BINGO GAME-BASED INSTRUCTIONAL STRATEGY: A PANACEA FOR PUPILS' ACHIEVEMENT IN BASIC MATHEMATICS OPERATIONS

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Abstract

Basic Mathematical Operations (BMOs) are fundamental arithmetic rules in Mathematics which are required to learn all aspects of Mathematics. However, literature revealed that most pupils' does not know how to manipulate these rules and the fear of BMOs is also reported among them. These are largely attributed to the teacher-centred method of deploring the mathematical concepts involving BMOs among primary school pupils. The study was anchored to Lev Vygotsky's Social-cultural Learning Theory, while the pretest-posttest control group quasi-experimental design was adopted. Simple random sampling technique was used to select participants for the study. The instruments used were Mathematics Achievement (r = 0.77) and Pupils' Mental Ability (r = 0.78) test. The data were analysed using Analysis of covariance at p ≤ 0.05. The findings revealed that here was significant main effects of treatment on achievement ($F_{(1;282)}$ = 147.14; partial η^2 = 0.54) The participants in bingo game instructional strategy (BGIS) had higher post-achievement mean score (34.71) followed by those in the control (15.57) group. The result revealed that BGIS enhanced pupils' achievement regardless of their mental ability. It was recommended among others that primary school mathematics teachers should always include games like bingo in the teaching of primary mathematics for better performance.

Keywords: Basic Mathematics Operations, Mathematics game, Bingo game instructional strategy

Introduction

Mathematics is a compulsory subject that is basic to both elementary and secondary education in Nigeria and a prerequisite for gaining admission to virtually all courses in Nigerian tertiary institutions. Mathematics is regarded as a fundamental subject because it is considered to prepare individuals with the basic Mathematical knowledge, skills, values and attitudes necessary for proper functioning in the society.

It is a vast and distinctive branch of knowledge that enables people to realise their own mathematical potential (Harris and Bourne, 2017). It is a subject with many different subfields of study and plays a crucial role in national development. It is a subject that frees a person from chaos and uncertainty, fosters logical reasoning, critical thinking, spatial reasoning, and instills in individuals the required and useful communication skills in their daily lives (Engel *et al*, 2016; Saward , 2017; Yousef, 2022; Abramovich, Grinshpan, and Millagan, 2019; Ohuoha-chidiebere and Ezenwa, 2020; Akinsola, 2023).

All areas of knowledge rely on Mathematics more than ever before to solve problems, formulate theories, and predict consequences. This is because it is a crucial instrument for generating new knowledge. Accountants' understanding of Mathematics allows them to keep track of financial transactions. This is due to the numerous computational tasks that must be completed correctly each time a voucher needs to be prepared (Marion, 2019; Lillian, Gilgert and Samson, 2020; Edeh, 2022). To strengthen the Nigerian economy, Nigeria, like any other developing country moving toward commendable technical growth, needs talented scientists, engineers, and technicians with solid mathematical backgrounds (Powell and Nelson, 2017; Ayuba and Timayi, 2018; Adigun and Sam-Kayode, 2022).

After numeration, basic Mathematics operation takes center stage in elementary school Mathematics. Basic operations involve addition, subtraction, multiplication and division which have application in most advanced mathematical theories. Thus,

knowing them turn into one of the keys to progressing in the comprehension of Mathematics, specifically algebra (Taha and Nese, 2022). These tasks are now much easier to complete with the help of electronic calculators, which can also lead to a dependency that makes grasping Mathematics in its truest sense quite challenging. Calculators can be a useful tool for checking results, but if pupils rely heavily on them, they may miss out on the kind of challenging mental exercises that will help them not only do Mathematics but fully grasp what they are doing (Alper and Halil, 2017; Sidik, Suryadi and Turmudi, 2021). Basic Mathematics operations have significant impact on academic achievement of elementary school pupils while pupils who lack basic mathematical skills struggle with other mathematical courses and their overall academic success.

Ajani and Olabode (2017) found that the performance of Nigerian children in the global numeracy index is not encouraging. Nigeria is ranked below South Africa and Ghana in the elementary education rankings, which are typically based on Mathematics, reading, and science. According to Nwogu (2016), the education sector support programme in Nigeria (ESSPIN) found that pupils in elementary five and six performed poorly in Mathematics and English courses. Number concepts, addition, subtraction, multiplication, and division were the core Mathematics concepts assessed by the ESSPIN. In a field work conducted by Oyeniran (2025) on pupils' performance in Mathematics common entrance examination in some local government in Oyo state, it was discovered that pupils' average performance was below 50%. It was confirmed from the teachers that the cut-off mark for admission to state junior secondary schools out of 100% was 30%.

