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Adaptive Functional Learning Strategies for Improved Achievement of Learners with Autism in Inclusive Classrooms

Bolanle Titilayo Segilola [1*] **and Philias Olatunde Yara** [2]

[1] Arts and Social Science Education/Faculty of Education, Lead City University, Ibadan, Oyo State, Nigeria
[2] Science Education, Faculty of Education/ Lead City University, Ibadan, Oyo State, Nigeria

segilola.bolanle@lcu.edu.ng
[*] Corresponding author

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Abstract

The globalisation of knowledge and information has increased the demand for improved technical and operational approaches across all sectors, including education. As technology advances rapidly, the education sector is expected to lead this transformation, particularly in its pedagogical practices. Pedagogy remains central to achieving the goals of teaching-learning, being embedded in the curriculum. This paper examined Adaptive Functional Learning (AFL), a teaching-learning strategy designed to enhance STEM activities in inclusive classrooms, with a focus on improving the academic achievement of learners with Autism Spectrum Disorder (ASD). The study was anchored on Social Cognitive and Situated Learning theories, guided by the Academic Functional Learning Aptitude Test (AFLAT), which aligns with the principles of AFL. A quasi-experimental design was adopted, involving 60 learners with ASD, sampled from inclusive classrooms across four regions and five states in Nigeria. Data were collected using AFLAT (PPMC $r = 0.87$, $p < 0.001$), and (Cronbach's $\alpha = 0.88$) were analysed with Analysis of Covariance (ANCOVA) with two hypotheses were tested at the 0.05 significance level. Findings revealed no significant interaction effect between AFL and gender on learners with ASD's academic achievement ($F(1,57) = 0.249$, $p>0.05$, $\eta 2 = 0.005$), and no significant interaction effect between AFL and location of residence ($F(1,55) = 0.824$, $p > 0.05$, $\eta 2 = 0.015$). Despite these, AFL strategy in STEM activities were shown to aid in improving the academic achievement of learners with ASD. The study concluded that AFL enhances learning outcomes and recommended its integration into STEM pedagogy, curriculum design, and assessment practices to foster inclusivity and better academic performance among learners with ASD.

Keywords: adaptive functional learning, STEM education, inclusive classroom, autism spectrum disorder learners

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1. Introduction

Sustainable Development Goal-4 (SDG-4) has its focus on ensuring inclusive, and equitable quality education. It also aims at promoting lifelong learning opportunities for the diverse users of this quality education, that is received at every turn of life event. Of these two directions that SDG-4 focuses on, sustaining the later purpose, which is promoting lifelong opportunities seems not to have been thoroughly dissected for maximum comprehension, in recognising its transformative effectiveness and the power of innovations that can emerge from this opinion (United Nation, 2024). While the intent of equity should reflect social collaboration bearing the context or situation of the experience that confronts the learners irrespective of the physical or psychological conditions in an inclusive school, the approach of impactful applicative learning should be considered in terms of constantly modifying its curriculum of study and/or the pedagogy of study to reflect updates as knowledge is evolving and transforming progressively.

It is on this premise that constant modification of curriculum through innovation, that is, the power of sustaining lifelong learning can yield the desired quality that the teaching-learning aspirations of the curriculum requires (Segilola & Adeyemi, 2022). A closer reflection about the concept on inclusive pedagogy is that which involves the participation of all learners irrespective of their physical or psychological conditions. With this, inclusion in a school setting can be defined as an environment that exist within the same sphere of learning features for learners who live with special learning impairments and the neurotypical learners, who are considered to live with no special learning impairments (Olufosoye, Olayemi & Oladimeji, 2023). The fact that the system is inclusive, should enable the school managers come to the relaisation that; the content, programme, facilities and activities of instructions should be considered on an individual-based and group-collaborations involving all categories learners, rather than segregating the categories learners. (Hehir, Grindal, Freeman, Lamoreau, Borquaye, & Burke, 2020). The intent of segregation, thereby leading to the de-harmonisation of the actual intent of inclusion, which can result in an underproductive outcome of the result from its practice.

2. Literature Review

2.1. Autism Spectrum Disorder

The learners who live with Autism Spectrum Disorder (ASD) have been identified to exhibit traits that are peculiar and unique to that individuals (Carmen B. Pingree Centre, 2020). These

traits have been found to be beneficial, and supportive to task orientation and improvement (Meng-Chuan, Lomnardo & Baron-Cohen, 2020). The neurodevelopmental disorder, which is now being explored in the areas of genetic composition has characteristic features in social communication and interaction defect, engagement in repetitive and stereotyped movement and behaviour maladjustment, which in most cases are the resultant effects of sensory discomforts that the victims experience (Rylaarsdam & Guemez-Gamboa, 2019). In academics, the discomfort is suppressed with sensorial comforting activities along with cognitive perceptive tasking of the brain network. These activities are performed in a quiet environment that is coded with sensory-perceptive materials along with structured activities that is aimed at specified academic achievement. This space is referred to as the multi-sensory space and it makes use of principles of variation and cognitive connectivity for the purpose of suppressing the discomfort that is experienced by the learner with ASD (Sven, Girdler & Marschik, 2019).

