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Effect of Activity-Based Instruction on Pupils' Understanding of Bearings and Distances in Basic Mathematics

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ABSTRACT

Mathematics as a core subject in Nigeria faces some hindrances with research proving that school pupils struggle with the comprehension of topics involving angles and measurements. This study investigated the effect of activity-based instruction on pupils' understanding of bearings and distances in basic Mathematics in Kwara State, Nigeria. One group pre-test and post-test pre-experimental research was used for this study. A total of 27 pupils from basic 8 were sampled for this study. Two were used for data collection. Bearing and Distance Instructional Guide (BDIG) and Bearing and Distance Mathematics Achievement Test (BDMAT). The BDMAT was tested for reliability using test-retest method and a reliability co-efficient of 0.83 was established. The findings of the study revealed that there was a significant main effect of activity-based instruction on pupils' understanding of bearings and distances in basic Mathematics. However, there was there was no significant interaction effect of activity-based instruction and gender on pupils' understanding of bearings and distances in basic Mathematics, regardless of pupils' gender. This study recommends that teachers be trained to adopt activity-based learning in teaching basic mathematics, and that workshops and seminars on mathematics be organised for teachers on how to teach complex topics using activity-based instruction.

Keywords: Achievement, Activity-Based Instruction, Bearings and Distances, Basic Mathematics

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INTRODUCTION

Mathematics, from time immemorial, has been an essential subject that has significant impact on pupils' cognitive and problem-solving ability. It is the basis for enhancing pupils' critical thinking, cognitive development and problem-solving abilities necessary for future academic and practical applications in primary school. Because of its logical and methodical approach, mathematics is in a unique position to develop vital abilities in pupils. Owing to its importance, it is now required in school curricula, guaranteeing that all children acquire the fundamental mathematics skills that they need to face obstacles in life (Sanjo & Konye, 2024). The fundamental mathematics refers to the fundamental skills that all children need to overcome the various challenges they will face in life. It is an important foundation that trains critical thinking, cognitive development and problem-solving skills that are essential for future academic and practical applications, starting in primary school. These skills include not only basic arithmetic operations, but also an understanding of abstract concepts such as angles and measurements, which are highly relevant in subjects such as navigation and surveying. Mathematics is uniquely positioned to develop vital skills in students thanks to its logical and methodical approach. Mathematics is therefore a compulsory subject in the school curriculum to ensure that all children acquire the basic mathematical skills they need. As a means to preparing students for higher education and establishing a solid basis for scientific and critical thinking, mathematics became a mandatory subject in elementary and secondary education.

Unfortunately, this goal is frequently compromised by the persistent application of conventional teaching techniques. Students who are exposed to these traditional approaches, frequently become inert and uncreative. According to (Dairo, Okonkwo, & Orakwe, 2024), the traditional lecture-based approach to teaching mathematics has been predominant; however, this method often results in passive learning, limited student engagement, and challenges in comprehending abstract concepts such as bearings and distances. The conventional lecture technique, in which teachers lead the class while students mostly listen and take notes, is still used by many teachers in Nigerian schools, as noted by scholars (Etokeren, Ibemenji, & Alamina, 2019; Abubakar, Muhammed, HarunaIbrahim, & Sani, 2021; Oginni, Saibu, Awobodu, & Olude, 2024). A lot of pupils have trouble understanding mathematical ideas; elementary school pupils generally find it difficult to understand abstract concepts that are frequently presented in mathematics (Agusdianita, Danim, Susanta, Yusnia, Izzania, & Irmayanti, 2024), especially when it comes to geometry and spatial reasoning. Bearing and distances presents similar difficulties for pupils (Thomas., 2021). Understanding directions, angles, and measurements is necessary for bearings and distances, which calls for a solid grasp of spatial awareness and visualization (Dairo et al., 2024). These challenges underscore the need for more interactive and student-centred teaching methodologies.

