

Activity-Based Learning Strategy and Performance on Dyscalculic Senior Secondary School Students in Circle Geometry in Port Harcourt Metropolis

WACHIJEM, IFEOMA DOMINICA¹, G. I. CHARLES-OGAN²

^{1,2} *Department of Science Education, University of Port Harcourt.*

Abstract- This study investigated Activity-Based Learning Strategy and Performance on Dyscalculic Senior Secondary School Students in Circle Geometry in Port Harcourt Metropolis. This study adopted a quasi-experimental pre-test, post-test, retention test design. Two objectives, two research questions and two null hypotheses guided this study. The population of the study comprised of Twenty-one thousand and seventy-nine (21,079) Senior Secondary School 2(SSS2) Students from which a sample size of one hundred (100) SSS2 students was drawn from two intact classes in two public coeducational Senior Secondary Schools in Port Harcourt Metropolis. A sample of two schools were selected using Simple random sampling technique with a sample size of one hundred students. In each school, an intact class was used. The validated instruments for data collection were the Students' Performance Test on Circle Geometry (SPTCG). The reliability of the instruments was ascertained using Kuder-Richardson -21 (KR-21) and a reliability coefficient of 0.84 was gotten for Students' Performance Test on Circle Geometry (SPTCG). Mean and standard deviation were used to answer the research questions while Analysis of Co-variance (ANCOVA) was used to test and analyze the hypotheses at 0.05 level of significance. The findings of this study showed that students with dyscalculia benefited more from Activity - Based Learning strategies compared to inductive method. It also revealed that both male and female students with dyscalculia experience substantial gain in mathematics performance when taught using Activity -Based Learning strategies. The study recommended that Mathematics teachers should use activity-based learning strategy in their teaching as it increases the performance and retention of students with Dyscalculia

Key word: *Activity-Based Learning, Dyscalculia, Mathematics*

I. INTRODUCTION

Mathematics is a fundamental discipline that plays a crucial role in everyday problem-solving, logical

reasoning, and academic success. It encompasses numbers, shapes, data, measurements, and logical activities, with vast applications in fields such as medicine, engineering, finance, natural sciences, and economics. Beyond academics, mathematics knowledge is essential in various aspects of life, including homes, offices, science and technology, industries, commerce, budgeting, banking, medicine, decision-making, law, logical arguments, and dispute resolution. It is also vital in vocations such as masonry, carpentry, weaving, farming, fishing, molding, shoemaking, hairdressing, sewing, knitting, sculpting, painting, and pottery (George & Charles-Ogan, 2023). From ancient civilizations to modern technological advancements, mathematics has remained central to human progress, making its teaching and learning essential for both personal and societal development. In today's fast-changing, technology-driven world, mathematics education is crucial for equipping students with the necessary skills, knowledge, and analytical mindset needed for innovation and problem-solving (European Commission, 2022).

Despite its significance, mathematics learning is not without challenges, particularly for students with dyscalculia—a specific learning disorder that affects numerical comprehension, arithmetic operations, and mathematical reasoning. Dyscalculic students often struggle to grasp mathematical concepts, leading to poor performance, reduced confidence, and a negative attitude toward the subject. Traditional instructional methods, which emphasize rote learning and abstract problem-solving, may not effectively support these students in overcoming their difficulties. Since mathematics involves higher-order cognitive processing, dyscalculic students require structured, engaging, and interactive teaching

strategies that facilitate conceptual understanding rather than mere memorization.

To address these challenges, Activity-Based Learning (ABL) has emerged as an effective instructional approach that fosters deep learning through experiential and hands-on activities. Mathematics learning involves concept learning, principle learning, and problem-solving—processes that require cognitive effort, practice, and meaningful engagement. ABL aligns with these requirements by incorporating interactive tools, real-world applications, and collaborative tasks that make mathematical concepts more tangible and accessible. By actively involving students in the learning process, ABL enhances comprehension, retention, and problem-solving skills, particularly in complex topics such as circle geometry, which demands spatial reasoning and visualization.

