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Correlationship Between Hardware Assistive Technology Integration and Academic Performance among Secondary School Science Students with Learning Disabilities in Adamawa State, Nigeria

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Abstract
This study investigated hardware assistive technology as a predictor of academic performance among secondary school science students with learning disabilities in Adamawa State, Nigeria. The study was guided by one objective, one research question, and one null hypothesis. A predictive correlational research design was employed, with a target population comprising 294 science students with learning disabilities from four special education centres in Adamawa State. A sample of 133 students was selected using purposive sampling technique based on identified learning disabilities, class level, and length of stay in school. Data were collected using a structured questionnaire titled Assistive Technology Questionnaire (ATQ) and an academic performance proforma. The instruments were validated by three experts and achieved a reliability coefficient of 0.83 using Cronbach Alpha. Descriptive statistics of mean and standard deviation were used to answer the research question, while linear regression analysis was employed to test the null hypothesis at a 0.05 level of significance. The findings revealed that the level of use of hardware assistive technology was high (Grand Mean = 3.93, S.D = 1.21). Regression analysis showed that hardware assistive technology significantly predicted academic performance, $F(1,131) = 44.935$, $p < 0.05$, accounting for 25.5% of the variance ($R^2 = 0.255$). The study concluded that hardware assistive technology is a significant positive predictor of academic performance among students with learning disabilities. It was recommended that schools continue to provide and upgrade hardware tools such as computers, Braille devices, and audio equipment to sustain and improve students' learning outcomes, and that the Ministry of Education should develop policies to ensure equitable distribution of hardware assistive technologies across all special education centres.

Keywords:

Introduction
Science education is widely acknowledged as a cornerstone of individual development and societal progress. It equips learners with essential knowledge, skills, and values necessary for meaningful participation in economic, social, and civic life. In recent decades, global educational reforms have increasingly focused on equity and access, recognizing education as a fundamental right that should be available to all learners regardless of ability or background (Maya, 2018). This shift reflects the understanding that sustainable national development depends on an educated population and that exclusion from education perpetuates inequality and poverty. The recognition of science education as a fundamental human right has led to international frameworks and national policies aimed at ensuring that no learner is left behind due to disability, socio-economic status, or other barriers. Building on this foundation, inclusive education has emerged as a central principle of modern educational systems. The United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) affirms inclusive education as a human right, emphasizing that students with disabilities must be provided equal learning opportunities alongside their peers (United Nations, 2018). Inclusive education promotes the integration of learners with diverse needs into mainstream classrooms while ensuring appropriate support services. In Nigeria, the National Policy on Education prioritizes inclusive education and aims to provide equitable learning environments for all students (Federal Republic of Nigeria, 2013). The policy recognizes that science students with special needs require specialized support to access the curriculum and achieve their full potential. Research indicates that, science students with learning disabilities benefit significantly from individualized instructional approaches and specialized learning resources (Higwayin, 2019;

