects Basic Science performance according to students' reasoning ability, particularly whether it offers an advantage over CDM among learners of varying reasoning levels in Benue State, Nigeria. Addressing this gap matters because instructional effectiveness may depend not only on the strategy employed but on learners' cognitive readiness to engage with its demands. This study therefore examined the effect of Model-Aided Inquiry-Based Learning on the academic performance of students with differing reasoning abilities in Basic Science in Benue State, Nigeria, comparing MAIBL with CDM and testing whether reasoning ability moderated the effect of instructional strategy on academic performance.

Statement of the Problem

Despite the recognised importance of Basic Science as a foundation for future specialisation in Biology, Chemistry, and Physics, students in Zone B, Benue State continue to record persistently inconsistent academic performance in Basic Science examinations. This performance has been linked to the abstract nature of some Basic Science concepts and the continued dominance of teacher-centred, conventional discussion methods that offer learners limited opportunity for active investigation or conceptual visualisation. While Inquiry-Based Learning has been advanced as a remedy, unsupported inquiry can impose excessive cognitive demands on learners, particularly when abstract concepts are explored without concrete or representational support. Model-Aided Inquiry-Based Learning (MAIBL) has therefore been proposed to integrate models into inquiry activities to ease this cognitive burden; however, empirical evidence on its effectiveness relative to conventional instruction in Basic Science remains limited, particularly within learners in Zone B, Benue State. Moreover, existing studies on related strategies, such as graphic organisers and concept mapping, have not established whether students' reasoning ability moderates the effectiveness of model-supported inquiry strategies. Consequently, it remains unclear whether MAIBL confers an academic performance advantage over the Conventional Discussion Method, and whether such an advantage, if it exists, is consistent across learners with differing levels of reasoning ability. This study therefore addressed the effect of Model-Aided Inquiry-Based Learning on the academic performance of students with varied reasoning abilities in Basic Science in Benue State.

Research Questions

The following research questions guided the study:

1. What is the difference in the mean academic performance scores of students taught Basic Science using model-aided inquiry-based learning and those taught using the conventional discussion method?
2. What is the difference in the mean academic performance scores of students with high, medium, and low reasoning abilities when taught Basic Science using model-aided inquiry-based learning?



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Hypotheses

The following null hypotheses were tested at a 0.05 level of significance:

1. There is no significant difference in the mean academic performance scores of students taught Basic Science using model-aided inquiry-based learning and those taught using the conventional discussion method.
2. There is no significant difference in the mean academic performance scores of students with varied reasoning abilities (high, medium, and low) when taught Basic Science using model-aided inquiry-based learning.

Research Methodology

A quasi-experimental pre-test, post-test non-equivalent control group design was adopted for this study. This design is appropriate because the researcher could not randomly assign individual students to groups; instead, intact classes were used as the unit of assignment. The population consisted of 18,420 JSS II students in 62 public co-educational upper basic secondary schools in Zone B, Benue State, for the 2024/2025 academic session (Benue State Teaching Service Board, 2023). Zone B was purposively selected because of its characteristically mixed urban-rural learner composition and persistent below-average performance in science subjects. The sample consisted of 88 JSS II students drawn from two co-educational public secondary schools in Makurdi Local Government Area using purposive sampling. These schools were selected on the basis of similarity in enrolment size, comparable pre-test mean scores (verified statistically), and availability of qualified Basic Science teachers willing to serve as research assistants. One school ($n = 42$) was randomly assigned to the experimental group (model-aided inquiry-based learning) and the other ($n = 46$) to the control group (conventional discussion method). Two instruments were used for data collection: the Basic Science Performance Test (BSPT) and the Reasoning Ability Test (RAT). The BSPT comprised 50 multiple-choice items drawn from the JSS II Basic Science curriculum, covering topics in physical science, life science, and earth science. The RAT comprised 20 multiple-choice items and assessed six reasoning modes: conservation, proportional, controlling variables, probabilistic, correlational, and combination reasoning. Based on RAT scores, students were classified into high ($RAT \geq 70\%$), medium ($40\% - 69\%$), and low ($< 40\%$) reasoning categories. Both instruments were validated by three experts: two from the Department of Science and Mathematics Education and one from the Department of Educational Measurement and Evaluation, Rev Fr Moses Orshio Adasu University, Makurdi. Reliability was determined through a trial test on 30 JSS II students using the Kuder-Richardson (KR-20) formula, reliability coefficients of 0.82 and 0.79 were obtained for the BSPT and RAT respectively. Two qualified experienced Basic Science teachers from the sampled schools as research assistants. Data were analyzed using Mean and Standard Deviation for research questions and ANCOVA for testing hypotheses, with pre-test scores serving as the covariate to control for initial group differences.