Activity-based learning (ABL) is a promising instructional technique that stresses active student participation through practical exercises and real-world problem-solving assignments (Abubakar, Sulyman, & Aliyu, 2020; Lathigara, Tanna, & Bhatt, 2021; Skulmowski, 2024). This approach seeks to directly include students in their educational experiences in order to increase learning effectiveness and engagement. Oribhabor (2020) demonstrated how effective activity-based learning is at improving pupils' comprehension and memorisation of mathematical ideas. For example, a study carried out in Lagos State found that when compared to students taught using conventional methods, elementary school students exposed to ABL showed notable gains in their performance in mathematics (Sanjo & Konye, 2024). These conclusions are supported by Adams

& Enu (2023) experimental study conducted with Grade 11 students in Ghana, revealing that pupils who got activity- based education in plane geometry scored better than their counterparts who received traditional training. In a similar vein, a study conducted in Ilorin, Nigeria by Abubakar et al. (2020) discovered that secondary school pupils who were taught binary numbers using ABL methodologies outperformed those who were taught using traditional approaches in terms of academic achievement. These results strongly suggest that ABL can significantly improve academic achievement, especially in challenging subjects such as mathematics. The success of ABL in Nigeria, as shown by this study, is in line with what other studies of ABL have found. These studies highlight the importance of active student participation, hands-on experience, and real-world problem-solving. This suggests that when students actively engage in the learning process, rather than passively receiving information (as in traditional methods), they understand and retain the material substantially better.

Notwithstanding activity-based learning's proven advantages, there are a number of obstacles to its adoption in Nigerian primary schools (Dairo et al., 2024). Large class sizes, a lack of resources, and inadequate time allotment for activity-based learning activities are some of the challenges that educators have mentioned. Furthermore, in order to successfully implement and incorporate activity-based learning approaches into the curriculum, comprehensive and ongoing teacher training is desperately needed (Sanjo & Konye, 2024). Previous studies have adopted the use of activity-based instructions to solve pupil's problems in several subjects. Bibi (2021) instigated the effect of activity-based games on leaners academic achievement in social sciences, the findings revealed that activity-based games improve pupil's achievement in social sciences. Similarly, Anwar (2019) investigated effect of activity-based learning on student's achievement and motivations, the findings revealed activity- based instructions improve student's achievement and motivations, the method was preferred than lecture method. Scholars have investigated the effects of activity-based instruction of college student's achievement in English and the study revealed that the methods significantly improve leaners achievement (Batool & Saeed, 2021). However, the studies reviewed did not specifically investigated the impact on a particular topic in mathematics some focusing on other subject such as English, Vocational subject and social studies, also the study samples were college students while this current study focuses on basic school level.

Hence, this study deemed it crucial to investigate efficient teaching methods that improve pupils' comprehension of bearings and distances because of their crucial significance in fundamental mathematics and their real-world applications in navigation and spatial reasoning. In order to provide insights that can guide teaching strategies and enhance learning outcomes, this study intends to examine how activity-based instruction affects pupils' understanding of bearings and distances in fundamental mathematics. The main problem with teaching basic mathematics, especially bearings and distances, is that conventional teaching methods are limited and passive, and do not involve students enough. These methods fail to develop a deep understanding of abstract concepts that require spatial reasoning and visualisation. These topics are very challenging for students to understand. Although the test does not give exact numbers about how hard the students

found the activity, the results of the test and the research design show that previous teaching methods were not good enough. This highlights the need for more interactive, student-centred teaching strategies to improve learning outcomes. Specifically, the study seeks to investigate the main effect of activity-based instruction on pupils' understanding of bearings and distances in basic Mathematics also to determine significant interaction effect of activity-based instruction and gender on pupils' understanding of bearings and distances in basic Mathematics.

METHODOLOGY

This study adopted a pre-experimental research design using one group pre-test and post-test research to examine the effect of activity-based instruction on pupils' understanding of bearings and distances in basic Mathematics. The pre-experimental research design is selected to enable the researcher establish cause an effect relationship within a group (Farooq, Nóvoa, Araújo, & Tavares, 2015). The population of the study was all basic school pupils in Kwara State, Nigeria, while the target population was all upper basic school one pupils. A class comprising of 27 pupils make up the sample for the study. 16 pupils from class form the experimental group while 11 pupils form the control group within the same class.