Teachers are one of the major reasons of Mathematics failure because most of them utilize inadequate teaching methods, and they are unable to make the subject understandable as well as practicable and majority of them have limited understanding of the subject matter (Iren, 2015). It is significant to emphasize that teacher bear majority of the responsibility for the pupils' poor performance in Mathematics at the primary school level during classroom instruction (Akinsola, 2023).

According to Jamie (2018), the utilization of games and other contemporary strategies is likely to significantly influence pupils' understanding of multi-digit addition and subtraction. According to Jamie (2018), upper elementary Mathematics education should adopt a sequence of instruction that progresses from concrete examples to representations and finally to abstract notions. This approach is necessary to ensure that children truly grasp the mathematical concepts and skills they are acquiring. Hui and Mahmud (2023) found that utilizing concrete materials can lead to the effective utilization of notational systems and promote pupils' conceptual development.

The Bingo game is a structured activity where players follow instructions on specially designed cards supplied by the teacher. The game involves participants trying to win within the boundaries set by the regulations. All pupils in the class actively engage in the bingo game, which serves as a motivating tool for them to study and review their previous learning. It functions as an instructional aid for teaching Mathematics, English, and various other disciplines (Rahayu and Widodo, 2016; Russo, Bragg, Russo, and Minas, 2023). Bingo actively involves pupils in the process of teaching and learning. Additionally, it can be employed as a captivating approach to revisiting the previously taught lesson. When the pupils are comfortable, enjoying themselves, and have a strong affinity for the game, it can foster a lively and enjoyable atmosphere for them. Bingo is an exceedingly pleasurable game to engage in with companions.

The game is highly accessible and serves as an effective tool for instructing a wide range of subjects, including Mathematics, history, and foreign language vocabulary. This game is pleasurable to engage in and is a card-matching game in which players match cards with numbers as the caller dials. Players are required to align the numbers on the card with the corresponding numbers on the printed or generated matrix. The card comprises a set of randomly chosen numbers (Tella and Fatoki, 2021; Putri and Kareviati, 2021). Both the entire class and small groups have the opportunity to partake in the game of bingo.

Bingo engrosses pupils' attention, stimulates their involvement in educational activities, and can also serve as an engaging approach to review the taught subject. When children have a sense of comfort and derive pleasure from the game, it can concurrently foster an enjoyable atmosphere (Cinco *et al,* 2021).

This research was based on the socio-cultural learning theory developed by Vygotsky. This theory sees learning as a socio-cultural theory

that explains how human intelligence is initiated in society or culture and makes it applicable to instructional strategy like bingo and game. The key idea of this theory is that social interaction is crucial to the development of cognition. Learning is also a cultural development that is essentially shaped by the use of tools and symbols. In order to foster the growth of cognition, learners are also permitted to collaborate with one another. The importance of adults or peers playing a role in a child's cognitive development is emphasized through a model of the zone of proximal development, which can be used by parents, teachers, caregivers and tutors to structure and accelerate the child's learning outcome.

Statement of the Problem

Most pupils perceived Mathematics as exceptionally tough and this made them to get nervous whenever they need to write tests or examinations in Mathematics. This nervousness which starts from primary school rarely fades away. The teaching methods employed by teachers in teaching Mathematics most especially at the elementary school have been teacher centered and have not given the pupils the opportunity of interacting with themselves and the teaching materials. Moreover, most pupils developed phobia for the subject and considered it to be abstract which led to poor performance of pupils in the subject. A teaching method that involves the use of game will allow pupils to be fully involved in the teaching activities of basic mathematical operations in the elementary school. The use of bingo games for teaching mathematical operation is yet to be fully explored. Previous studies on the impact of game often considered the impacts of two modes of games for teaching other concept apart from basic mathematical operations. Several studies in Nigeria have attempted the use of games to improve pupils' Mathematics achievement but most of these studies used game to teach other aspects of Mathematics without giving exclusive attention to basic mathematical operations and basic operations are mathematical concept that cut across all other mathematical concepts. Based on the foregoing, this study determined the effects of Bingo game-based instructional strategies as panacea for primary school pupils' achievement in basic Mathematics operations in primary schools in Oyo town, Oyo state.