Activity-Based Learning is an instructional strategy that emphasizes active student participation and engagement in the learning process (Albadi & David, 2019). It involves hands-on activities, real-life problem-solving tasks, group work, and the use of manipulatives, technology, and interactive resources (Brown & Taylor, 2023). This approach promotes a deeper understanding of concepts, critical thinking, and enhanced problem-solving skills while providing meaningful learning experiences. By creating a multi-sensory and interactive learning environment, ABL can effectively support dyscalculic students by offering alternative pathways to understanding mathematical concepts. Investigating the effects of ABL on dyscalculic students can provide valuable insights for educators, policymakers, and curriculum developers, helping them design instructional methods that cater to the diverse needs of students in mathematics education. Performance in education is influenced by various factors, including the teacher's effectiveness, the student's attitude and effort, the nature of the subject, curriculum design, and logistical considerations. In academic settings, performance is increasingly judged based on effective learning outcomes. According to Bloom's Taxonomy, learning occurs at multiple levels, ranging from basic knowledge acquisition to higher-order thinking skills such as application, analysis, and evaluation (Prasad, 2021).

Thus, ensuring effective mathematics instruction, especially for dyscalculic students, requires teaching strategies that promote active engagement and deep understanding.

Gender is another important factor influencing students' performance in mathematics. Certain subjects and careers have traditionally been gender-stereotyped, with fields such as catering and hairdressing perceived as female-oriented, while engineering and carpentry are often seen as male-dominated professions. Research has consistently examined whether males are more inclined toward science and mathematics than females. Nwona and Akogun (2015) noted a gender imbalance in science, technology, and mathematics, with these subjects often perceived as male-dominated. Some teachers and parents still hold the misconception that females are less capable in mathematics and sciences, leading to low motivation, reduced self-confidence, and limited participation among female students. Although efforts have been made to bridge the gender gap in STEM education, gender inequality remains a significant barrier to achieving equitable learning outcomes. For effective mathematics instruction, socio-cultural, school-related, and policy-related factors, as well as curriculum and environmental influences, must be considered to create an inclusive and supportive learning environment for all students.

Several studies have examined the impact of ABL on student achievement in mathematics and related disciplines. Noreen and Rana (2019) worked on the effect of activity-based teaching and traditional methods of teaching on students' achievement in mathematics at the elementary stage. Their research, based on a pre-test, post-test control group design, found that students taught through activity-based teaching performed better in post-tests. They recommended the use of mathematics kits to enhance learning. Similarly, Okotubu (2020) investigated the effect of the demonstration teaching method on students' academic achievement and retention in auto mechanics trade. The study revealed that demonstration teaching significantly improved student achievement compared to conventional lecture methods. Nwalo and Eze (2021) worked on the effects of project and demonstration teaching

methods on male and female students' achievement and retention in basic electricity in technical colleges. The result showed that male and female students taught basic electricity using project teaching method had better academic performance. Ajayi and Ogbeba (2017) explored the effect of gender on students' achievement in stoichiometry using hands-on activities, the study revealed that there is no significant difference in the mean achievement scores between male and female students taught stoichiometry using hands-on activities. Furthermore, Okolocha and Benstowe (2021) examined the impact of internship experiential learning on students' academic achievement in model office technology utilization, finding that students exposed to experiential learning scored higher than their peers in traditional learning settings. The findings also revealed that both male and female benefited from internship experiential learning activities used for teaching model office technologies. Albadi and David (2019) compared activity-based learning with passive learning and found that ABL significantly enhanced student achievement and engagement. Fizza (2019) also examined the effects of ABL on student motivation and academic achievement, reporting that students in the experimental group performed better than those in the control group. While these studies highlight the benefits of ABL in improving student achievement across different subjects, there remains a gap in research specifically focused on dyscalculic students.

II. STATEMENT OF THE PROBLEM

In the teaching and learning of circle geometry, dyscalculic students often struggle with cognitive and procedural understanding, making it difficult for them to grasp fundamental concepts. Learning difficulties, particularly in Mathematics, remain a major concern in schools, as mathematical proficiency is essential for academic success and everyday problem-solving. However, a significant number of students face challenges in Mathematics, with dyscalculia being a primary factor contributing to their struggles.

Dyscalculia is a specific learning disability characterized by persistent difficulties in understanding and manipulating numerical and

spatial concepts. Students with dyscalculia may experience challenges with arithmetic operations, number sense, spatial reasoning, and overall mathematical reasoning, all of which are essential in circle geometry. This difficulty in processing mathematical concepts not only affects students' academic performance but also impacts their confidence and long-term mathematical development. Despite the recognition of dyscalculia as a learning disability, many teachers lack the necessary knowledge and instructional strategies to support affected students effectively. Traditional teaching methods often fail to address the unique learning needs of dyscalculic students, leading to continued struggles in mathematical comprehension. In particular, circle geometry requires strong spatial and logical reasoning, which poses additional challenges for dyscalculic students when applying theorems to problem-solving.

