

ENHANCING JUNIOR SECONDARY STUDENTS' PERFORMANCE IN ALGEBRA THROUGH THE USE OF MODEL-LEAD-TEST INSTRUCTIONAL STRATEGY

BY

OBAJE, EMMANUEL AYEGBA, ACHIMUGU, LAWRENCE AND
FASANYA, AYODELE GABRIEL

Department of Science Education
Prince Abubakar Audu University
Anyigba, Kogi State, Nigeria

Corresponding Author: emmanuelobaje001@gmail.com, +2348134870139

Abstract: This study investigates the effect of the Model-Lead-Test (MLT) instructional strategy on junior secondary school students' academic performance towards algebra. The study is guided by two research questions and two hypotheses. A quasi-experimental design was used, involving two groups: an experimental group taught using the Model-Lead-Test strategy and a control group taught using conventional discussion method. Data were analyzed using descriptive and inferential statistics. Results indicated that students taught with Model-Lead-Test showed significantly improved performance and a more positive attitude towards algebra compared to those in the control group. These findings suggest that Model-Lead-Test is an effective approach for enhancing students' understanding of algebra at the junior secondary school level. Furthermore, Model-Lead-Test instructional strategy not only improves immediate academic outcomes in algebra but also presents a viable method for reducing educational inequities between urban and rural learners.

Keywords: *Model-Lead-Test, Algebra, Academic Performance, Attitude, Junior Secondary School, Instructional Strategy*

Introduction

Mathematics is an essential tool that humans cannot do without. The subject as stated by Achimugu (2018) is the scientific study of identifying patterns. Eche (2023) describes Mathematics as the science that draws necessary conclusions. Mathematics therefore can be defined as the scientific study of identifying patterns to draw necessary conclusions. The importance of Mathematics cannot be over-emphasized. One needs knowledge of mathematics in having a degree in the following areas; Chemistry, Physics, Engineering, Biology, Pharmacy (Achimugu & Igbogwu, 2021).

Algebra is a foundational aspect of mathematics education, despite its importance, many junior secondary school students struggle with understanding its abstract concepts. The poor academic performance in algebra often leads to a negative attitude toward mathematics as a whole. Conventional teaching methods, which often rely on rote memorization and teacher-centered instruction, may not effectively support conceptual understanding. The Model-Lead-Test (MLT) strategy, derived from Direct Instruction, provides a structured and interactive method of teaching that has shown promise in enhancing student engagement and comprehension.

Algebra is a central component of the mathematics curriculum and serves as a gateway to higher-level mathematical thinking and problem-solving. It is not only a branch of mathematics that deals with symbols and the rules for manipulating those symbols, but it also plays a crucial role in developing students' abstract reasoning abilities (Kaput, 2008). According to the National Council of Teachers of Mathematics (NCTM, 2000), algebra provides a way for students to represent and analyze relationships among quantities, understand patterns, and model real-world situations.

The learning of algebra has long been recognized as a significant challenge for many students at the junior secondary school level. One of the major difficulties lies in the transition from arithmetic, which is mostly concrete and procedural, to algebra, which requires a higher level of abstraction and the ability to generalize (Kieran, 1992). Students often struggle with understanding the use of letters to represent unknowns or variables, and this confusion can hinder their ability to solve equations or apply algebraic reasoning effectively. Kilpatrick et al (2001) argue that proficiency in algebra involves five intertwined strands: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. Effective algebra instruction, therefore, should focus on helping students make sense of algebraic concepts and develop the ability to reason mathematically.

Usman (2002) emphasizes that poor teaching strategies contribute significantly to students' underperformance in algebra. Traditional teaching methods tend to emphasize rote memorization and procedural fluency without ensuring conceptual understanding. These approaches do not adequately support the cognitive development required for mastering algebraic concepts. As a result, students may learn to manipulate symbols without truly understanding their meaning or relevance.

In recent years, instructional strategies such as the Model-Lead-Test (MLT) strategy have been recommended for their structured and scaffolded nature, which aligns well with the cognitive demands of learning algebra. The MLT strategy allows teachers to first model a problem-solving process, then lead students through guided practice, and finally assess their independent understanding. This gradual

release of responsibility helps students internalize algebraic thinking (Archer & Hughes, 2011). Hence the researcher is poised to determine the effectiveness of Model-Lead-Test instructional strategy on enhancing junior secondary students' performance in Algebra.

In Nigeria, educational disparities between urban and rural areas remain a pressing concern. These disparities are often rooted in the broader socio-economic and infrastructural differences that characterize urban and rural settlements. Understanding these differences is crucial for contextualizing the challenges faced by students, especially in subjects like mathematics where consistent support and quality instruction are essential.