Hypotheses

$H_0$1: There is no significant main effect of treatment on pupils' achievement in basic Mathematics operations.

$H_0$2: There is no significant main effect of mental ability on pupils' achievement in basic
Mathematics operations.

$H_0$3: There is no significant interaction effect of treatment and mental ability on pupils' achievement in basic Mathematics operations

Methodology

This research adopted a quasi-experimental pre-test, post-test Control group design.The population of the study comprised of 520 public primary four pupils in schools in Atiba Local Government Areas of Oyo Town, Oyo State. A multistage sampling was adopted in the study. Six public primary schools who met the successive criteria were simple randomly selected for the study. The primary four class whose: school has completed primary three Mathematics syllabuses as at the time of data collection; school has stable Mathematics teacher; Mathematics teacher was willing to participate in the study. From the list of primary schools which satisfy the criteria, simple random sampling technique was used to select 199 primary four pupils for the study.

Research Instruments

Four research instruments were used for the study, which include two stimuli instruments and two response instruments: The instruments were Instructional guide on bingo games strategy (IGBGS), Instructional Guide on Modified Conventional Method (IGMCM), Basic Mathematic Operation Achievement Test (BMOAT) and Pupils' Mental Ability Test (PMAT)

Instructional Guide on Bingo Games Strategy (IGBGS).

General information like subject, topic, and class are included in this guide. It also included details on the process, activities for the teacher and pupils (such as the bingo game), the curriculum, resources, and overall goals. There were two phases to the guide. A training instructional guide for Mathematics teachers was the first stage, and an experiment examining the use of bingo games to improve learning results was the second. Using oral questions based on the subject delivered, the teacher assessed the class to conclude the lesson. The subjects and instructional objectives were chosen in a way that guarantees the validity of IGBGS. The final draft of the guide was created when it has been trial-tested on 40 primary school pupils who were not part of the study sample.

Instructional Guide on Modified Convectional Method (IGMCM)

The guide's elementary components formed general information, which includes the topic, subject, procedure, overall goals, pupils and teacher activities, weekly contents, and pupil evaluation guide. Experienced Mathematics teachers teaching primary four received the IGMCS to review; all of their recommendations were incorporated into the guide.

Basic Mathematical Operation Achievement Test (BMOAT)

The BMOAT consisted of 40-item multiple choice test with four options. This assessment evaluates pupils' proficiency in performing fundamental mathematical operations, including addition, subtraction, multiplication, and division. The test items were designed in accordance with Bloom's taxonomy of educational objectives, specifically targeting the knowledge, understanding, and reasoning levels of the pupils' cognitive domain.

A preliminary set of 50 items was created and distributed to mathematical experts and primary four Mathematics teachers to assess their face and content validity. The products were given to a group of 40 primary four pupils from a school in Ibadan city who will not be involved in the main study. An item analysis was conducted on the scores to determine the difficulty level and the discriminative potential of each test item. Items with difficulty indices outside the range of 0.40 to 0.70 were removed. Items with difficulty levels above 70% were considered too difficult and items level below 40% were considered too easy and were discarded. The dependability coefficient of the chosen items was calculated using Kuder-Richardson (KR 20) formula. After eliminating ten questions with severe difficulty indices, the test now consists of a total of 40 items. The test has a reliability index of 0.77 and an average item difficulty value of 0.51.

Primary School Pupils' Mental Ability Test (PSPMAT)

The PSPMAT contained 20-items of fill-in the gap questions. Pupils were asked to complete the statement pronounced by the teacher. It was a standardised test from Wechsler pre-school and elementary scale of intelligence. The test items were given to experts in Mathematics education for scrutiny. The 20 item test was administered to 20 primary four pupils outside the local government area of study to test the difficulty indices of the test. The reliability index of 0.68 and an average item difficulty value of 0.54 was obtained.

