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Effect of Growth Mindset-Enriched Inquiry-Based Learning on Attitude and Academic Performance in Mathematics among Upper Basic Students in Niger State, Nigeria

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ABSTRACT

This study investigated the effect of Growth Mindset-Enriched Inquiry-Based Learning (GMEIBL) on attitude and academic performance in mathematics among Upper Basic II students in Minna Metropolis, Niger State, Nigeria. The study adopted pretest–posttest quasi-experimental non-equivalent control group design. A sample of 178 students from a population of 4,044 students in 12 government-owned secondary schools was used for the study. The selected schools were assigned to intact experimental class (GMEIBL = 88) and intact control class (conventional = 90) using simple random sampling process. Mathematics Performance Test (MPT) and Attitude towards Mathematics Scale (ATMS) were used for data collection. The test–retest reliability of MPT items were analyzed using Pearson Product Moment Correlation while the internal consistency of the ATMS was analyzed using Cronbach's alpha, and their reliability coefficients were found to be (MPT = 0.75) and (ATMS = 0.82), respectively. The research questions were answered using Mean and standard, while the null hypotheses were tested at 0.05 significance level using ANCOVA. GMEIBL produced higher attitude scores (M = 85.03, SD = 5.49) than conventional instruction (M = 68.21, SD = 4.89), $F(1,175) = 438.467$, $p < .05$, and higher performance (M = 77.40, SD = 13.16) than 60.37 (SD = 14.51), $F(1,175) = 67.332$, $p < .05$. Based on the results, the study concludes that GMEIBL proved more effective in improving performance and attitude towards mathematics compared to conventional method. It is recommended that mathematics teachers and curriculum designers should integrate growth mindset principles into inquiry-based instruction to enhance students' performance in mathematics.

Keywords: Growth Mindset, Inquiry-Based Learning, Attitude, Mathematics, Performance, Upper Basic Students.

INTRODUCTION

Mathematics accentuates the beauty of nature as it covers the study of number, quantity, space, change, and relationships. It involves both empirical problem-solving and abstract theoretical frameworks developed across diverse cultures and ages. According to Ernest (2019), mathematics is both a body of knowledge and a way of thinking that enables individuals to model, analyze, and solve real-life problems. In Nigeria, Mathematics is made compulsory at the basic and secondary levels because it helps students to develop logical reasoning, problem-solving skills necessary for the choice of future career paths and effective functioning in the society (NERDC, 2013; UNESCO, 2023). Despite its importance, students' performance in mathematics has remained below expectation as indicated by classroom assessments and public examination reports (Awofala & Fatade, 2023; Nnaike, 2024). In Niger State, Ahmad et al. (2024) reported recurring problem-solving errors among junior secondary students in Minna Metropolis, suggesting difficulties in understanding and applying mathematical concepts. As a result, some students avoid challenging mathematics tasks, lose persistence and underachieve, even though they are capable of doing better with appropriate support. Several studies have identified ineffective teaching strategies, negative attitudes, teachers' and students' mathematical mindsets as factors responsible for students' disengagement, apathy, underachievement in mathematics (Abdullahi & Ibrahim, 2025; Awofala & Akinoso, 2024; Bizimana, 2025; Zeeshan, 2025).

Attitude towards mathematics can be seen as students' feelings, enjoyment, motivation and perceived value of learning mathematics which determines their response to instructional process and willingness to engage in challenging mathematical exercises (Aquilina et al., 2025). Attitude is one of the important factors mediating the relationship between instructional method and students' academic achievement. Oladele et al. (2024) in their study involving Junior Secondary School students in Lagos, established that attitude and academic performance are significantly positively correlated. In another study comprising 5,711 Viatnamese students, Liu et al. (2024) found that inquiry-based instruction significantly improved academic performance and students' attitudes towards mathematics. Their findings further established that students' attitudes positively mediated the relationship between inquiry-based instruction and mathematics performance. These results show that efforts aimed at improving academic performance in mathematics should

take both the cognitive and affective domains of students into consideration.