2.2. STEM vs STEAM: Activities For ASD

An important course of study that can be beneficial to the practice of inclusion is embeded in STEM education. This being the acronym for the integration of Science, Technology, Engineering and Mathematics. This is a learning strategy that infuses various aspects of different subjects into a cohesive learning experience, which focuses on real-life application learning (Ntara & Bouchillon, 2025). STEM is the method of the integration of learning that aims to develop the learner's critical thinking, problem-solving and innovative skills, which are the attributes that prepare the learners with ASD for future careers in related fields for the navigation of technology-driven world. It seeks to proffer solutions to lifelong problems through innovations, which is how the learners with ASD thrive in academics. For instances engaging the learners with leadership roles in readiness for the creation of a constitution (book of law) and its delivery during a parliamentary session, which was drawn from a lesson in National Symbols from the Social Studies subject. Another is the integration of STEM in creation of an ecosystem aimed at solving water drainage problems in the environment, a lesson in Science. For STEM to be effectively actualised, it is important for the current curriculum of studies to be reviewed in such a way that the STEM activities will be infused in the scheme of work. This will include the integration of concepts, which will focus on identifying persistent problems that are relative to societal needs and solutions for improvement.

The STEM approach to pedagogy implementation has a variation, which is known as STEAM. The acronym, "A" includes the infusion of Arts and design, which are essential for innovative

creations. It exposes the varieties that come with tasks specialisation, thereby expanding the scope of job creation and specialised fields of study in readiness for the 4th industrial revolution in the creation of non-existing jobs. Thus, STEM and STEAM incorporate the components of science and technology, however STEAM emphasises the presentation of arts and creative design. While STEM develops technical and problem-solving skills through a structured, hands-on approach, STEAM integrates the culture of arts to foster creativity, innovation and provide a broader understanding of how these subjects connect in real-life application through the introduction of presentation skill (Taylor, 2024). Table 1 shares the differences that make each experience unique and a course for consideration in pedagogy improvement.

Table 1. *The Difference between STEM vs STEAM Approaches to Learning*

AREAS	STEM	STEAM
Focus	Core are science, technology, engineering and mathematics	Integrates arts (visual, music, drama and designs) into STEM fields
Learning Process	Observation, research, innovation, problem-solving	Creative problem-solving. Critical thinking and collaborative in connecting different subjects' principles
Skill Developed	Technical, analytical and logical thinking skills	Technical, creativity, innovation, communication and socialisation
Example	Building project via: specific material, calculation, structural integrity and engineering principles.	Designing and building projects, but it requires the presentation of ideas, etiological story connections and/or artistic structures -patterns, colours, shapes and their implications in the structure built or project.

Source: Taylor, 2024

Having established the role of STEM education in the development of inclusive pedagogy, it is expedient to identify the operative functional path of adopting this strategy in the pedagogy of an inclusive classroom setting for the learners with ASD. This operational path is considered as being effective because it infuses both individualised and social collaborative activities, which is based on the needs, abilities and interest of each learner in the inclusive classroom.

2.3. Adaptive Functional Learning (AFL) Strategy for ASD

The strategy of Adaptive functionality is considered for individual instructional learning approach or the technology that can be adjusted to suit the learner with ASD's styles of learning (Bernard, Borokhovski, Schmid, Waddington & Pickup, 2019). In the light of this, the approach can be translated into the workplan as; Adaptive Functional Curriculum of Study (AFCS) and it can be applied when lesson instructions are being given to modify the styles of learning desired for personalised learning activities. Adaptive functional learning strategies denotes individualised, practical, and context-responsive teaching approaches, such as structured routines, task analysis, visual supports, and behavior modification techniques, which are

designed to enhance learners' independence and academic success. The components adopted by the strategy of adaptive functionality is the consideration of aptitude or ability of the learner to understand and perform the instructional task, as the teacher or instructor decides on the approaches for moderating the support that is required by the learner to perform the task required. The teacher would equally be required to figure out the problems that could be identified from the task, where any may arise. This procedure is the Dynamic Adjustment Approach (DAA) of adaptive functional learning, which can be changed base on real-time feedback from learners in order to ensure that the learning experiences acquired are optimally challenging and engaging too (Bernard, et al, 2019). During the process of the application of STEM teaching-learning activities, it focuses on how individual learner with ASD interacts with the team, it determines the needs of each learner, directs the path to task achievement and identifies that learners have diverse logical outcome. Finally, it strives to create an environment where each learner can thrive by addressing their specific strengths, in order to boost their weakness (Sven, et al 2019).

In addition to these, the dynamic adjustment approach of adaptive functionality also identifies how instructions can be modified within a given situation or contextual framework so as to suit the learner's understanding and aid in the performance of the required key focus of the task. The interrelationship between these instructional strategies and learner with ASD's academic achievement is illustrated in section 2.8. The fact that the approach is hands-on and flexible, best suit the application of STEM teaching-learning experience and it ensures that the contributions of each learner is captured during task performances (Taylor, 2024). The strategy adjusts the pace, content and activities of learning in order to ensure that all learners can learn effectively. When the learners each manage their pace, content and activities, it reveals innovation in the performance and the skills applied by each learner, either in the group or individual performance (Yang, Zhong, & Wozniak, 2021). There is usually a distinct outlook in the performance rater that sets the learners apart from one another. This should be of interest to the teacher as the it can enhance collaboration, socialisation and improve communication in ASD learners among their neurotypical peers.