Presentation Of Results

The results of the data analysis and interpretation are presented according to research questions and test of null hypotheses.

Research Question 1: What is the difference in the mean academic performance scores of students taught Basic Science using model-aided inquiry-based learning and those taught using the conventional discussion method? This research question is answered in Table 2.

Table 1: Mean and Standard Deviation of Students' Academic Performance under Model-Aided Inquiry-Based Learning and Conventional Discussion Method



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Gender	Sample (n)	Pre-Test		Pre-Test		$\bar{x}$ Gain
		$\bar{x}$	SD	$\bar{x}$	SD	
Model-Aided Inquiry-Based Learning	42	18.12	5.67	36.14	3.14	18.02
Conventional Discussion Method	46	21.83	5.76	26.78	5.43	4.95
$\bar{x}$ Gain Difference		3.71		9.36		13.07

Table 1 shows that students taught Basic Science using Model-Aided Inquiry-Based Learning had a pre-test mean academic performance score of 18.12 (SD = 5.67), which increased to 36.14 (SD = 3.14) at post-test, giving a mean gain of 18.02. Students taught using the Conventional Discussion Method had a pre-test mean of 21.83 (SD = 5.76), which increased to 26.78 (SD = 5.43) at post-test, with a mean gain of 4.95. At post-test, the mean academic performance score of students taught using Model-Aided Inquiry-Based Learning was 9.36 points higher than that of students taught using the Conventional Discussion Method. The mean gain difference between the two groups was 13.07 in favour of Model-Aided Inquiry-Based Learning. The post-test standard deviations were 3.14 and 5.43 for the Model-Aided Inquiry-Based Learning and Conventional Discussion Method groups, respectively, with a difference of 2.29, indicating that students taught using Model-Aided Inquiry-Based Learning had less variation in their post-test performance. By implication, students' academic performance in but group improved, but the improvement was considerably greater among students taught using Model-Aided Inquiry-Based Learning.

Research Question 2: What is the difference in the mean academic performance scores of students with high, medium, and low reasoning abilities when taught Basic Science using model-aided inquiry-based learning? This research question is answered in Table 2.

Table 2: Mean and Standard Deviation of Students' Academic Performance by Reasoning Ability under Model-Aided Inquiry-Based Learning

Reasoning Ability Levels	Sample (n)	Pre-Test		Post- Test		Mean Gain Within Groups
		$\bar{x}$	SD	$\bar{x}$	SD	
High	12	12.42	3.34	38.83	2.21	26.41
Moderate	17	18.00	4.30	35.71	2.42	17.71
Mean Diff. Between Groups		5.58		3.12		8.70
High	12	12.42	3.34	38.83	2.21	26.41
Low	13	23.54	3.28	34.23	3.17	10.69
Mean Diff. Between Groups		11.12		4.60		15.72
Moderate	17	18.00	4.30	35.71	2.42	17.71
Low	13	23.54	3.28	34.23	3.17	10.69
Mean Diff. Between Groups		5.54		1.48		7.02

Table 2 shows that Model-Aided Inquiry-Based Learning improved students' academic performance across all reasoning ability levels. High-reasoning students increased from a pre-test mean of 12.42

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(SD = 3.34) to a post-test mean of 38.83 (SD = 2.21), yielding the highest mean gain of 26.41. Moderate-reasoning students increased from 18.00 (SD = 4.30) to 35.71 (SD = 2.42), with a mean gain of 17.71, while low-reasoning students increased from 23.54 (SD = 3.28) to 34.23 (SD = 3.17), with a mean gain of 10.69. The gain differences of 8.70, 15.72 and 7.02 between high-moderate, high-low and moderate-low groups, respectively, favoured the higher-reasoning groups. The reduced post-test standard deviations also indicate more consistent performance after the intervention, particularly among high- and moderate-reasoning students.