Table 1: Factorial Matrix							
Group	Pretest	Treatment	Post test		Gender		
Basic	01	Х	O2	Male	Female		

Procedure for Data Collection

- Step 1: One school was randomly selected while obtaining approval from the school
- Step 2: Pupils were pre-tested using Bearing and Distance Instructional Guide (BDIG) and randomly assigned to either experimental and control within same group.
- 3: Experimental pupils were exposed to activity based instructions (Field Step experiences on four cardinal point) while the rest pupils were taught using traditional method
- Step 4: Posttest administration and analysis. The data collected were analyzed using inferential statistics of Analysis of covariance.

The indicators measured in this study were students' understanding of bearings and distances in basic mathematics. The Bearing and Distance Mathematics Achievement Test (BDMAT) was given to the students before and after the experiment to measure the results. The BDMAT was developed to evaluate students' comprehension of direction, angles, and measurement, which are components of the curriculum on bearings and distances. Researchers have tested the reliability of the BDMAT itself using the test-retest method and it produced a reliability coefficient of 0.83. Data collections lasted for 4 weeks, while the data analysis was carried out using Statistical packages for social sciences SPSS. The research hypotheses were analyzed using inferential statistics of Analysis of Covariance at 0.05 level of significant.

RESULT AND DISCUSSION

This section presents the results and discussion of research findings. These findings examine the effect of activity-based instruction. This instruction is on students' understanding of bearings and distances in basic mathematics. Before presenting the data and analysis, it is important to understand the data collection steps and statistical analysis techniques employed. Data were collected over four weeks using the Bearing and Distance Mathematics Achievement Test (BDMAT) to measure both the pre-test and the post-test. After data collection, analysis was conducted using the Statistical Package for the Social Sciences (SPSS). The research hypotheses were analysed using inferential statistics and analysis of covariance (ANCOVA) at a significance level of 0.05. This methodological approach ensures the validity and reliability of the findings presented in the following section.

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Source	Type III Sum of	df	Mean	F	Sig.	Remark
	Squares		Square			
Corrected Model	625.125 ^a	2	312.563	12.043	.000	
Intercept	359.790	1	359.790	13.863	.001	
Pretest	138.290	1	138.290	5.328	.030	
Group	414.847	1	414.847	15.984	.001	*Significant
Error	622.875	24	25.953			
Total	11691.000	27				
Corrected Total	1248.000	26				

 Table 2: Summary of ANCOVA on significant effect of treatment (Image-Based Instructional Strategy) on pupils fluency skills

a. R Squared = .501 (Adjusted R Squared = .459)

The table above revealed summary of ANCOVA on significant main effect of activity-based instruction on pupils' understanding of bearings and distances in basic Mathematics. From table above, the F value 15.984 is significant at 0.05 alpha level (p=.001 < 0.05). This indicate that the earlier stated hypothesis there is no significant main effect of activity-based instruction on pupils' understanding of bearings and distances in basic Mathematics was not retained which implies that there is significant main effect of activity-based instruction on pupils' understanding of bearings and distances in basic Mathematics was not retained which implies that there is significant main effect of activity-based instruction on pupils' understanding of bearings and distances. It can be affirmed that pupils taught bearings and distances in basic Mathematics using activity-based instruction performed better than those taught using traditional method.

The study investigated the investigated the effect of activity-based instruction on pupils' understanding of bearings and distances in basic Mathematics. The findings from this study revealed a significant main effect of activity-based instruction on pupils' understanding of bearings and distances in basic Mathematics. This result is in consonance with the findings of Çelik (2018) who investigated the effects of activities based learning among grade six pupil's achievement and engagement. The study revealed that activity based learning improve elementary pupil's achievement and attitude towards mathematics. The findings also concurred with the works of

Adams & Enu (2023) who revealed that activity- based instruction significantly impact the achievement of pupils in plane geometry. This is also in line with Tian (2025) and Vansdadiya, Vasoya, & Gondaliya (2023) who reported that mathematics achievement of leaners tends to significantly improved when exposed to activity based instructions adopting constructivist approach. This finding also align with the submissions of the following scholars (Kaybiyaynen, Matveeva, Shagieva, Dulalaeva, & Nikitina, 2022; Sanjo & Konye, 2024; Singh, Meitei, Singh, & Devi (2025). They found the significant contribution of activity-based learning on pupil's academic achievement. However, the study is not in line with the submission of De Barros, Fajardo-Gonzalez, Glewwe, & Sankar (2023) who investigated the limitations of activity-based instruction in India does not significantly improve pupil's achievement, this could be due to time wastage. The variation in findings could be because of time requirements of activity. Research Question Two: There is no significant interaction effect of activity-based instruction

Table 3: Summary of ANCOVA on significant interaction effect of activity-based instruction and gender on pupils' understanding of bearings and distances in basic

Mathematics

and gender on pupils' understanding of bearings and distances in basic Mathematics.