2.4. AFL: Location and Gender Effect on Achievement of Learners with ASD

The location of residence remains a crucial natural determinant of how effectively adaptive functional learning strategies can be implemented to improve the academic achievement of learners with ASD in inclusive classrooms. The effectiveness of these strategies is strongly

affected by the learner's residential environment, which either reinforces or constrains school-based interventions. The residential environment provides the foundation for reinforcing adaptive learning strategies that are introduced in inclusive classrooms. Learners with autism benefit from consistency across settings, particularly in the use of structured routines, spatial/visual schedules, and predictable learning patterns. Kahveci et al. (2024) established that sensory-friendly and well-structured residential environments significantly improve behavioral regulation and engagement among learners with autism. When parents repeat classroom-based adaptive strategies, such as visual cues, spatial directions, step-by-step instruction, and reinforcement systems, learners experience continuity, which strengthens skill acquisition and transfer. This alignment between residence and school enhances functional learning and ultimately improves academic achievement.

Access to specialised services within a learner's residential location further strengthens adaptive functional learning. Emerson et al. (2020), highlighted that proximity to intervention services, such as speech and occupational therapy, significantly enhances developmental outcomes. These services often provide parents with training on how to implement adaptive strategies such as task breakdown, prompting, and reinforcement techniques. When such support systems are readily available within the residential environment, learners benefit from continuous skill development beyond the classroom. Structured residence may not necessarily be found in the urban setting or suburban setting, but a structure residence is seen to practice the training or instructions taken from the training. When the residential environment mirrors the structured nature of adaptive functional learning strategies used in inclusive classrooms, such as consistent schedules, clear expectations, and reinforcement systems, learners are better able to generalise skills across contexts. This continuity is essential for improving functional competencies such as communication, self-regulation, and problem-solving, which directly impact academic achievement in inclusive settings.

The effect of gender on AFL strategies is yet to be directly established in most empirical studies, however, few studies provide assertive support suggestion that female learners with ASD perform better in certain adaptive or learning-related areas, which could influence how they respond to structured interventions. For instance, female learners with ASD have been speculated to demonstrate better adaptive and social-related functioning that can support learning achievements. It was found that females show higher cognitive empathy. This empathic nature significantly predicts adaptive functioning for female than male (Shulman et

al. 2026). A contextual approach argued that females often demonstrate better socio-emotional skills than males, and this supports classroom engagement and learning. It was further interpreted that since AFL strategies involves partly social responsiveness and adaptive behaviour, female may sometimes appear to benefit more than male (Head et al. 2014).

2.5. Theories Supporting AFL Strategy for Learners with ASD

These attributes are supported by social cognitive theory, which emphasises the role of social interaction, observation, and modelling in learning (collaborative learning in inclusive classrooms). The STEM education approach can be challenging, if collaboration, which is achieved by social interaction is not embraced during adaptive functional learning. Where the learners perform the task without supervision pose certain level of emotional disengagement from the task, and reduce the urge of continuity of the task. This is unlike when there is interaction among the learners and each one of them make contributions to the progress and building of the task. STEM learning is most effective when learners are engaged in hands-on authentic, real-life tasks. It breeds that fact that learning is concrete and interwoven with the situation and culture of occurrence. A further attribution was made to the fact that knowledge produces social interaction and its participation requires practice. This narration explains Situated Learning Theory (SLT) which suggests that learning is deeply connected to social interaction and a connection with life informal knowledge that is acquired communal practice and engagement in any given situation (Northern Illinois University, 2012). Both social cognitive and situated learning theory were infused into the principles of academic functional learning aptitude test (AFLAT) procedures while engaging the learners in STEM activities. These principles include: the identification of learners' unique abilities that aid ultimate performance; directing the path of learning using the learner's strength aptitude; using the dynamic adjustment approach; determining the learning path using performance-baseline aptitude to identify the strength and weakness of the learners and projecting the best functional area(s) of task division (Segilola et al, 2022).

2.6. Problem Statement

The problem identified in this study was as result of the observations made during classroom lesson procedures, where learners with ASD were not attended to in their inclusive classrooms. It was observed that the learners were neglected and, misunderstood by teachers and their peers.

They were not participating in activities, rather, the learners with ASD were asked to sit apart and watch, while their neurotypical peers perform the task. Even in instances where the learner with ASD seem to know what to do, and could achieve the task faster with accuracy, there would be some kind of impatience in the level of attention that is received from the teacher. These actions often lead to frustration on the learner with ASD, thereby leading to violence and misbehaviour, for lack of optimally articulation of unique characteristics in order to achieve the expected learning outcome. Thus, having a sequentially flexible structure that engages hands-on activities and real-life integration seem to be the perfect form of classroom engagement for learners with ASD.

2.7. Aim and Objectives of the Study

The aim of this study is to determine the interaction effect of Adaptive Functional Learning (AFL) strategies on the academic achievement of Autism Spectrum Disorder learners in Nigerian inclusive schools while the objectives of the study are to:

i. Determine the interaction effect of AFL strategies and gender (male and female) on academic achievement of ASD learners in Nigerian Inclusive Schools.
ii. Determine the interaction effect of AFL strategies and location of residence (urban and suburban) on academic achievement of ASD learners in Nigerian Inclusive Schools.