Hypothesis 1: There is no significant difference in the mean academic performance scores of students taught Basic Science using model-aided inquiry-based learning and those taught using the conventional discussion method. This hypothesis is tested in Table 3.

Table 3: ANCOVA Summary of Students' Academic Performance by Instructional Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1950.485 ^a	2	975.242	48.647	.000	.534
Intercept	7294.274	1	7294.274	363.854	.000	.811
Pretest	26.954	1	26.954	1.345	.249	.016
Strategy	1605.285	1	1605.285	80.075	.000	.485
Error	1704.015	85	20.047			
Total	89592.000	88				
Corrected Total	3654.500	87				

Table 3 indicates that $F(1, 85) = 80.075$; $p = 0.000 < 0.05$. Since the probability level is less than the specified alpha level of 0.05, the null hypothesis is rejected. It implies that there is a significant difference in the mean academic performance scores of students taught Basic Science using Model-Aided Inquiry-Based Learning and those taught using the Conventional Discussion Method after controlling for students' pre-test academic performance scores (covariate). The partial eta squared value of 0.485 for instructional strategy implies that 48.5% of the difference in students' academic performance scores can be accounted for by the instructional strategy. This indicates a large effect size. The result suggests that the instructional strategy had a significant effect on students' academic performance in Basic Science.

Hypothesis 2: There is no significant difference in the mean academic performance scores of students with varied reasoning abilities (high, medium, and low) when taught Basic Science using model-aided inquiry-based learning. This hypothesis is tested in Table 4.

Table 4: ANCOVA Summary of Students' Academic Performance by Reasoning Ability under Model-Aided Inquiry-Based Learning

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	137.639 ^a	2	68.820	10.033	.000	.340
Intercept	54002.706	1	54002.706	7873.181	.000	.995
Reasoning	137.639	2	68.820	10.033	.000	.340
Error	267.504	39	6.859			
Total	55270.000	42				



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Corrected 405.143 41
Total

Table 4 indicates that $F(2, 39) = 10.033$; $p = 0.000 < 0.05$. Since the probability level is less than the specified alpha level of 0.05, the null hypothesis is rejected. It implies that there is a significant difference among the mean academic performance scores of students with high, medium, and low reasoning abilities when taught Basic Science using Model-Aided Inquiry-Based Learning, after controlling for students' pre-test academic performance scores (covariate). The partial eta squared value of 0.340 for reasoning ability implies that 34.0% of the difference in students' academic performance scores can be accounted for by their reasoning ability. This indicates a large effect size.

Table 5: Bonferroni Post Hoc Test of Academic Performance by Reasoning Ability Level

(I) Reasoning Ability Level	(J) Reasoning Ability Level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
High	Moderate	3.1275*	.98745	.009	.6572	5.5977
	Low	4.6026*	1.0484	.000	1.9797	7.2254
3						
Moderate	Low	1.4751	.96493	.403	-.9388	3.8890

Table 5 shows that the Bonferroni post hoc test revealed a significant difference between students with high and moderate reasoning abilities (Mean Difference = 3.1275, $p = 0.009 < 0.05$) and between students with high and low reasoning abilities (Mean Difference = 4.6026, $p = 0.000 < 0.05$), indicating that students with high reasoning ability had significantly higher adjusted mean academic performance scores than those with moderate and low reasoning abilities. However, the difference between students with moderate and low reasoning abilities was not significant (Mean Difference = 1.4751, $p = 0.403 > 0.05$). The findings show that students with high reasoning ability performed significantly better in Basic Science when taught using Model-Aided Inquiry-Based Learning than students with moderate and low reasoning abilities, while students with moderate and low reasoning abilities had comparable academic performance.