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Bode, 2017; Wafka, 2019; Jokan, 2023). Learning disabilities are neurodevelopmental conditions that affect students' ability to acquire, process, or use information effectively, particularly in areas such as reading, writing, mathematics, and problem-solving. These conditions include dyslexia (difficulties in reading accuracy, fluency, and comprehension), dyscalculia (difficulties in understanding numbers, arithmetic, biology and mathematical reasoning), and attention disorders (conditions marked by persistent difficulties in sustaining attention, regulating impulses, and organizing tasks). Students with these conditions often struggle with traditional instructional methods because such approaches overload their working memory with irrelevant or inaccessible information. Despite the recognized importance of inclusive education and the efforts made globally and nationally, science students with disabilities continue to experience poor academic outcomes. Research indicates that science students with learning disabilities consistently exhibit lower academic performance than their peers. This disparity is often attributed to challenges in cognitive processing, memory, attention, language development, and executive functioning in scientific reasoning, which can negatively affect learning, classroom participation, and academic achievement across various science subjects (Adjei et al., 2024; Gilmour et al., 2019). The challenges faced by these students are often compounded by inadequate support systems, limited access to specialized resources, and insufficient teacher preparation in inclusive science education practices. This challenge of poor academic performance of science students with learning disabilities is particularly evident in Adamawa State, where inclusive practices are still developing (Daily Trust, 2024). Although educational outcomes for science students with disabilities have improved nationally, many learners in Adamawa State continue to struggle academically due to limited access to appropriate learning support (Mahmud, 2017) however, special education in Adamawa state, faces numerous challenges including limited educational infrastructure, inadequate funding for special education, and insufficient trained personnel to support science students with learning disabilities. Several interrelated factors contribute to this ongoing underachievement. Financial constraints limit schools' ability to acquire, maintain, and update assistive technologies (Abdi et al., 2022). Infrastructural challenges, including unreliable electricity and poor internet connectivity, further restrict effective implementation (Nyumba et al., 2023). Additionally, many teachers lack adequate training in the use of assistive technologies, leading to underutilization even where tools are available (Okwudishu & Ibe, 2022). Sociocultural barriers such as stigma toward disability and low awareness among parents and educators also discourage adoption (Mwangi & Gitonga, 2023). Weak policy implementation, insufficient funding, and dependence on imported technologies that are poorly aligned with local curricula further reduce accessibility and effectiveness (Yusuf & Umar, 2022; Nyumba et al., 2023). Hardware-based assistive devices including tablets, specialized keyboards, voice-recognition software, and electronic worksheets have been shown to significantly enhance both engagement and academic performance among science students with learning disabilities, particularly in science education areas such as reading, and science related subjects (Scherer, 2017; Davis, 2020; Dixon, 2014). These devices provide alternative input and output methods that reduce physical and cognitive barriers to learning, allowing students to access instructional materials in ways that align with their individual abilities. Scherer (2017) explains that hardware assistive tools facilitate more effective interaction with science educational content by simplifying navigation, supporting writing, computation and enabling students to demonstrate understanding without being constrained by traditional paper-and-pencil tasks. Hardware assistive technologies encompass a wide range of physical devices designed to support learning. These include alternate keyboards with larger keys or keyguards designed for science students with motor impairments, enabling more precise typing; Braille displays and reading for students with visual impairments; speech-generating devices that help science students with communication difficulties; talking calculators that support mathematical computation; digital audio players for accessing recorded science content; and specialized computer systems with accessibility of abstract features. Low-tech hardware tools such as pencil grips, slant boards, and raised-line paper also play an essential role in supporting students with fine scientific skills challenges. Dixon (2014) emphasizes that hardware-based supports such as these increase student engagement by offering flexible and interactive learning experiences, particularly for learners who face physical challenges in addition to learning difficulties. Davis (2020) further notes that hardware-based supports promote independence by enabling science students to complete assignments at their own pace and with reduced reliance on external assistance. The use of hardware assistive technologies has also been associated with increased student confidence, active participation, and sustained academic engagement. When science students are provided with appropriate hardware tools, they experience reduced frustration and anxiety, which in turn fosters a positive attitude toward learning and academic achievement. The theoretical framework for understanding the role of hardware assistive technology in academic performance is provided by Cognitive Load Theory

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(CLT), developed by John Sweller (1988). CLT explains how the human cognitive system processes, stores, and retrieves information during learning. Cognitive Load Theory identifies three types of cognitive load: intrinsic, extraneous, and germane load. Intrinsic load relates to the inherent difficulty of the learning material itself; extraneous load arises from poor instructional design or unnecessary distractions; and germane load refers to the mental effort dedicated to processing, organizing, and integrating new information into long-term memory. The goal of effective instruction is to reduce extraneous load, manage intrinsic load, and optimize germane load. This theoretical framework provides a robust foundation for investigating the predictive relationship between hardware assistive technology and academic performance of science students in Adamawa state Nigeria. Several studies have shown that hardware assistive technologies can enhance academic performance and self-confidence among science students with learning disabilities by providing alternative and individualized means of accessing science subjects, (Griffiths & Tsimpli, 2015; Abdi & Omari, 2022). These tools support reading, writing, and problem-solving, enabling students to engage more actively and independently with learning tasks. Despite this evidence, the extent to which hardware assistive technologies are used in Adamawa State schools and their actual impact on students' academic performance remain unclear.