2.8. Conceptual Model of Study

Figure 1 provides and interaction of the independent variables (control & experiment strategies) of conventional and AFL approaches and the dependent variable (academic achievement) of learners with ASD.

In this figure, there are two independent variable, one dependent variable and two moderating variables. The independent variables are the interaction between the conventional strategies (control) and adaptive functional strategies (experimental) on the activities of learners with ASD in inclusive classrooms. While the dependent variable is the achievement, basically the academics, which is enhanced by factors such as gender and location of residence, which are the moderators. The independent variables are the practical strategies that are applied, by modifying the levels of instructions and guiding the direction of activities in order to enhance the performance of the learners. The experimental group reflects the interactive effects of AFL on gender and location of residence of learners with ASD, on their academic achievement in

comparison with the control group, which are exposed to the conventional approaches of activities and the resulting effect of this on academic achievement.

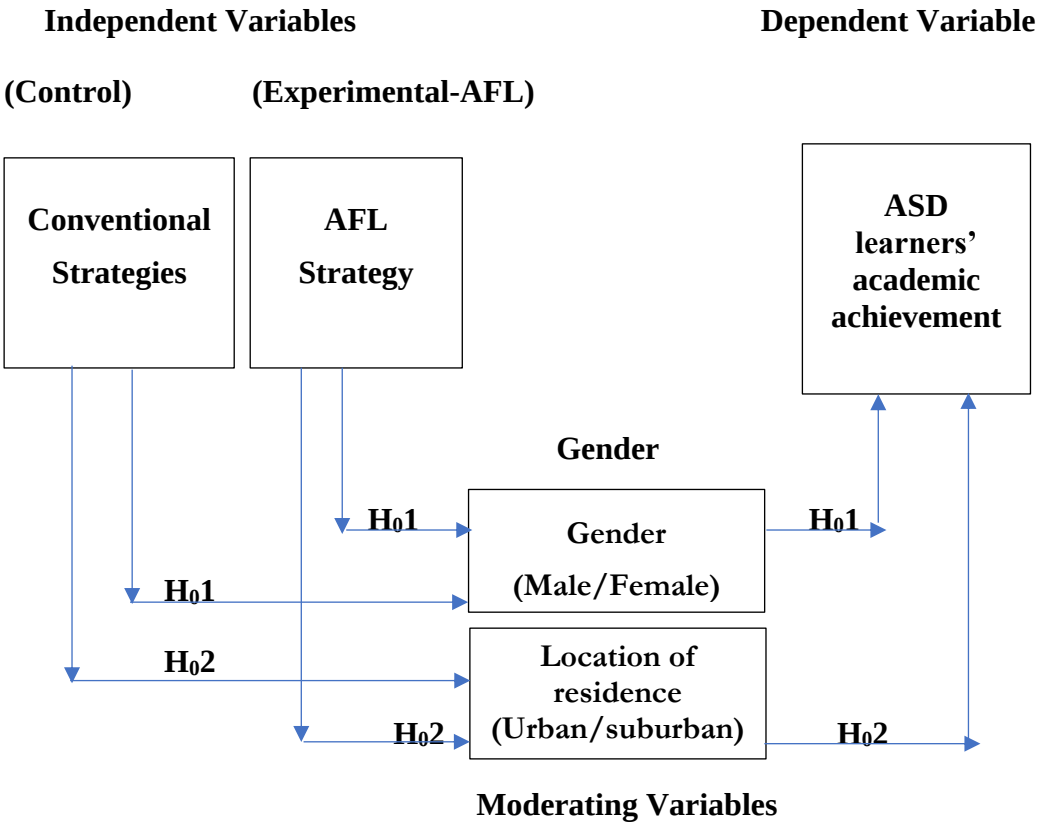

Figure 1. *Conceptual Framework: Adaptive Functional Strategies for Academic Achievement of Learners with ASD*

2.9. Hypotheses

In order to determine the statistical significance of AFL strategies on the academic achievement of learners with ASD, this study tested the assumptions regarding the impact of gender and location of residence on the academic achievement outcome of learners with ASD. Consequently, the following null hypotheses were formulated to guide the analysis:

- **H01** There was no significant interaction effect of Adaptive Functional Learning (AFL) strategies and gender (male and female) on academic achievement of learners with ASD in Inclusive Schools.
- **H02** There was no significant interaction effect of Adaptive Functional Learning (AFL) strategies and location of residence (urban and suburban) on academic achievement of learners with ASD in Inclusive Schools.

3. Methodology

3.1. Design

This study design is quasi experimental that is used to determine the causal interaction effect of Adaptive Functional Learning (ADL) strategies in STEM inclusive activities of learners with Autism Spectrum Disorder (ASD).

The target population of sixty (60) ASD learners were sampled from four (4) regions and five (5) states across Nigeria. Multi-stage sampling technique was used to obtain the selections of regions, states, local government areas, inclusive schools and ASD learners. These include; simple random sampling; used to select the regions (Northern Central, South-south, Southeast and Southwest) and states (Oyo, Enugu, Rivers, Plateau and Federal Capital Territory-FCT Abuja), stratified random sampling was used for classification, while convenience sampling was used to select five (5) inclusive schools that participated in this study, and purposive sampling was used to select ASD learners who participated in this study.