Two weeks training was done for the participating primary four teachers on the use of bingo games in teaching basic mathematics operations in each of the selected schools. Administration of pretest on BMOAT was done to the pupils by the teachers and researcher after the training. Administration of treatment was later done for the experimental groups and this lasted for eight weeks. Administration of posttest was done to the pupils after the treatment. The data analysis was based on the information gathered from the Basic Mathematical Operation Achievement Test (BMOAT) and the Pupils Mental Ability Test (PMAT). The acquired data were analyzed using inferential statistics, specifically Analysis of Covariance (ANCOVA). The posttest scores were analyzed, with the pretest scores serving as covariates. All hypotheses that have been formulated were tested at a threshold of significance of $p < 0.05$.

Results and Discussions

Table 1: Distribution of the Participants by Treatment and Mental Ability

Variables	Frequency (N)	Percentage (%)
Treatment groups		
Bingo Game Instructional Strategy (BGIS)	95	47.74
Conventional Method (CM)	104	52.26
Total	199	100.0
Mental Ability		
Low	58	29.15
Medium	109	54.77
High	32	16.08
Total	199	100.0

Table1 depicts the findings of the participants by treatment and mental ability. The result revealed that 95 (47.74%) of the participants were under BGIS and CM group were 104 (52.26%). In addition, the mental ability scale revealed that 58 (29.15%) of the participants had high mental ability, 109 (54.77%) had medium mental ability and 32 (16.08%) had low mental ability.

Hypotesis1: There is no significant main effect of treatment on pupils' achievement in basic Mathematics operations.

Table 2: Analysis of Covariance (ANCOVA) of Post-Treatments and Mental Ability

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	134633.617	6	7479.645	793.707	.000	.982
Intercept	21623.660	1	21623.660	2650.236	.000	.915
Post Achievement	16.564	1	16.564	2.030	.155	.008
Treatment	2401.040	1	1200.520	147.138	.000*	.544
Mental Ability	3.039	2	1.519	.186	.830	.002
Treatment x Mental Ability	24.300	3	6.075	.745	.562	.012
Error	2015.309	186	8.159			
Total	200899.000	199				
Corrected Total	20102.502	198				

R Squared = .900 (Adjusted R Squared = .886) * denotes significant p<.05

Table 2 showed that the treatment had a substantial impact on the pupils' achievement in Mathematics basic operations ($F_{(1, 282)}$ =147.14; p<0.05, partial η2 = 0.54). The effect size of 54.0% was revealed in Table 2. In this ANCOVA model, the substantial main effect of the treatment accounted for 54.0% of the total 98.0% variation observed (Adjusted R^2 = 0.98) in pupils' post-treatment scores in Mathematics. Thus, hypothesis 1 was rejected.

This conclusion is consistent with Adesina, Owolabi and Adebayo (2021) study, who found that using the bingo game strategy show a significant main effect of qualitative ability on pupils' achievement. They also suggested that teachers should adopt the bingo game strategy more regularly into their teaching methods, since it has the ability to improve pupils' ability. In their 2016 research, Puput and Sprih emphasised the importance of primary pupils' competency in basic mathematical operations, notably multiplication. The study resulted in a blueprint for a very successful game called "ganbatte incredible" and a Mathematics bingo game for teaching multiplication in primary schools. Potenciano (2018) discovered that playing the bingo number tower game resulted in a considerable increase in pupils' Mathematics learning skills over many weeks. Tella and Fatoki's (2021) research on the effects of the bingo game on Mathematics accomplishment in public elementary schools in Oyo state, Nigeria, revealed a strong Interplay effect between the bingo game and the participants' numeric abilities. This impact favoured high-ability pupils who got the bingo game strategy, since they had higher mean values than their peers in the convetional group.

The poor academic performance of the participants in the traditional technique, as seen by posttest achievement scores, might be linked to the CM's teacher-centered focus. The conclusions of this study are consistent with the work of Russian psychologist Lev Semyonovich Vygotsky in Saul (2023), who believes that learning is a social activity that plays an important part in the development of human intellect. Vygotsky claimed that collaborative learning is essential in the creation of cognition.

Hypothesis 2: There is no significant main effect of mental ability on pupils' achievement in basic Mathematics operations

The results from Table 2 revealed that there was an absence of observable impact of mental ability on pupils' performance in Mathematics. The F-value was .19, indicating a lack of significance (p > .05). The effect

size, measured by partial η2, was .002. Therefore, hypothesis 2 was not negated. This indicates that mental ability did not have any impact on pupils' performance in Mathematics. The analysis in Table 4 presents the Marginal mean estimate, which measures the difference in achievement based on mental ability.