The learning experiences of the students may affect their beliefs about their capability to learn, understand, and excel in mathematics-related tasks. Persistent failures and difficulties may cause some learners to view mathematical ability as inborn or fixed, which may induce fear and affect their desire to persist when faced with challenging tasks. This can result to negative attitude, disengagement, and underachievement. Gunderson et al. (2018) demonstrated reciprocal relations among achievement, fixed-ability beliefs and mathematics anxiety, indicating that these factors reinforce one another. Instructional practices may also influence these beliefs. Teaching that lays so much emphasis on memorization, speed and correct answers rather than reasoning, effort and improvement may communicate that mathematical success depends mainly on innate ability or natural gifts. Research evidence has shown that teachers' instructional practices with less focus on learning process and engagement were linked to students' disengagement and poor achievement in mathematics (Awofala & Akinoso, 2024; Ramirez et al. , 2018). Hence, there is need to develop innovative instructional practices that caters for both students' cognitive and affective developments.

Inquiry-based learning (IBL) is one process-based and student-centered instructional strategy that encourages students' active cognitive engagement. Typically, IBL is structured through the 5E learning cycle (Bybee et al., 2006). It encourages students to ask questions, explore mathematical concepts, investigate problems, construct knowledge and explain their reasoning. It has been found to improve achievement and enhance attitude towards mathematics (Adewumi & Oloja, 2025; Adolphus & Nweke, 2025; Bashir & Usman, 2026; Liu et al., 2024). In Minna Educational Zone, Niger State, Ahmad et al. (2023) reported that Senior Secondary School students taught mensuration using IBL significantly performed better than those taught through conventional method. Similarly, Eya et al. (2026), in a study among upper basic students in Niger State, found that IBL significantly improved students' attitudes towards mathematics but did not produce a significant improvement in their performance. This finding suggests that although inquiry-based instruction can promote positive attitudes, its use alone may not always be enough to improve students' performance in mathematics. This is because despite the collaborative and process-oriented nature of IBL and its potential to promote student enjoyment of mathematics, it often does not adequately cater for disadvantaged students who may be struggling with fear of failure, lack of confidence and resilience. This calls for instructional strategies that target these students' psychological problems that may affect their performance. A number of research evidence revealed that teacher-led interventions within inquiry classrooms can successfully address these issues (OECD, 2021; Yeager et al., 2019; Zhou & Zhang, 2024).

Growth mindset provides a possible means of strengthening inquiry-based learning. It is based on the belief that abilities can be developed through effort, effective strategies, persistence, constructive feedback and learning from mistakes (Ayoola & Ibrahim, 2024; Dweck, 2006). Local growth mindset studies have indicated improvement in the achievement of underachieving secondary students (David et al., 2025). Related evidence also showed that sustained inquiry can itself shift growth mindset (Tawfik et al., 2025). Integrating these principles into inquiry-based learning may encourage students to approach mathematical challenges with confidence, regard mistakes as opportunities for improvement and persist in solving difficult problems. Supporting this possibility, Kajuru et al. (2026), in their study among upper basic students in Niger State, found that Growth Mindset-Enriched Inquiry-Based Learning (GMEIBL) significantly reduced mathematics anxiety and improved mathematics performance compared with conventional instruction. Other research evidence also revealed the positive effects of combining IBL with growth mindset principles. Klein (2020), for instance, found that enriching IBL with growth mindset principles created a growth mindset and positively influenced elementary mathematics learners' mindsets. Similarly, Pedersen and Haavold (2023) also found that enjoyment of mathematics was linked to IBL practices combined with growth mindset beliefs. These findings provide promising evidence that integrating growth mindset principles in IBL classroom may improve academic achievement and enhance students' attitude towards mathematics. Bui et al. (2023) and Stohlmann and Yang (2024) highlighted the significance of combining mindset interventions with classroom instructional activities rather than treating them as isolated pedagogical practices.