3.2. Instrument and Data Collection

The data were collected using the academic achievement tests and a corresponding aptitude assessment test. These tests are made up of the second component of AFLAT tool, which integrates the infusion of various flexible strategies, including adaptive functional learning strategies during learning activities. In this study, AFL strategies made use of STEM instructional activities to guide the learners with ASD in experimental group. The academic test comprised of one integrated project activity item in environmental pollution in Science (Appendix A), while the aptitude items (statements) infused five corresponding aptitude statements in geometry, spatial reasoning, logical reasoning, and verbal reasoning (Appendix B). The aptitude statements were bases on expected performance, with a view to display of flexible cognition, effort and information processing rates. These were measured with 5-point Likert scale.

3.2.1. *Reliability and Validation*

The academic aptitude tests instrument (which is the component that integrates the strategies adopted in AFLAT tool was subjected to face and content validity by senior school managers and psychometric analyst for objectivity. The instrument adapted existing aptitude test format to suit the learners operating environment, such the contents were based on what were

observable within the school. Pilot study process was conducted, in order to determine the stability of the instrument over six (6) months in order to validate the appropriateness of the tool. The stability and internal structure of the AFL instrument were examined using both classical test theory (SPSS) and Rasch measurement (Winsteps) for a sample of 60 learners with ASD. The test–retest reliability showed a strong positive correlation *($r = 0.87$, $p < 0.001$)*, indicating high stability over the six-month interval. The paired samples t-test showed no significant difference *($t(59) = -1.02$, $p > 0.05$)*, confirming that the score is consistent over time. The internal consistency reliability was high *(Cronbach's $\alpha = 0.88$)*. Rasch analysis further demonstrated strong measurement properties, with **person reliability = 0.88** and **item reliability = 0.91. This** indicates good reproducibility of both person ability and item difficulty estimates. Fit statistics (Infit and Outfit mean square) fell within (0.5 – 1.5), which is an acceptable range, confirming that the data fit the Rasch model adequately. In all, the AFL instrument is **psychometrically comprehensive, stable over time, and appropriate for assessing learners with Autism Spectrum Disorder**. Table 2 shows a summary statistic of the person and item measurement, as indicated below.

Table 2. *Summary of Measurement of Person & Item Statistics*

Category	Mean Measure (logits)	SD	Separation	Reliability
Persons	0.52	1.15	2.65	0.88
Items	0.00	0.75	3.10	0.91

Source: Field Survey, 2023

3.2.2. *Administration of Data*

The study guided the STEM instructional activities (safety walk-through around the school compound) using the adaptive functional strategies to guide and modify the instructions during the field observation and reporting process. The content of instruction was continuous prompted and adjusted to suit the learner with ASD's understanding, performance and task delivery. A control group which made use of the conventional strategy was introduced to compare the interaction effect of the strategies.

3.2.3. *Data Analysis*

The data collected were analysed using the descriptive statistics of frequency and percentage for the demographic data and inferential statistics of Analysis of Covariance at 0.05 level of significance to test the hypotheses.

4. Results

4.1. Descriptive Analysis

The demographic characteristics of the participants are categorized by gender, geographical location and residence location are presented in Table 3.

Table 3. *Distribution of the Participants*

Gender	Frequency	Percent (%)
Male	48	80.000
Female	12	20.000
Total	60	100.000

Geographical Location	Frequency	Percent (%)
South-West (SW)	10	16.700
North-Central (NC)	35	58.300
South-East (SE)	6	10.000
South-South (SS)	9	15.000
Total	60	100.000

Location of Residence	Frequency	Percent (%)
Urban	39	65.000
Sub-urban	21	35.000
Total	60	100.000

Treatment	Frequency	Percent (%)
Treatment (Academic Functional Learning Aptitude Test Strategy)	45	75.000
Control (Conventional Strategy)	15	25.000
Total	60	100.000

Source: Field Survey, 2025

Table 3 reveals that 80.0% of the participants are males, while 20.0% are females, and indication that more male than female ASD learners participated in this study. The regions reveal that over more than half (58.3%) of the participants are sampled from North-central, while the lowest (10.0%) were from South-east. The participants who attend inclusive schools

in the urban areas are more (65.0%), than the participants are attending inclusive school in the sub-urban areas (35.0%). The participants sampled for experimental group, (75.0%) is an indication that most were exposed to Adaptive Functional Strategies during the STEM instructional activities than the control (15.0%) group.

4.2. Inferential Analysis

The section discusses the statistical cling upon which each hypothesis is tested, and the results are presented in Table 4 and Table 5.

Hypotheses

$H_0$1: There will be no significant interaction effect of Adaptive Functional Learning (AFL) strategies and gender on academic achievement of learners with Autism Spectrum Disorder in Nigerian inclusive schools.