To bridge this gap, specialized instructional strategies are needed to enhance the learning experiences of dyscalculic students. Activity-Based Learning (ABL) has been identified as an effective approach that promotes hands-on engagement, interactive exploration, and conceptual understanding, making it a suitable method for improving students' performance and retention in Mathematics. However, research on the effectiveness of ABL specifically for dyscalculic students in circle geometry remains limited. Therefore, this study seeks to investigate the impact of Activity-Based Learning on the performance and retention of dyscalculic senior secondary school students in circle geometry in the Port Harcourt Metropolis.

III. AIM AND OBJECTIVES OF THE STUDY

The aim of the study was to investigate activity-based learning and performance of dyscalculic senior secondary school students in circle geometry in Port Harcourt metropolis. Specifically, the objectives of the study intend to:

1. determine the effect of activity-based learning strategy on the mathematics performance of students with Dyscalculia

- ascertain the differences in male and female students' performance with Dyscalculia when taught with activity based learning

IV. RESEARCH QUESTIONS

Two research questions guided this study,

- What is the effect of activity-based learning strategy on the Mathematics performance of students with Dyscalculia?
- What is the effect of the differences in male and female students' performance with Dyscalculia when taught with activity based learning?

Hypotheses

The following null hypotheses formulated were tested at 0.05 level of significance.

- There is no significant difference between the mean performance scores of Dyscalculia students' exposed to Activity Based Learning strategy and inductive method
- There is no significance difference between the mean performance scores of male and female students taught Mathematics using Activity Based Learning strategy and inductive method

V. METHODOLOGY

This study adopted a quasi-experimental pre-test, post-test, non-equivalent group design, which is appropriate for research involving human participants where full randomization is not feasible. The study was conducted in Port Harcourt Metropolis, Rivers State, Nigeria, a highly populated and economically significant area with numerous public secondary schools. The population comprised 21,079 Senior Secondary School 2 (SS2) students from 32 public secondary schools in the metropolis. A sample of 100 SS2 students was selected using a simple random sampling technique from two co-educational public schools, with one class chosen from each school.

The instrument for data collection was the Students' Performance Test on Circle Geometry (SPTCG), consisting of 25 multiple-choice questions, each carrying two marks, totaling 50 marks. The test covered topics such as angles on parallel lines,

theorems on triangles, the intercept theorem, and concepts of similarity and difference in triangles. The instrument was validated by experts in Measurement and Evaluation and subjected to a trial test in a nearby school not included in the main study. The reliability of the instrument was determined using the Kuder-Richardson 21 (KR-21) formula, yielding a reliability coefficient of 0.84.

Data analysis was carried out using mean and standard deviation to answer research questions, while Analysis of Covariance (ANCOVA) was used to test the hypotheses at a 0.05 level of significance.

VI. RESULTS

Research Question 1: What is the effect of activity-based learning strategy on the mathematics performance of students with Dyscalculia?

Table 1: difference in Mean and standard deviation of activity-based learning strategy on the mathematics performance of students with Dyscalculia

Methods	Pretest		Posttest		Gain Scores	
	N	Mean	Std	Mean		Std
Activity-based	50	4.58	2.31	14.84	6.13	10.26
Inductive	50	3.84	1.88	12.50	2.63	8.66

Table 1 indicates the difference in mean and standard deviation of activity-based learning strategy on the Mathematics performance of students with Dyscalculia. Students taught Mathematics with activity-based learning strategy had a mean gain of 10.26, while those taught Mathematics using inductive method had a mean gain of 8.88. This implies there is an improvement in the Mathematics performance of students with Dyscalculia when exposed to activity-based learning strategy.

Research Question 2: What is the effect of the differences in male and female students' performance with Dyscalculia when taught with activity based learning?

Table 2: Mean, standard deviation, and Mean gain of the effect of activity based learning strategy on the

Mathematics performance of male and female students with Dyscalculia

Gender	N	Pre-test		Post – test		Mean gain
		\bar{x}	SD	\bar{x}	SD	
Male	4	4.12	1.6	14.0	4.5	9.90
	9		8	2	2	
Female	5	4.29	2.5	13.3	5.1	9.04
	1		0	3	2	

Table 2 shows the mean, standard deviation, and Mean gain of the effect of activity based learning strategy on the Mathematics performance of male and female students with Dyscalculia. Male students taught with activity based learning strategy had the mean gain of 9.90 while female students exposed to activity based learning strategy had the mean gain score of 9.04. This indicated that male students taught Mathematics with activity based learning strategy performed better than their female counterparts with Dyscalculia.