An urban settlement is typically defined as a densely populated area characterized by advanced infrastructure, access to social services, and diversified economic activities (National Population Commission [NPC], 2010). Urban areas generally have better-resourced schools, higher teacher-to-student ratios, and more exposure to educational innovations. In contrast, a rural settlement refers to a sparsely populated area where the majority of residents engage in agriculture and other primary sector activities. Rural areas often lack adequate infrastructure, including educational facilities, which significantly affects students' learning outcomes (Adebayo, 2014; Olayemi, 2016).

Studies have shown that students in urban schools tend to outperform their rural counterparts due to differences in school environment, teacher qualifications, access to learning materials, and parental involvement (Umeh & Eze, 2018). These structural inequalities contribute to a persistent achievement gap, particularly in core subjects like mathematics and algebra. Rural students often experience limited instructional time, overburdened teachers, and fewer opportunities for remediation and enrichment.

Given this context, instructional strategies that are flexible, low-cost, and effective across varying school settings are urgently needed to reduce these disparities. The Model-Lead-Test (MLT) instructional strategy, which emphasizes explicit teaching, guided practice, and student independence, is well-positioned to serve this role. Therefore, the researcher is poised to investigate the effect of model-lead-test strategy on the academic performance of urban and rural students in Algebra.

Research Questions

1. What is the mean difference between the academic performance of students taught algebra using model-lead-test and those taught using conventional discussion strategy?
2. What is the mean difference between the academic performance scores of urban and rural students taught algebra using model-lead-test strategy?

Hypotheses

H₀₁: There is no significant difference between the mean academic performance scores of students in taught algebra using Model-lead-test strategy and those taught using the conventional discussion strategy.

H₀₂: There is no significant difference between the mean academic performance scores of urban and rural students taught algebra using model-lead-test?

Methodology

This study used a quasi-experimental design using the pretest-posttest control group. The design was chosen for its ability to assess the effectiveness of interventions by selecting groups with pre-existing characteristics (Achimugu *et al.*, 2024). This study consisted of two groups: experimental group that will be exposed to model-lead-test strategy and the Control group. Prior to the implementation of the instructional strategies, both groups were subjected to a pretest to measure their initial academic performance. Subsequently, the designated instructional strategies were applied, and posttests was administered to assess the changes. The population of the study consists of 17517 (9,213 urban and 8,304 rural) Upper Basic Two Mathematics students from 254 public secondary schools in Kogi State. The sample size for the study was 197 (102 urban and 95 rural) Upper Basic Two Mathematics students from the three Senatorial districts of Kogi State. The multi-stage sampling technique was employed in the sampling procedures. Firstly, stratified sampling technique was employed to divide the state into urban and rural strata based on geographical location. Then the Simple Random Sampling technique was used to select schools from each stratum. The instruments used for data collection was the Algebra Performance Test (APT) which was validated by experts. The reliability coefficients of (APT) using Richardson 20 formula yielded 0.72. Data were analyzed using descriptive and inferential statistics.

Results

Research Question One:

What is the mean difference between the academic performance scores of students taught algebra using model-lead-test and those taught using conventional discussion strategy?

Table 1: Mean Academic Performance Scores of Students Taught Algebra Using Model-lead-test Strategy and Those Taught Using Conventional Discussion Strategy.

Variable		Pre test		Posttest		Mean gain	Mean
Method of Teaching	N	\bar{x}	SD	\bar{x}	SD		Diff
Model-lead-test Strategy	102	47.54	7.480	67.18	8.530	19.64	10.00
Conventional Discussion Strategy	95	46.61	8.350	56.25	9.060	9.640	

Table 1 indicates the mean performance scores of students taught algebra using model-lead-test strategy and those taught using conventional discussion strategy. From the results, upper basic 2 students taught algebra using model-lead-test strategy had a mean performance score of (\bar{X} = 47.54, SD=7.48) for pre-test and (\bar{X} = 67.18, SD=8.53) for post-test with a mean gain of 19.64. Furthermore, Table 1 shows that students' exposed to conventional discussion strategy had a mean performance score of (\bar{X} = 46.61, SD=8.35) for pre-test and (\bar{X} = 46.25, SD=9.06) for post-test with a mean gain of 9.64. A mean difference of 10.00 was obtained from the result. This is an indication that model-lead-test and conventional discussion strategy are potent in improving the academic performance scores of upper basic 2 students in algebra. Nevertheless, model-lead-test strategy proved to be more potent in increasing the academic performance scores of algebra students' more than conventional discussion strategy.

Research Question Two: What is the mean difference between the urban and rural students' academic performance scores of students taught algebra using the model-lead-test?