Table 4. *Analysis of Covariance of Interaction Effect of AFL Strategies and Gender on Academic Achievement of Learners with Autism Spectrum Disorder*

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	11717.371	4	2929.343	69.581	0.000	0.835
Intercept	488.727	1	488.727	11.609	0.001	0.174
Pretest	11013.383	1	11013.383	261.603	0.000	0.826
Treatment	611.980	1	611.980	14.536	0.000	0.209
Gender	20.896	1	20.896	.496	0.484	0.009
Treatment * Gender	10.476	1	10.476	.249	0.620	0.005
Error	2315.479	55	42.100			
Total	155459.000	60				
Corrected Total	14032.850	59				

Estimated Marginal Means of AFL Strategies and Gender on Academic Achievement of Learners with Autism Spectrum Disorder

Treatment	Gender	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Treatment (AFLAT Strategies)	Male	50.116	1.082	47.948	52.284
	Female	53.048	2.179	48.681	57.415
Control (Conventional Strategies)	Male	41.997	1.873	38.243	45.750
	Female	42.478	3.789	34.885	50.071

Source: Field Survey, 2025

Table 4 shows that there is no significant interaction effect of Adaptive Functional Learning (AFL) strategies (treatment) and gender on academic achievement of learners with Autism Spectrum Disorder in Nigerian inclusive schools at($F_{(1,55)}$=0.249, p>0.05, η^2=0.005).The null hypothesis was therefore accepted. The partial eta square value of 0.249 shows larger contributing effect size of 24.9%.

$H_0$2: There will be no significant interaction effect of AFL strategies and location of residence on academic achievement of learners with Autism Spectrum Disorder in Nigerian inclusive schools.

Table 5 shows that that there is no significant interaction effect of AFL strategies (treatment) and location of residence on academic achievement of learners with Autism Spectrum Disorder in Nigerian inclusive schools ($F_{(1,55)}$=0.824, p>0.05, η^2=0.015).The null hypothesis was therefore accepted. The partial eta square value of 0.015 shows contributing effect size of 1.5%.

Table 5. *Analysis of Covariance of Interaction Effect of AFL Strategies and Location of Residence on Academic Achievement of Learners with Autism Spectrum Disorder*

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	11764.799	4	2941.200	71.324	0.000	0.838
Intercept	544.547	1	544.547	13.205	0.001	0.194
Pretest	10628.641	1	10628.641	257.743	0.000	0.824
Location of Residence (LoR)	30.035	1	30.035	0.728	0.397	0.013
Treatment	607.839	1	607.839	14.740	0.000	0.211
LoR * Treatment	33.994	1	33.994	0.824	0.368	0.015
Error	2268.051	55	41.237			
Total	155459.000	60				
Corrected Total	14032.850	59				

Estimated Marginal Means of AFL Strategies and Location of Residence on Academic Achievement of Learners with Autism Spectrum Disorder

Treatment	Location of Residence	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Treatment (AFLAT Strategies)	Urban	51.639	1.119	49.396	53.881
	Sub-Urban	48.082	1.871	44.333	51.832
Control (Conventional Strategies)	Urban	42.053	2.622	36.798	47.308
	Sub-Urban	42.180	2.151	37.870	46.491

Source: Field Survey, 2025

5. Discussion of Findings

In hypothesis one, female participants in the treatment group had a higher mean score than their male counterparts. This implied that the interaction of treatment and gender had a better effect on academic achievement of female learners with Autism Spectrum Disorder whose learning was adjusted using AFL strategies in Nigerian inclusive schools than their male counterparts.

Even though adaptive functional learning strategies are inherently individualised and responsive to learner needs rather than gender differences, strategies such as task breakdown, visual/spatial supports, structured routines, and prompting support practices are designed interventions to enhance deficits in communication, social interaction, and behaviour, which are core characteristics of ASD that are largely consistent across genders. This study showed that when these strategies are effectively implemented, task engagement is improved, completed, and learning yield better outcomes in female than male with ASD as revealed also in. Shulman, C. et al, (2026). This effect resulted from the cognitive function of difference in brain form of ASD male (lower cortical thinning). With this defect, ASD males' functioning and engagements in hand-on or motor-perceptual activities are slower when compared with ASD female. Such this and other considerations had effect on the performance rater and consequently lowering the achievement level of males (Wrigley-Asante, Akach, & Frimpong, 2023).

Hypothesis two revealed that participants who are in urban areas in the treatment group had a higher mean score than their counterparts in sub-urban areas. This implies that the interaction of treatment and location of residence had a better effect on academic achievement of urban learners with Autism Spectrum Disorder who were exposed to AFL strategies during STEM activities in inclusive schools, than their sub-urban counterparts. There is evidence from Kahveci et al. (2024), Durkin et al. (2014), Emerson et al. (2020), and Scheeren et al. (2022) demonstrates that residential location significantly influences access to resources, environmental structure, and opportunities for reinforcing adaptive learning strategies outside the classroom.

Learners in urban areas benefitted from greater access to specialised services, trained professionals, assistive technologies, and inclusive educational resources. These advantages enhance the implementation and reinforcement of adaptive functional learning strategies, thereby improving these learners' academic achievement. In contrast, the learners with ASD in

suburban and less-resourced areas faced limitations in accessing these services, which can reduce the consistency and effectiveness of these strategies beyond the classroom setting.

Furthermore, the residential environment determines the extent to which parents and caregivers can support adaptive strategies at home. Where there is alignment between home and school practices, such as the use of visual schedules, structured routines, and reinforcement systems, learners are more likely to generalize skills and achieve better academic outcomes. Consequently, the literature suggests that location of residence can moderate the effectiveness of adaptive functional learning strategies, making it more likely that an interaction effect exist.