Although, the reviewed studies have established positive effects of IBL (Adewumi & Oloja, 2025; Adolphus & Nweke, 2025; Ahmad et al., 2023; Bashir & Usman, 2026; Eya et al. (2026); Liu et al., 2024) and Growth Mindset Interventions (David et al., 2025) on attitudes and performance when implemented separately including their effects when combined (Bui et al., 2023; Klein, 2020; Pedersen & Haavold, 2023; Stohlmann & Yang, 2024), most of the studies operate in isolation with some focused only on inquiry methods, while others focused only on mindset training with some reporting a less conclusive picture of the effectiveness of growth mindset interventions (Macnamara & Burgoyne, 2023). In addition, most studies were conducted outside Minna metropolis and among different educational levels, particularly, most Nigerian studies focused more on senior secondary students, leaving upper basic (Junior Secondary) students less examined. This is a critical gap because upper basic students are at a transitional stage where foundational

attitudes and cognitive skills are formed. Consequently, there is little local empirical evidence on an integrated Growth Mindset-Enriched Inquiry-Based Learning model in Nigerian upper basic mathematics classrooms, particularly in Niger State. This study, therefore, addressed this gap by examining the effect of GMEIBL on attitude and performance among JSS II students in Minna Metropolis, Niger State, Nigeria. The finding of this study is hoped to provide evidence-based data that would inform mathematics educators, curriculum developers, and educational policymakers on the effectiveness of integrating growth mindset principles into inquiry-based instructional practices for improving both affective and cognitive learning outcomes in mathematics.

Research Questions

The following research questions guided the study:

1. What is the difference between the mean attitude score of upper basic II students taught mathematics using GMEIBL and those taught using the conventional method?
2. What is the difference between the mean performance score of upper basic II students taught mathematics using GMEIBL and those taught using the conventional method?

Hypotheses

The following null hypotheses were formulated to guide the study and were tested at a 0.05 level of significance:

H_{01}: There is no significant difference between the mean attitude score of upper basic II students taught mathematics using GMEIBL and those taught using the conventional method.

H_{02}: There is no significant difference between the mean performance score of upper basic II students taught mathematics using GMEIBL and those taught using the conventional method.

METHODS

The study adopted a quasi-experimental pretest–posttest non-equivalent control group design. The population comprised 4,044 Upper Basic II students across 12 public secondary schools in Minna Metropolis, Niger State. A multi-stage sampling method was used. To start with two schools out of the 12 schools were selected through simple random sampling (balloting without replacement). Afterwards, the two selected schools were randomly assigned to the experimental and control groups using toss of a coin. Finally, from the selected schools, intact Upper Basic II classes were randomly selected and assigned to experimental (GMEIBL, n=88) and control (conventional, n=90) groups.

Data were collected using two instruments: the Mathematics Performance Test (MPT) and the Attitude Towards Mathematics Scale (ATMS). The MPT is a 20-item multiple-choice test with four options (A-D) developed by the researcher from the following topics: bearing and distances, Pythagoras theorem, areas of cylinders and cones, volumes of cylinders and cones, and measurement of squares using tables which were contained in the third term syllabus of JSS II students. The difficulty and discrimination indices of the items were analyzed and good items were proportionately distributed using a table of specification. The ATMS is a 20-item Likert-type scale adopted by the researcher to measure affective responses. The ATMS items were adopted because they were validated for secondary school mathematics students with similar socio-economic background as the present study group.

Data were collected using the Mathematics Performance Test (MPT) and Attitude Towards Mathematics Scale (ATMS). Five experts (3 from secondary school and two from mathematics Department, ABU, Zaria) in Mathematics validated the MPT instrument focusing on alignment with JSS II syllabus, students' cognitive levels, language clarity and simplicity while three experts in measurement and evaluation validated the ATMS instrument for content and face validity. Pilot testing was conducted using 40 Upper Basic II students selected from a public secondary school in Bosso outside Minna Metropolis, but with characteristics similar to the study population. The instruments were administered twice at a two-week interval. MPT items were analyzed to determine temporary stability of the scores over time using Pearson Product Moment Correlation, and test–retest reliability yielded 0.75. Cronbach's alpha was used to analyze the internal consistency of the ATMS and the reliability coefficient was found to be 0.82. The reliability coefficients were within acceptable threshold to be used for the actual investigation.