Table 2: Pre-test/Post-test of the Mean Academic Performance Scores of Urban and Rural Students Taught Algebra Using Model-lead-test Strategy

Variable		Pretest		Posttest		Mean Gain	Mean Diff
Location	N	\bar{X}	SD	\bar{X}	SD		
Urban	52	47.39	7.760	62.48	9.740	15.09	0.0900
Rural	50	47.35	8.550	62.35	9.550	15.00	

The result in Table 2 shows the mean and standard deviation on the effect of settlement area on students' mean performance in algebra. From the result, the pre - test mean performance score of urban students taught algebra was (\bar{X} = 47.39, SD=7.760) with a post-test score of (\bar{X} = 62.48, SD=9.740) and a mean gain of 15.09 while their rural counterpart taught algebra had a pre-test mean performance score of (\bar{X} = 47.35, SD=8.550) and post-test (\bar{X} = 62.35, SD=9.550) with a mean gain of 15.00. The mean difference obtained for both groups was 0.0900. This result is an indication that urban students had a higher mean performance score in algebra when compared to the rural students when taught using model-lead-test strategy.

Hypotheses

HO₁: There is no significant difference between the mean academic performance scores of students in the experimental and control groups

Table 3: Analysis of Covariance (ANCOVA) of Difference in the Mean Academic Performance Scores of Students in Algebra When Exposed to Model-lead-test Strategy and Discussion Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Dec.
Corrected Model	1841.297 ^a	13	141.638	16.685	0.00	0.24	
Intercept	50.641	1	50.265	5.921	0.16	0.78	
Pretest	298.828	1	298.641	35.180	0.00	0.00	
Methods	55.034	4	54.049	6.483	0.01	0.23	S
Error	984.711	178	19.681				
Total	496735.000	197					
Corrected Total	2826.008	196					

Note: S = Significant, NS = Not Significant and η^2_p = partial eta squared

With respect to hypothesis one (H_{01}), Table 3 shows the ANCOVA result for the significant difference in the mean performance scores of students taught algebra using model-lead-test strategy and those taught with discussion method. The result shows that an F-ratio 6.483, $p < 0.01$ was obtained. The associated exact probability value of 0.01 obtained is less than 0.05 level of significance set for decision making. Hence, the null hypothesis was rejected. Inference drawn is that, there is a significant difference in the mean performance scores of students in algebra when taught using model-lead-test strategy and discussion Method in favour of model-lead-test strategy with higher mean score. More so, Table 4.8 shows a partial eta square (η^2_p) of 0.23. This means that 23% of the increase in the mean performance scores of students in algebra was due to the effect of the model-lead-test strategy.

H₀₂ There is no significant difference between the mean academic performance scores of urban and rural students taught algebra using mode-lead-test.

Table 4: Analysis of Covariance (ANCOVA) of the Difference in the Mean academic Performance score of Urban and Rural Students Taught Algebra Using Model-lead-test Strategy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Dec.
Corrected Model	1806.728 ^a	11	180.673	17.940	0.00	0.75	
Intercept	0.004	1	.004	.000	0.98	0.00	
Pretest	416.941	1	416.941	41.401	0.00	0.42	
Methods	90.066	3	45.033	4.472	0.02	0.17	
Location	120.578	2	60.289	6.332	0.31	0.18	NS
Error	523.684	84	10.071				
Total	235535.000	102					
Corrected Total	2330.413	101					

Note: S = Significant, NS = Not Significant and η^2_p = partial eta squared

The result in Table 4 shows the result of ANCOVA difference between urban and rural students performance scores when taught algebra using Model-lead-test strategy. The result was statistically significant at (F)=6.332, p = 0.31, η^2_p = 0.18). Since the associated probability value of 0.31 is greater than 0.05 set as level of significance, the null hypothesis was accepted. Thus, inference drawn is that there was no statistically significant difference between urban and rural students academic performance scores when taught algebra using model-lead-test strategy. The result further showed the effect size (η^2_p = 0.18), which indicates that eighteen percent (18%) of the increase in the mean academic performances scores of students in algebra was due to the effect of model-lead-test strategy.

Discussion of Findings

The findings of this study revealed that the Model-Lead-Test (MLT) instructional strategy has a significant impact on students' academic performance in algebra. Students taught using the MLT approach demonstrated higher post-test scores compared to those taught through conventional instructional methods. This result confirms the effectiveness of the MLT strategy in enhancing algebraic understanding, building procedural fluency, and boosting learners' confidence in mathematics.