6. Conclusion and Recommendations

This study seeks to determine the interaction effect of Adaptive Functional Learning (AFL) strategies (this being one of the strategies applied in Academic Functional Learning Aptitude Test (AFLAT) instrument, in STEM activities with ASD learners in Nigerian inclusive classrooms. The result revealed no significant interaction between AFL strategies and gender (male & female), and also between AFL strategies and location of residence of ASD learners, leading to the acceptance of the null hypotheses.

The study further revealed that there are more ASD cases in the Central Northern region of Nigeria than the Southern region put together. More male learners with ASD are revealed than the female learners with ASD. The urban resident learners are better achievers in academic than the sub-urban resident ASD learners. More so, the study revealed that female ASD learners achieved better results in academics when exposed to the adaptive functional learning strategy, in STEM instructional activities.

This study recommends that the practical application of Adaptive Functional Learning (AFL) strategy should be adopted as teaching-learning guide among neurodivergent learners especially learners with ASD in inclusive classroom. It further added that STEM or STEAM activities should be organised to involve neurodivergent learners, using the guidelines described in adaptive functional learning approach. Finally, this study contributes to the need for Adaptive Functional Learning (AFL) approach to be extend beyond mere strategy, to curriculum content development and assessment procedures. This consideration will enable academic flexibility for learners with impairment in inclusive schools.

Disclosure Statement

The authors declare that there is no conflict of interest regarding the publication of this article. No financial, personal, or professional relationships have influenced the research, analysis, or conclusions presented in this work.

Notes on Contributors

Bolanle Titilayo Segilola holds a B.Ed. in Chemistry (Lagos State University), M.Ed. in Test, Measurement & Evaluation (University of Lagos), and Ph.D. in Education (Measurement and Evaluation, Lead City University, Ibadan). With over two decades in education practices—from preschool to post-tertiary—she has served as teacher, lecturer, vice principal, and administrator, using the Nigerian and British curricula. She prepares students for Checkpoint and IGCSE exams, and she is a British Council SchoolNow Partner leader. She specialises in education test, measurement & evaluation, with her experience in a neurodivergent classroom, she developed the academic aptitude assessments tool AFLAT for neurodivergent learners (ASD, ADHD) in neuro-inclusive settings. The tool is used for academic aptitude diagnosis, tailored learning strategies and predictive latent metrics of the neurodivergent learners. Her expertise spans human capacity building, character education, special education (neurodivergent disorders), research, and curriculum development. She served as examiner for examination conducting institutes, co-authored study packs, and organised conferences, workshops, and career events. Currently Director of Education Services Research and Development at MOTEB Educational Services. She leads neuro-education projects in higher institutions. Enjoys team sports, writing, cooking, and movies. Open to collaborations advancing neuro-inclusivity.

segilola.bolanle@lcu.edu.ng

Philias Olatunde Yara was born in January 1954, he is a dedicated family man, married with four children. His academic journey includes NCE (Mathematics/Physics) from FCE Pankshin (1981), B.Ed. (Mathematics) from ABU Zaria (1984), M.Ed. (Mathematics) from University of Ibadan (1989), PGD (Computer) from OAU Ile-Ife (1995), and PhD (Mathematics Education) from UI Ibadan (2008). Joining Lead City University in 2013 as an Adjunct Lecturer and promoted to Senior Lecturer in 2014, he previously served as Principal Education Officer at the Federal Ministry of Education and Principal System Programmer at University of Ibadan's Computer Science Department. He completed a sabbatical at Kampala International University as Senior Lecturer and Director of Academic Affairs. An expert in Mathematics Education, Prof. Yara teaches undergraduate/postgraduate courses, supervises projects

(graduating 12 PhDs, 25+ Masters), and leads research on Math-phobia, attitudes, class size, and resources. His prolific output includes 28 authored books, 51 journal articles, and key administrative roles like HOD Science Education (2018–present).

yara.po@lcu.edu.ng

ORCID

Bolanle Titilayo Segilola https://orcid.org/0009-0009-6482-0925

Philias Olatunde Yara https://orcid.org/0009-0000-3810-9886

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Appendix A

Specified Achievement Test (SAT)

(Moderated Instructional Guide)

DATE OF ASSESSMENT: _____

TIME OF ASSESSMENT: _____

CHILD'S AGE: _____

GENDER: _____

LOCATION: _____

SUBJECT: Science: Environmental Pollution

FIRST NAME	
MIDDLE NAME	
SURNAME	

READ THESE INSTRUCTIONS FIRST:

Write your names in the spaces at the top of this page.
Write in clear HB pencil.

ANSWER ALL QUESTIONS.

Read all subject instructions before you start your trip.

Objective: Field Trip observation & reporting hazardous objects in the school Compound

Activity: Classroom instruction is received about hazardous objects

Presentation A:

1. Learners received guided tour on safety walk through around school compound.
2. Learners received guided instructions to determine objects that are not safe in the location they are found. They were also asked why such objects were not safe in the position found.
3. Learners were guide to write simple words/sentences.

Presentation B:

Integrating real-life activities with specified subjects using dynamic adjustment approach (where the instructions given and responses received are moderated for learners with ASD.