Discussion of Findings

The finding showed that both Model-Aided Inquiry-Based Learning and the Conventional Discussion Method improved students' academic performance, with greater improvement under MAIBL. The corresponding hypothesis revealed a significant difference, with instructional strategy accounting for 48.5% of the variance, indicating a large effect. This finding may be attributed to the active and investigative nature of Model-Aided Inquiry-Based Learning, which engages students in observing and manipulating models, investigating concepts, asking questions and constructing explanations, rather than relying mainly on teacher-directed transmission of information. The finding aligns with Abdi (2014), who reported higher academic performance under inquiry-based learning than traditional instruction. Similarly, Ronoh et al. (2020) found greater academic gains with model-supported instruction. Finding aligns with that Demirçal and Selvi, M. (2022) who found that found that the experimental group achieved higher scores in the performance test compared with those of the control group. Findings also support that of Kpiranyam et al. (2024) who reported superior academic performance following concept-mapping-enriched instruction. The findings also align with Kpiranyam et al. (2023) who found that Graphic Advance Organizer instruction outperformed



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discussion. Similarly, it agrees with Enemarie et al. (2025) who reported higher Basic Science academic performance under guided inquiry than demonstration instruction. The superior MAIBL performance may be attributed to physical and conceptual models that made abstract concepts concrete and supported active exploration. As noted by Bybee et al. (2006), structured inquiry promotes active participation and deeper understanding, suggesting that combining models with inquiry can enhance academic performance.

The finding revealed that Model-Aided Inquiry-Based Learning improved students' academic performance across all reasoning ability levels, with the greatest improvement among high-reasoning students. The hypothesis test showed a significant difference in performance across the three reasoning ability levels, with reasoning ability explaining 34.0% of the variance, indicating a large effect. Post hoc analyses confirmed that high-reasoning students significantly outperformed their peers, whereas performance between moderate and low-reasoning students showed no meaningful difference. The findings may be attributed to the interactive and structured nature of Model-Aided Inquiry-Based Learning, which enabled students to explore concepts and draw conclusions. The high-reasoning students benefited more by leveraging their reasoning abilities to interpret models and make connections. The finding agrees with that of Furtak et al. (2012), who found a positive effect of inquiry-based science teaching on student learning, with stronger effects associated with teacher-guided inquiry. Similarly, Heindl (2019) and Kaçar et al. (2021) reported positive effects of inquiry-based learning on academic achievement, particularly among secondary-school students. This finding also tallies with that of Gee and Wong (2012) who found that the use of models or applications during inquiry was positively associated with enhancement of performance. The finding may therefore be attributed to the structured opportunities provided by Model-Aided Inquiry-Based Learning for students to explore concepts, interpret models and construct understanding. The large effect of reasoning ability observed in the present study is also consistent with evidence that inquiry-based approaches can promote higher-order thinking and cognitive engagement in science learning (Antonio & Prudente, 2024). However, Jerrim et al. (2019) found little evidence that the frequency of inquiry-based instruction was associated with higher science performance. The findings imply that Basic Science teachers should integrate Model-Aided Inquiry-Based Learning into classroom instruction, using physical and conceptual models to improve students' academic performance across different reasoning ability levels. They also highlight the need for differentiated scaffolding, teacher training and adequate instructional resources to support learners with varying reasoning abilities effectively.

Conclusion

The study concludes that Model-Aided Inquiry-Based Learning is more effective than the conventional lecture method in improving the academic performance of Upper Basic II students in Basic Science in Benue State. The strategy enhanced performance across all reasoning ability levels, with students of high reasoning ability recording the greatest improvement. The strategy therefore offers a promising approach for improving Basic Science learning and addressing persistent challenges of poor academic performance at the upper basic school level.

Recommendation

Based on the findings, the following recommendations are proposed to enhance students' academic performance in Basic Science:



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1. Basic Science teachers should integrate Model-Aided Inquiry-Based Learning into regular classroom instruction by using locally available models and inquiry activities to improve students' academic performance across different reasoning ability levels.
2. The Federal Ministry of Education, State Ministries of Education, UBEC, SUBEB and teacher education institutions should provide model kits, instructional resources and capacity-building programmes for Basic Science teachers to facilitate effective implementation of Model-Aided Inquiry-Based Learning and improve students' academic performance.