The success of the MLT strategy can be largely attributed to its structured, scaffolded, and interactive nature. It follows a three-step process: Model—where the teacher demonstrates the concept or procedure; Lead—where the teacher guides students through practice; and Test—where students independently apply the concept. This gradual release of responsibility fosters mastery and supports the development of both conceptual and procedural knowledge (Archer & Hughes, 2011). By repeatedly engaging students in guided practice followed by independent performance, the MLT approach allows learners to internalize problem-solving steps, thereby reducing errors and increasing retention. Moreover, this study supports existing research that emphasizes the role of explicit and systematic instruction in improving mathematical outcomes. According to Rosenshine (2012), structured instruction with opportunities for guided practice, checks for understanding, and scaffold learning is especially beneficial for students who struggle with abstract concepts such as algebra. The MLT strategy operationalizes these principles effectively.

An important and novel implication of this study is the potential of the MLT strategy to bridge the academic performance gap between students in urban and rural schools. In Nigeria, as in many developing countries, rural students often face disadvantages such as limited access to qualified teachers, inadequate instructional resources, and larger class sizes (Adebayo, 2014; Umeh & Eze, 2018). These factors contribute to persistent underperformance in core subjects like mathematics. The MLT strategy, due to its simplicity, adaptability, and low-resource requirements, is especially suited for such contexts. Teachers in rural areas can

apply the MLT framework without needing advanced technological tools or extensive materials. Its focus on modeling and guided repetition can compensate for students' prior learning gaps and low exposure to enriched mathematical instruction. This is supported by findings from Swanson and Hoskyn (2001), who emphasize that structured teaching approaches are particularly effective for students with learning difficulties or those in underserved environments.

Furthermore, the strategy encourages active student participation, immediate feedback, and consistent practice—all of which are crucial in environments where learner autonomy and confidence may be underdeveloped. By demystifying algebraic procedures and breaking down abstract concepts into learnable units, the MLT strategy can help rural students catch up with their urban counterparts.

In conclusion, the MLT instructional strategy not only improves immediate academic outcomes in algebra but also presents a viable method for reducing educational inequities between urban and rural learners. Given its adaptability and effectiveness, it holds promise for broader implementation in mathematics instruction across varying educational contexts in Nigeria and beyond.

References

- Achimugu, L. (2018). Gender differences in the study habits and academic performance among university students in Ghana. *International Journal of Educational Administration and Policy Studies*, 6(8). 151 – 157.
- Achimugu, L. & Igbogwu, E. L. (2021). The role of mole concept in simplifying mathematical tasks. *Home Rehabilitation Medicine Role*, 54(1). Retrieved from *Journal of Science Teaching of Nigeria*. website: <http://www.jstn.com/0795-7270/>
- Achimugu, L., Mohammed, S. A. Enefu, S. M. & Offor, M. (2024). *Comprehensive Research Method and Statistics in Education, Published by Ahmadu Bell University, Press Limited Zaria*.
- Adebayo, A. M. (2014). Rural-urban dichotomy and students' academic performance in Nigeria: The case of Ekiti State. *International Journal of Education and Research*, 2(10), 225– 234.
- Archer, A. L., & Hughes, C. A. (2011). *Explicit Instruction: Effective and Efficient Teaching* Guilford Press.
- Kaput, J. J. (2008). What Is Algebra? What Should It Be? In C. Greenes & R. Rubenstein (Eds.), *Algebra and Algebraic Thinking in School Mathematics* (pp. 3–17). National Council of Teachers of Mathematics.

- Kieran, C. (1992). The Learning and Teaching of School Algebra. In D. A. Grouws (Ed.), *Handbook of Research on Mathematics Teaching and Learning* (pp. 390–419). Macmillan.
- Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding It Up: Helping Children Learn Mathematics*. National Academy Press.
- Mata, M. D. L., Monteiro, V., & Peixoto, F. (2012). Attitudes towards mathematics: Effects of individual, motivational, and social support factors. *Child Development Research*, 2012
- National Council of Teachers of Mathematics (NCTM). (2000). *Principles and Standards for School Mathematics*. Reston, VA: NCTM.
- National Population Commission (NPC). (2010). *Nigeria Demographic and Health Survey*. NPC and ICF Macro.
- Olayemi, S. O. (2016). The effect of rural and urban location on students' academic performance in senior secondary school physics. *Journal of Education and Practice*, 7(22), 104–109.
- Rosenshine, B. (2012). Principles of instruction: Research-based strategies that all teachers should know. *American Educator*, 36(1), 12–19.
- Swanson, H. L., & Hoskyn, M. (2001). *Instructing students with learning disabilities: Interactions of teacher behaviors and student characteristics*. Lawrence Erlbaum Associates.
- Umeh, A. N., & Eze, E. E. (2018). Influence of school location on students' academic achievement in mathematics. *Nigerian Journal of Educational Research and Evaluation*, 17(2), 103–110
- Usman, I. A. (2002). *The Relevance of Teaching Strategies to the Learning of Algebra in Nigerian Schools*. *Journal of Educational Research and Development*, 2(1), 102–110.