Spatial Viewing:

Look at these pictures, write the place where the object is found on the school compound.

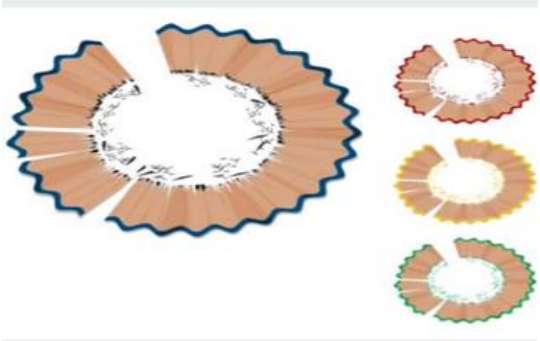
Picture I

Picture II

Picture III

Picture IV

Picture V



Picture VI

Picture VII

Picture VIII

Picture IX

Picture X

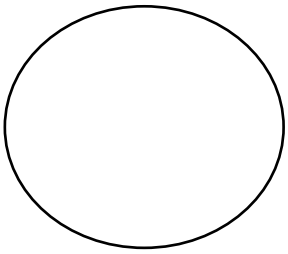
Report Sheet:

Object Number	The place that the object is found in my school location
I	
II	
III	
IV	
V	
VI	
VII	
VIII	
IX	
X	

Geometric Link:

Look at each object carefully again, write the name of the shape that looks closely like one of the objects in I – X

rectangle

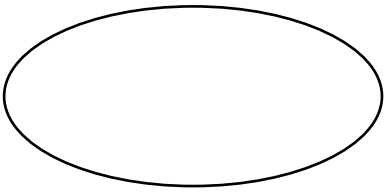


cycle

heart

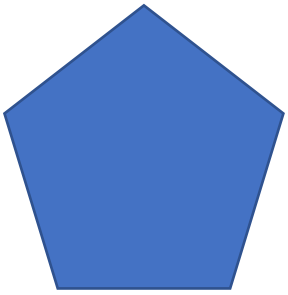
square

star

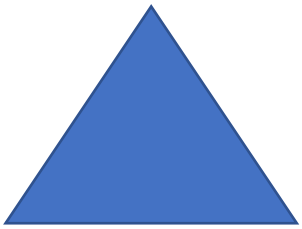


oval

cylinder



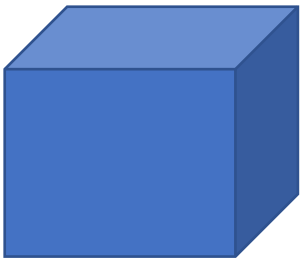
pentagon



triangle

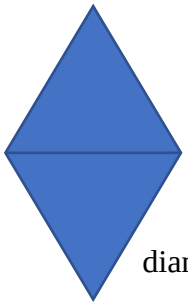
crescent

prism



cube

cuboid



diamond

Report Sheet:

Object Number	The name of the shape that looks closely like one of the objects
I	
II	
III	
IV	
V	
VI	
VII	
VIII	
IX	
X	

Logical Reasoning:

Use the information from the report of geometric link to answer this report:

Object Number	Shape	How many of this shape did you found in the picture
I		
II		
III		
IV		
V		
VI		
VII		
VIII		
IX		
X		

Verbal Reasoning:

Look at the pictures:

1.Say the name of each object
2.Say the name of the shape that they look like.

Report Sheet:

Object Number	Response to each name mentioned			
	Say it on 1st Prompt (4)	**Say it on 2nd Prompt (3)**	**Say it on 3rd Prompt (2)**	**Say it on 4th Prompt (1)**
I				
II				
III				
IV				
V				
VI				
VII				
VIII				
IX				
X				

Appendix B

Academic Aptitude Assessment Report (AAA-R)

Aim: To determine the Learner with ASD's aptitude upon exposure to independent learning procedures.

Purpose: To enable Independent Functionality-(IF) using Adaptive Functional Learning Strategies.

Date Taken: _____

Biodata: _____

Gender: _____

Location (Urban or Suburban): _____

Primary Language of Communication: _____

Period Taken: _____

S/N	TASK	SPECIFIC OBSERVATION	Scale					Total score
			5	4	3	2	1	
	Spatial Reasoning	Maintained steady eye-view at the object.						
		Focused on object for up to a minute.						
		Could merge picture with report.						
		Could spell the name of the location in words.						
		Led the instructor to the location instead.						
	Geometric Link	Identify the look-alike shape.						
		Write the name of the shape correctly.						
		Linked object with shape correctly.						
		Count the number of sides of shapes.						
		Could associate shapes with visible picture.						
	Logical Reasoning	Identify all the shapes that are linked with pictures.						
		List the number of shapes that are linked with picture.						
		Point at all shapes linked with one picture.						
		Associate more than one shape with picture.						
		Could count the number of sides of shapes.						
	Verbal Reasoning	Say the name of each object.						
		Say the name of the associated shapes.						
		Point at the objects only.						
		Point at the objects as linked with the shapes.						
		Use more words than one to describe object's shape.						

Key:

Satisfactory	**5**
Very Good	**4**
Good	**3**
Fair	**2**
Ungraded	**1**