References

- Abdi, A. (2014). The effect of inquiry-based learning method on students' academic achievement in science course. *Universal Journal of Educational Research*, 2(1), 37–41.
- Abdullahi, S., Asniza, I. N. ., & Muzirah, M. . (2021). Effect of 7E instructional strategy on the achievement and retention of students in biology in public secondary schools in Adamawa State, Nigeria: Research Article. *Journal of Turkish Science Education*, 18(4), 748-764. <https://doi.org/10.36681/tused.2021.101>
- Achor, E. E., & Musa, J. H. (2021). Use of simulation and students' cognitive load in Basic Science. *International Centre for Science, Humanities and Education Research*, 5(1), 20–34.
- Achor, E. E., Agogo, P. O., & Duguryil, A. (2015). Effects of cognitive reasoning ability and prior exposure to content on Basic Science achievement of upper basic two students in Plateau State. *Journal of Science, Technology, Mathematics and Education*, 11(1), 170-184
- Ajay, E. E., Aboho, D. A., & Ajayi, V. O. (2018). Effects of experiential and inquiry teaching strategies on upper basic students' achievement in social studies. *Benue State University Journal of Education*, 18(1), 119–129.
- Alqawasmi, A., Alsalhi, N. R., & Al Qatawneh, S. S. (2024). The influence of utilizing inquiry-based learning strategy on science accomplishment of primary students' stage. *International Journal of Interactive Mobile Technologies*, 18(5), 62–76. <https://doi.org/10.3991/ijim.v18i05.47011>
- Antonio, R. P., & Prudente, M. S. (2024). Effects of inquiry-based approaches on students' higher-order thinking skills in science: A meta-analysis. *International Journal of Education in Mathematics, Science and Technology*, 12(1), 251-281. <https://doi.org/10.46328/ijemst.3216>
- Ayeni, M. F. (2022). Effects of experiential and problem-solving strategies on academic performance of Biology students in senior secondary schools in Nigeria. *International Journal of Education, Learning and Development*, 10(4), 1–8.
- Benue State Teaching Service Board. (2023). *Record and statistics of secondary schools*. Teaching Service Board.
- Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Powell, J. C., Westbrook, A., & Landes, N. (2006). *The BSCS 5E instructional model: Origins and effectiveness*. BSCS.
- Demirçalı, S. & Selvi, M. (2022). Effects of model-based science education on students' academic achievement and scientific process skills. *Journal of Turkish Science Education*, 19(2), 545-558.
- Enemarie, V., Fatima, I., Achadu, O. S., & Kpiranyam, F. S. (2025). Efficacy of guided-inquiry instructional strategy on students' academic performance in Basic Science in Otukpo, Benue State. *BSU Journal of Science, Mathematics and Computer Education*, 5(1). 106-115.
- Etobro, A. B., & Fabinu, O. E. (2017). Students' perceptions of difficult concepts in Biology in senior secondary schools in Lagos State. *Global Journal of Educational Research*, 16(2), 196–216.