The researchers sought the consent of the Principals of the chosen schools after the approval of the Niger State Ministry of Education before the administration of treatment commenced. The regular mathematics teachers of the selected intact classes taught the lessons to control for the teacher-effect extraneous variable. The experimental teacher was trained by the researchers for 14 days prior to the intervention on the implementation of the GMEIBL strategy. Teachers with similar qualifications and years of experience taught two groups. The treatment lasted for six weeks using similar lesson plans to ensure uniformity. The experimental group was exposed to Growth Mindset-Enriched Inquiry-Based Learning, a learning strategy which combined the 5E inquiry learning cycle with growth mindset principles. The lessons were delivered using double periods of 80-minutes every day of the week. The lessons followed the 5E steps outlined as: Engage (normalizing struggle), Explore (seeing error as a normal process of learning), Explain (correcting mistakes helps improve), Elaborate (encouraging resilience to solve related problems), and Evaluate (reflecting on mistakes to improve). The control group was exposed to similar mathematics topics through the teacher-centered conventional method without growth mindset messaging,

for the exact same duration and frequency. Both groups were pretested immediately before the six-week treatment to establish their initial attitude and performance levels. This is to control for testing effects and extraneous variables. The MPT was reshuffled and was administered along with the ATMS to both groups immediately after the intervention.

The data analysis involved descriptive and inferential statistics. Thus, the research questions were answered using Mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at the 0.05 level of significance. Since the study used non-equivalent intact classes for a pretest-posttest quasi-experimental design, the ANCOVA was used to statistically adjust for any initial baseline differences between the groups by using the pretest scores as a covariate.

RESULTS

Research questions and null hypotheses one and two are answered and tested at $\propto =$ 0.05 levels of significance as follows:

Research Question One: What is the difference between the mean attitude score of upper basic II students taught mathematics using GMEIBL and those taught using the conventional method?

Table 1: Mean and Standard Deviation of Attitude towards Mathematics Scores by Group

Group	N	Mean	SD	Mean Diff.
Experimental	88	85.03	5.49	
				16.82
Control	90	68.21	4.89	

The results in Table 1 show that students exposed to GMEIBL (Experimental) obtained a mean attitude score of 85.03 (SD = 5.49), while students taught using the conventional method obtained a mean score of 68.21 (SD = 4.89) and the mean difference of 16.82. Students in GMEIBL obtained higher attitude scores (M = 85.03, SD = 5.49) compared to the conventional group (M = 68.21, SD = 4.89).

Hypothesis One: There is no significant difference between the mean attitude score of upper basic II students taught mathematics using GMEIBL and those taught using the conventional method.

Table 2: ANCOVA Summary of Attitude towards Mathematics Scores by Instructional Group

Source	Type III Sum of Squares	df	Mean Square	F-value	Sig.	ηp^2
Corrected Model	12600.689[a]	2	6300.345	232.820	<.001	
Intercept	8143.365	1	8143.365	300.927	<.001	
Pretest	8.216	1	8.216	0.304	.582	0.002
Group	11865.354	1	11865.354	438.467	<.001	.715
Error	4735.670	175	27.061			
Total	1059802.000	178				
Corrected Total	17336.360	177				

Table 2 presents the Analysis of Covariance (ANCOVA) results on students' attitude toward mathematics indicated that the main effect of instructional method was statistically significant, $F(1,175) = 438.467$, $p < .001$. Since the observed p-value (<.001) is less than the 0.05 alpha level, the null hypothesis (**H_{01}**) was rejected. The effect size was large ($\eta p^2 = 0.715$), indicating that 71.5% of the variance in attitude scores was may be partly attributable to the treatment given that the covariate (pretest) was also not significant (p = .582).