Trachematics							
Source	Type III Sum of	df	Mean Squar	F	Sig.	Remark	
	Squares		e				
Corrected Model	655.573 ^a	4	163.893	6.086	.002		
Intercept	353.099	1	353.099	13.112	.002		
PRETEST	118.209	1	118.209	4.390	.048		
Group	415.826	1	415.826	15.442	.001		
Gender	30.413	1	30.413	1.129	.299		
Group * Gender	1.081	1	1.081	.040	.843	Not Significant	
Error	592.427	22	26.929				
Total	11691.000	27					
Corrected Total	1248.000	26					

a. R Squared = .525 (Adjusted R Squared = .439)

The table above revealed the summary of ANCOVA on significant interaction effect of activity- based instruction and gender on pupils' understanding of bearings and distances in basic Mathematics. The F-value of 0.040 showing the interaction effect of activity-based instruction and gender on pupils' understanding of bearings and distances in basic Mathematics is not significant at 0.05 alpha level (p=.843 > 0.05). This implies that there is no significant interaction effect of activity-based instruction and gender on pupils' understanding of bearings and distances in basic Mathematics. This implies that the effect of activity-based instruction on pupils' understanding of bearings and distances in basic Mathematics. This implies that the effect of activity-based instruction on pupils' understanding of bearings and distances in basic Mathematics in basic Mathematics.

The study findings also revealed no significant interaction effect of activity-based instruction and gender on pupils' understanding of bearings and distances in basic Mathematics. This implies that the activities based methods is effective to both male and female pupils without gender interferences. The finding of the study is in line with the submission of Nwoke (2021) who observed that activity-based instructions improved pupil's achievement in geometry regardless of pupil's gender, implying that both male and female pupil's performances improved when taught geometry using activity-based instructions. Similarly, Ibrahim, & Shuaibu (2024) who investigated the effect of interaction effects of activities based instructions and gender on student's achievement in Adamawa state. The results revealed that gender has no significant interaction effects on activity-based instructions towards improving students' achievement in mathematics. Contrastingly, this is not in line with findings of (Lu, Zhang, & Zhou, 2023) who revealed that gender significantly influences pupil's achievement in mathematics, specifically male leaners had better achievement in mathematics compared to female leaners.

CONCLUSION

This study found that there was no significant main effect of activity-based learning. This was on students' understanding of bearings and distances in elementary mathematics. This means that the initial hypothesis, which stated that there was no significant effect, was not supported. Instead, a significant main effect of activity-based learning on students' understanding of bearings and distances was found. This suggests that students taught bearings and distances using activity-based instruction performed better than those taught using traditional methods. These findings are consistent with previous studies showing that activity-based learning can improve students' achievement and attitudes towards mathematics. However, it should be noted that some studies have found limitations of activity-based learning in improving school productivity, possibly due to the time and material requirements necessary for adequate implementation.

Furthermore, this study examined whether there was a significant interaction effect between activity-based learning and gender on students' understanding of bearings and distances in elementary mathematics. The results showed that there was no significant interaction effect between activity-based learning and gender. The effectiveness of activity-based methods on students' understanding of bearings and distances is not affected by their gender. In other words, both male and female students benefit equally from activity-based learning. These findings are consistent with those of other studies which have observed that activity-based instruction improves student achievement in geometry regardless of gender. However, they contrast with some studies showing that gender significantly affects mathematics achievement, with male students performing better than female students.

Consequently, it can be deduced that activity-based learning has been demonstrated to enhance students' comprehension of bearings and distances in fundamental mathematics. In addition, this method is also suitable for both male and female students, indicating that gender has no significant effect on its effectiveness. In light of these findings, the study puts forward the

recommendation that teachers should be trained to adopt activity-based learning when teaching basic mathematics. Furthermore, workshops and seminars should be organised for teachers on how to teach complex topics using activity-based instruction.

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