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- Furtak, E. M., Seidel, T., Iverson, H., & Briggs, D. C. (2012). Experimental and quasi-experimental studies of inquiry-based science teaching: A meta-analysis. *Review of Educational Research*, 82(3), 300–329. <https://doi.org/10.3102/0034654312457206>
- Gee, K. A., & Wong, K. K. (2012). A cross-national examination of inquiry and its relationship to student performance in science: Evidence from the Programme for International Student Assessment (PISA) 2006. *International Journal of Educational Research*, 53, 303–318. <https://doi.org/10.1016/j.ijer.2012.04.004>
- Griskevica, I., & Iltner, M. (2021). Relationship between academic self-efficacy and cognitive load for students in distance learning. *Education Innovation Diversity*, 2(2), 31–40.
- Heindl, M. (2019). Inquiry-based learning and the pre-requisite for its use in science at school: A meta-analysis. *Journal of Pedagogical Research*, 3(2), 52–61. <https://doi.org/10.33902/JPR.2019254160>
- Jerrim, J., Oliver, M., & Sims, S. (2019). The relationship between inquiry-based teaching and students' achievement: New evidence from a longitudinal PISA study in England. *Learning and Instruction*, 61, 35–44. <https://doi.org/10.1016/j.learninstruc.2018.12.004>
- Kaçar, T., Terzi, R., Arikan, İ., & Kırıkçı, A. C. (2021). The effect of inquiry-based learning on academic success: A meta-analysis study. *International Journal of Education and Literacy Studies*, 9(2), 15–23.
- Kpiranyam, F. S., Achor, E. E., & Fakaa, S. G. (2024). Scaling up emotional intelligence and critical thinking of students in Biology using concept mapping strategies. *FNAS Journal of Mathematics and Science Education*, 5(4), 96–105.
- Kpiranyam, F. S., Ode, J. O., & Ajio, C. E. (2023). A field report on the efficacy of Graphic Advance Organizer approach on students' performance and retention in Biology in Gboko Metropolis. *African Journal of Science, Technology and Mathematics Education*, 9(3), 110–116.
- Kpiranyam, F.S., Samba, R.M.O., & Onah, D. (2021). Will student team achievement division strategy enhance secondary school students' critical thinking in biology? A Field Report. *Education Review Letters*, 6(12), www.mindsourcingoa.com
- Mardonov, Z. (2019). The importance of Biology education at schools. *European Journal of Reflection in Educational Science*, 7(12), 909–912.
- Nwuba, I. S., & Osuafor, A. M. (2021). Effect of experiential learning approach on secondary school students' academic achievement in Biology in Awka Education Zone. *South Eastern Journal of Research and Sustainable Development*, 4(2), 1–15.
- Ode, J.O., & Fakaa, G.S. (2023). Evaluation of basic science textbooks used at universal basic education (UBE) schools in Benue state, Nigeria. *International Journal of Multidisciplinary Research and Growth Evaluation*, 4 (5), 698–703.
- Ogbaga, E., Olodu, G., Omebe, C. A., Egbe, I., & Iruka, E. (2024). Effects of guided inquiry instructional strategy on students' achievement and retention in Basic Science in secondary schools. *Journal of the Nigerian Association of Mathematical Physics*, 6(6), 85–98.
- Okuakaji, M. M., & Sukolatambaya, I. (2020). Effect of experiential learning strategy on Biology students' academic achievement in Dutsin-Ma Local Government Area of Katsina State. *Al-Hikmah Journal of Education*, 7(1), 166–172.
- Omaga, J.O., & Kpiranyam, F.S. (2024). Effects of 7Es Model and Problem-Based Strategy on Performance in Wave Motion among Secondary School Students in Bauchi Metropolis. *Zamfara International Journal of Education*, 4(1), 1–10.
- Piaget, J. (1964). Part I: Cognitive development in children: Piaget – Development and learning. *Journal of Research in Science Teaching*, 2(3), 176–186.



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DOI: <https://doi.org/10.64348/zije.2026569>

Effect of Model-Aided Inquiry-Based Learning on ... Fakaa, G. S., Et. al. (2026)

Roadrangka, V., Yeany, R. H., & Padilla, M. J. (1983). *GALT, Group Assessment of Logical Thinking*. University of Georgia.

Ronoh, P. K., Wachanga, S. W., & Keraro, F. N. (2020). Relative effects of experiential computer-assisted instruction on secondary school students' self-concept in Biology in Bomet County, Kenya. *International Journal of Humanities Social Sciences and Education*, 7(7), 77–84.

Samba, R. M. O., & Kpiranyam, F. S. (2021). Effects of assertive questioning instructional strategy on students' critical thinking and performance in Biology in Vandeikya of Benue State, Nigeria. *Education Review Letters*, 6(6).
<https://www.researchgate.net/publication/357539540>

West African Examinations Council (WAEC). (2022). *Chief examiner's report: Basic Education Certificate Examination (BECE)*. WAEC.