Table 4: Marginal Mean Estimates for Post-Treatment by Pupil Mental Ability

			95% Confidence Interval	
Mental Ability	Mean	Std Error	Lower Bound	Upper Bound
Low	25.04	.35	24.65	26.02
Medium	25.33	.24	25.32	26.26
High	25.79	.53	24.00	26.07

Table 4 showed that pupils with strong mental ability had the highest results (25.79) in Mathematics basic operations compared to pupils with medium (25.33) and low (25.04) mental ability. The order is expressed as low, followed by medium, and then high. This suggests that pupils with high mental ability performed better in Mathematics basic operations compared to those with medium and low mental ability.

The study found that mental ability had no significant overall influence on pupils' performance in Mathematics basic operations. According to Table 4, pupils with high mental ability had the highest scores (25.79) compared to pupils with medium (25.33) and low (25.04) mental ability. This suggests that pupils with high mental ability performed better in than those with medium and low mental ability. This could be unconnected because the treatment provided equitable learning environments for all pupils, regardless of cognitive abilities. This conclusion supports Meral, Derman, and Arzu (2020), who found that there was no significant difference between the pre-test, post-test scores and overall scores of the conventional group.

The observed result contradicts Adeyemi and Awolere's (2016) results, which revealed that mental competency in biology had a significant effect on learners' academic achievement in environmental concepts. Bolaji et al (2016) found that pupils' mental ability, academic self-perception, and scientific temperament were strong predictors of pre-service teachers' performance in basic general Mathematics in Oyo State, Nigeria.

Hypothesis 3: There is no significant interaction effect of treatment and mental ability on pupils' achievement in basic Mathematics operations.

Table 2 showed no significant interaction impact between treatment and mental ability on pupils' achievement in Mathematics basic operations ($F_{(3,279)}$ =.75; p>.05, partial η2 =.012). Hypothesis 3 was thus not rejected. This implies that treatment and mental ability had no impact on pupils' Mathematics basic operations achievement.

The findings revealed that the combined effect of treatment and mental ability on pupils' Mathematics basic operations achievement was not statistically significant. This suggests that mental ability levels (high, medium, and low) are irrelevant; what genuinely determine pupils' success are the fair opportunities provided by both structures. Exposing learners with varied degrees of mental capacity to activity-based strategies will surely result in enhanced performance regardless of the learner's level of mental capability in terms of accomplishment. Duru and Obasi (2023) investigated the relationship between cognitive aptitude and academic performance in Mathematics among senior secondary school two (SS2) pupils. This observation is consistent with the results of that study. It was found that the ability to think critically had an impact on all pupils' academic Mathematics achievement. According to the research, there is no relationship between critical thinking ability and accomplishment level among high achievers.

Conclusion

The research investigated how teaching approches like bingo game instructional strategy has effect on pupils' achievement in basic mathematical operations in Oyo, Oyo state. The effects of mental ability on their comprehension of basic mathematical operations were explored. Three null hypotheses were formulated and tested at a significance level of 0.05. The study used a pre-test, post-test conventional method quasi-experimental design. Furthermore, owing to

the participatory nature of the game strategy, pupils were able to completely comprehend the ideas and solve problems involving basic mathematical operations. According to the findings, the game formats might be used to improve academic performance in many concepts in Mathematics. The study was based on Vygotsky's socio-cultural theory of human learning, which holds that learning is a social process and that society and culture affect human intelligence.

Recommendations

The following recommendations were made based on the results of this study:

i. Mathematics teachers should encourage the use of games, such as bingo in basic Mathematics teaching as this strategy have shown to be quite effective in improving pupils' Mathematics abilities in the subject.
ii. The State Universal Basic Education Board (SUBEB) officers should provide re-training programmes for primary school Mathematics teachers as well as pupils' parents emphasizing the effective use of games like bingo in classrooms. These programmes might take the form of lectures, workshops, or conferences.
iii. Government should be educated on the need to equip schools with game resources, such as bingo cards, to promote regular and successful usage. Furthermore, Mathematics teachers should be encouraged to improvise where necessary.
iv. Curriculum planners should include the concepts that will allow the use of Mathematics games like bingo in the primary Mathematics curriculum.

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