Hypothesis 1: There is no significant difference between the mean performance scores of Dyscalculia students exposed to Activity Based Learning strategy and inductive method

Table 3: ANCOVA analysis of mean performance scores of Dyscalculia students' exposed to Activity Based Learning strategy and inductive method

Source	Type III		Mean Square	F	Sig.	Partial Eta Squared
	Sum of Squares	df				
Corrected Model	199.977 ^a	2	99.989	4.570	.013	.086
Intercept	2868.743	1	2868.743	131.127	.000	.575
Pretest	63.087	1	63.087	2.884	.093	.029
Methods	102.668	1	102.668	4.693	.033	.046
Error	2122.133	97	21.878			
Total	21009.000	100				
Corrected Total	2322.110	99				

Table 3 shows significant difference between the mean performance scores of Dyscalculia students exposed to Activity Based Learning strategy and those exposed to inductive method ($F(1, 97) = 4.693$; $P < 0.05$; partial eta square = 0.046). Therefore, hypothesis is rejected across the two methods.

Hypothesis 2: There is no significant difference between the mean performance scores of male and female students taught Mathematics using Activity Based Learning strategy and inductive method

Table 4: ANCOVA analysis of mean performance scores of male and female students taught Mathematics using Activity Based Learning strategy and inductive method

Source	Type III		Mean Square	F	Sig.	Partial Eta Squared
	Sum of Squares	df				
Corrected Model	112.035 ^a	2	56.018	2.459	.091	.048
Intercept	2756.178	1	2756.178	120.968	.000	.555
Pretest	100.238	1	100.238	4.399	.039	.043
Gender	14.727	1	14.727	.646	.423	.007
Error	2210.075	97	22.784			
Total	21009.000	100				
Corrected Total	2322.110	99				

Table 4 shows there is no significant difference between the mean performance scores of male and female students taught Mathematics using Activity Based Learning strategy and those taught with inductive method. $F(1, 97) = 0.646$; $P > 0.05$; partial eta square = 0.007. Therefore, hypothesis is accepted.

VII. DISCUSSION OF RESULTS

The results in table 1 indicate that students with dyscalculia perform significantly better in mathematics when taught using an activity-based learning strategy compared to an inductive method. The mean gain scores reflect a considerable improvement in performance, demonstrating the effectiveness of engaging students through interactive and hands-on activities. This implies that students with dyscalculia benefit more from activity-based learning strategies compared to inductive methods. The gain scores also show a substantial improvement in Mathematics performance for the activity-based group, which can be attributed to the engaging and interactive nature of this teaching method. The pretest scores were relatively low for both groups, but the posttest scores showed a marked increase, particularly for the activity-based group, suggesting that these students responded well to the hands-on, sensory-engaging activities.

Noreen and Rana (2019) support these findings by emphasizing that activity-based learning enhances understanding, promotes independence, and fosters an active learning environment. Activities that engage multiple senses are more effective in helping students retain information and apply their knowledge in various contexts. This aligns with the observation that the activity-based group had a higher mean gain, indicating better retention and application of mathematical concepts.

Albadi and David (2019) found similar results in their study, where students taught using activity-based learning showed higher achievement and increased motivation compared to those taught using traditional methods. This suggests that the interactive nature of activity-based learning not only improves academic performance but also enhances students' enthusiasm and engagement with the subject matter. The ANCOVA analysis in Table 3 confirms a significant difference between these teaching methods, demonstrating the effectiveness of activity-based learning in enhancing the academic performance of students with dyscalculia. The partial eta squared value of 0.046 indicates that the teaching method accounts for 4.6% of the variance in performance scores, highlighting its impact on academic performance.

Moreover, the study by Fizza (2019) found that activity-based teaching significantly increased student motivation and academic achievement. The experimental group's posttest scores were notably higher than those of the control group, illustrating the effectiveness of activity-based learning in enhancing student performance and that activity-based learning strategies are more effective than traditional inductive methods in improving Mathematics performance for students with dyscalculia.

Table 2 reveals that both male and female students with dyscalculia experienced substantial gains in mathematics performance when taught using an activity-based learning strategy. Male students had a higher mean gain than their female counterparts. This suggests that although both genders benefited from the activity-based approach, male students showed slightly higher improvements. This difference could be attributed to various factors, including possible

differences in engagement or prior knowledge. These findings align with those of Nwalo and Eze (2021), who found that project-based methods improved both male and female students' performances in technical subjects, with males slightly outperforming females.