Research Question Two: What is the difference between the mean performance score of upper basic II students taught mathematics using GMEIBL and those taught using the conventional method?

Table 3: Mean and Standard Deviation of Mathematics Performance Scores by Group

Group	N	Mean	SD	Mean Diff
Experimental	88	77.40	13.16	
				17.03
Control	90	60.37	14.51	

The results in Table 3 indicate that students exposed to GMEIBL obtained a higher mean mathematics performance score (M = 77.40, SD = 13.16) compared to students taught using the conventional method (M = 60.37, SD = 14.51) and mean difference was 17.03.

Hypothesis Two: There is no significant difference between the mean performance score of upper basic II students taught mathematics using GMEIBL and those taught using the conventional method.

An Analysis of Covariance (ANCOVA) was conducted to test this hypothesis using pretest scores as a covariate. The results are presented in Table 4.

Table 4: ANCOVA Summary of Mathematics Performance by Instructional Group

Source	Type III Sum of Squares	df	Mean Square	F-value	Sig.	ηp^2
Corrected Model	12973.830	2	6486.915	33.667	<.001	
Intercept	39629.966	1	39629.966	205.678	<.001	
Pretest	73.050	1	73.050	0.379	.539	0.002
Group	12973.405	1	12973.405	67.332	<.001	0.278
Error	33718.925	175	192.680			
Total	888901.110	178				
Corrected Total	46692.755	177				

The ANCOVA results on mathematics performance showed a significant main effect of instructional method, $F(1,175) = 67.332$, $p < .001$ as seen in Table 4. Since the p-value is less than the 0.05, the null hypothesis ($\mathbf{H_{02}}$) was rejected. The effect size was moderate-to-large ($\eta p^2 = 0.278$). The pretest covariate was non-significant ($p = .539$). This indicates that the improvement performance may be due to the use of GMEIBL.

DISCUSSION

The first finding revealed that students exposed to GMEIBL had significantly higher attitude than their counterparts taught using the conventional method. This indicates a substantial difference in students' attitudes in favor of GMEIBL. A possible explanation is that the intervention provided students with opportunities to participate actively in mathematical activities, explore problems, discuss ideas, explain their reasoning and reflect on their learning. In addition, the growth mindset components encouraged students to regard mathematical difficulties and mistakes as normal parts of learning rather than evidence of inability. Such experiences may have helped students develop more positive feelings towards mathematics and become more willing to participate in classroom activities. This is consistent with Dweck's (2006) position that learners who believe their abilities can develop through effort, appropriate strategies and feedback are more likely to approach challenging tasks positively. It also agrees with Pedersen and Haavold (2023), who associated students' mathematical beliefs and motivation with inquiry-based mathematics teaching, and Stohlmann and Yang (2024), who highlighted the importance of growth mindset practices in mathematics education. The finding further supports Oladele et al. (2024), who reported a positive relationship between students' attitudes, teaching methods and achievement in junior secondary school mathematics. Similarly, Liu et al. (2024), in their study involving 5,711 students in Vietnam, found that students' positive attitudes played an important role in explaining the relationship between inquiry-based pedagogy and mathematics performance. The present finding also agrees with Eya et al. (2026), who reported that inquiry-based learning significantly improved Upper Basic students' attitudes towards mathematics in Niger State. These studies provide supporting evidence that instructional approaches which encourage active participation and positive learning experiences can contribute to improved attitudes towards mathematics.

However, the positive effect of mindset-oriented instruction should not be regarded as automatic or universal. Macnamara and Burgoyne (2023), in a systematic review and meta-analysis of growth mindset interventions, reported that the overall effect of such interventions on academic achievement was very small and became statistically non-significant after accounting for possible publication bias. Bui et al. (2023) also highlighted the need to consider how mindset interventions are designed and integrated into classroom practices. These positions suggest that simply communicating positive messages about ability may not be sufficient to improve students' learning experiences. The present study therefore offers a context-specific contribution by examining growth mindset principles as part of an organized inquiry-based mathematics program rather than as isolated motivational messages. Nevertheless, because students' growth mindset beliefs were not measured directly, the improvement in attitude cannot be attributed exclusively to a change in mindset beliefs.

The second finding showed that students exposed to GMEIBL achieved significantly higher mathematics performance scores than those taught using the conventional method. This result indicates that GMEIBL was associated with better mathematics performance under the conditions of the study. One possible explanation is that the inquiry-based component provided students with opportunities to investigate mathematical problems, explore different approaches, construct understanding and explain their solutions instead of depending mainly on teacher explanations and memorization. The growth mindset elements may also have encouraged students to persist when they encountered difficult problems, reconsider incorrect solutions, apply alternative strategies and use feedback to improve their work. These learning experiences could have supported deeper engagement with mathematical concepts and better performance in the achievement test. This finding is consistent with Ahmad et al. (2023), who reported that inquiry-based learning significantly improved students' performance in mensuration compared with conventional instruction. It also supports Kajuru et al. (2026), who found that

GMEIBL significantly improved mathematics performance among Upper Basic students in Niger State. Furthermore, David et al. (2025) reported positive academic achievement outcomes following a growth mindset intervention among underachieving secondary school students. The present finding is also consistent with Liu et al. (2024), whose study showed that inquiry-based pedagogy could improve mathematics performance through students' attitudes towards the subject. Together, these findings provide support for instructional approaches that combine active mathematical investigation with appropriate motivational and learning support.

Nevertheless, evidence from previous studies also indicates that positive attitudes do not necessarily translate into improved academic performance in every instructional context. For instance, Eya et al. (2026), in a study involving Upper Basic students in Niger State, found that inquiry-based learning significantly improved students' attitudes towards mathematics but did not produce a significant improvement in their mathematics performance. This difference is important because it suggests that encouraging students to participate actively in mathematics lessons may not by itself, guarantee improved achievement. The additional growth mindset elements in the present intervention may have provided further encouragement to persist with difficult tasks, learn from mistakes and improve problem-solving strategies. This offers a possible explanation for why the present study recorded significant improvements in both attitude and performance. However, the study did not include an inquiry-based learning group without growth mindset enrichment; consequently, it cannot establish that the growth mindset component alone accounted for the difference between the two groups.

Collectively, the findings provide evidence in support of GMEIBL as an instructional approach for improving both attitude towards mathematics and academic performance among Upper Basic students in the study area. They also contribute to the existing literature by addressing an important gap arising from earlier findings in the same educational context. While Eya et al. (2026) established that inquiry-based learning improved attitude but not performance, Kajuru et al. (2026) reported that GMEIBL reduced mathematics anxiety and improved performance. The present study extends this line of investigation by examining whether GMEIBL could improve both attitude and performance within the same study. The results provide encouraging evidence in this regard.

CONCLUSION

From the findings of this study it can be concluded that GMEIBL proved effective in improving the academic achievement and attitudes toward mathematics among upper basic students in Minna metropolis, Niger State. The study indicate that combining structured mathematical inquiry with classroom practices that encourage effort, persistence, learning from mistakes, constructive feedback and reflection can provide a useful alternative to conventional teacher-centered mathematics instruction. Therefore, the findings established GMEIBL as an effective hybrid instructional model for improving both students' attitudes and performance.

Limitations of the Study

The use of quasi-experimental design opened the study to selection bias which may influence the results. The delimitation of the study to only JSS II students in public secondary schools in Minna Metropolis, Niger State may restrict generalization of the study to other geographical locations and levels of education. The long-term effects the study was not established as it only investigated the effects of GMEIBL over a six-week intervention period.

Recommendations

The following recommendations are made based on the findings of the study:

1. Mathematics teachers should be trained and encouraged to integrate growth mindset principles into IBL mathematics classroom to improve students' attitudes and academic performance.
2. Future research should investigate long-term effects of GMEIBL across wider geographical regions and educational levels, considering possible moderating variables such as gender, prior achievement and teachers' instructional faithfulness in implementing the intervention.

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