Table 4 provides an ANCOVA analysis of mean performance scores, indicating no significant difference between the mean performance scores of male and female students taught using activity-based learning strategies versus the inductive method. This lack of significant difference implies that both methods are similarly effective across genders, though the slightly higher mean gain in males could be due to individual variability rather than instructional strategy effectiveness. The result from Ajayi and Ogbeba (2017) supports this finding, showing no significant gender difference in achievement when students are engaged in hands-on activities. This suggests that while activity-based learning is effective, its benefits are broadly distributed across genders.

The effectiveness of activity-based learning compared to other methods is further supported by literature. Okotubu (2020) found that the demonstration method significantly improved students' academic achievement and retention compared to conventional lecture methods. Similarly, Okolocha and Benstowe (2021) highlighted the benefits of experiential learning in improving academic performance, irrespective of gender.

VIII. CONCLUSION

The study investigated the investigate activity-based learning and performance of dyscalculic senior secondary school students in circle geometry in Port Harcourt metropolis. The findings of this study revealed that students with dyscalculia benefit more from activity-based learning strategies compared to inductive methods. It also revealed that both male and female students with dyscalculia experienced substantial gains in mathematics performance when taught using an activity-based learning strategy. According to this study the activity-based learning strategy had a measurable impact on the retention of students with Dyscalculia. This study also showed that female students exhibited a smaller mean gain

compared to male students when taught using activity-based learning strategies. It also showed that both male and female students showed higher mean gain scores with the activity-based learning strategy compared to the inductive method, indicating its effectiveness in enhancing performance across genders.

IX. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made

1. Mathematics teachers should use activity-based learning strategy in their teaching as it increases the performance and retention of students with Dyscalculia
2. Governments at all level should encourage the use of activity-based learning strategy to enhance dyscalculia's students' performance and retention in Mathematics.
3. Curriculum planners should carry out a review of Mathematics curriculum for secondary schools with a view to incorporate activity-based learning strategy into the teaching of Mathematics.
4. Male and female students should be given equal opportunity to participate, compete and cooperate in classroom activities in Mathematics.

REFERENCES

- [1] Albadi, A., & David, S. A. (2019). The impact of activity-based learning on students' motivation and academic achievement: A study among 12th-grade science and environment students in a public school in Oman. *Journal of Education and Educational Development*, 4(2), 44-53.
- [2] Ajayi, V. O., & Ogbeba, J. (2017). Effect of gender on senior secondary chemistry students' achievement in stoichiometry using hands-on activities. *American Journal of Educational Research*, 5(8), 839-842.
- [3] Brown, A., & Taylor, H. (2023). The effects of activity-based learning on middle school mathematics achievement. *Journal of Educational Research*, 116(2), 121-134.
- [4] European Commission. (2022). *Mathematics and science learning in schools 2022*. Retrieved from <https://eurdice.eacea.ec.europa.eu/publications/mathematics-and-science-learning-schools-2022>
- [5] Fizza, A. (2019). Activity-based teaching, student motivation, and academic achievement. *Journal of Education and Educational Development*, 6(1), 154-170.
- [6] George, N. R., & Charles-Ogan, G. I. (2023). *Essentials of mathematics teaching and learning*. UlchDigi Prints & Services Nig.
- [7] Noreen, R., & Rana, A. M. (2019). Activity-based teaching versus traditional method of teaching in mathematics at elementary level. *Bulletin of Education and Research*, 41(2), 145-159.
- [8] Nwalo, C. N., & Eze, T. I. (2021). Effects of project and demonstration teaching methods on male and female students' achievement and retention in basic electricity in technical colleges. *Advances in Research*, 22(2), 50-62. <https://doi.org/10.9734/air/2021/v22i230298>
- [9] Nwona, H. A., & Akogun, N. A. (2015). Breaking gender barrier in science, technology, and mathematics education. *Nigeria Journal of Research in Education*, 2(1), 98-108.
- [10] Okolocha, C. C., & Benstowe, F. S. (2021). Effect of internship experiential learning on students' academic achievement in utilization of model office technologies in federal colleges of education in South-South, Nigeria. *British Journal of Education, Learning and Development Psychology*, 4(1), 76-89. <https://doi.org/10.52589/BJELDPVFXPY4ND>
- [11] Okotubu, J. O. (2020). Effect of demonstration teaching method on students' academic achievement and retention in auto mechanics trade in technical colleges in Delta State. *International Journal of Education and Evaluation*, 6(5), 6-14.
- [12] Prasad, G. N. R. (2021). Evaluating student performance based on Bloom's taxonomy levels. *Journal of Physics: Conference Series*, 1797, 1-10.