Statement of the problem

Given the persistent gap between the expected academic outcomes for inclusive education and the current reality of poor performance among science students with learning disabilities, several factors appear to contribute to this situation. Many science students with learning disabilities in Adamawa State have limited access to hardware assistive technologies, including physical devices, specialized equipment, and related support services. As a result, learners often struggle to cope with conventional instructional methods. Koh and Lee (2019) report that students who lack access to tools such as alternative keyboards, audio recorders, Braille displays, and other hardware resources frequently fall behind their peers, leading to academic stagnation. In addition, inadequate teacher training and inconsistent classroom use of available technologies further constrain effective learning support in Adamawa State.

Purpose of the study

This study seeks to examine

1. Whether the use of hardware assistive technology among science students with learning disabilities significantly predicts the academic performance of secondary schools in Adamawa State.

Research questions

The following research question was raised to guide the study:

1. What is the level of the use of hardware assistive technology of science students with learning disabilities in Adamawa State?

Null Hypothesis:

The following null hypothesis was formulated and tested at a 0.05 level of significance:

Ho_1: There is no significant prediction of hardware assistive technology on the academic performance of secondary schools science students with learning disabilities in Adamawa State.

Research Methodology

Correlational research design was used, enabled the researcher to make informed inferences about the relationships and predictive strength among the variables, thereby contributing to evidence-based practices in inclusive education. Area of the Study Adamawa State which is located in the North-Eastern part of Nigeria, the population of this study consisted of all 294 science students with learning disabilities in the four special education centers in Adamawa State. These include Special Education Center Mubi, Special Education Center Jada, Remi Education Foundation, and St. Monica Lutheran Academic Yola. Sample and Sampling Technique: From the population, a sample size of 133 science students with learning disabilities was used from Senior Secondary School 1 (SS1) to Senior Secondary School 3 (SS3) levels across four selected inclusive secondary schools in Adamawa State. The selection of participants was carried out using the purposive sampling technique, a non-probability method employed to ensure that only individuals who meet specific criteria relevant to the study were included. The criteria for inclusion were: (i) students formally identified or diagnosed with learning disabilities by qualified educational or medical personnel; (ii) students that offering science subjects currently enrolled in SS1 to SS3; and (iii) students who had been in their current school for at least one academic session to ensure sufficient exposure to any available assistive technology interventions. Instrument for data collection, two instruments were used for data

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collection in this study: a structured questionnaire and a student academic performance profoma. The questionnaire, titled Assistive Technology Questionnaire (ATQ). The ATQ consisted of sections including demographic information and a section on the use of hardware assistive technology with six items. Each item was rated on a five-point modified Likert scale, which measured the level of usage or exposure to assistive technology. The response options included: Very High Level (VHL = 5), High Level (HL = 4), Moderate Level (ML = 3), Low Level (LL = 2), and Very Low Level (VLL = 1). In addition to the questionnaire, a student academic performance profoma was used to obtain objective data on academic performance. This record included students' results in academic science subjects such as English Language, Mathematics, biology, chemistry, physics, obtained from the official school records of the third term. The data for this study were collected through the Assistive Technology Questionnaire (ATQ). The data were analyzed using descriptive and inferential statistics with the aid of SPSS version 25. Descriptive statistics such as mean and standard deviation were used to answer the research question. The decision rule for interpreting the mean scores followed the real limits: 4.50–5.00 = Very High Level (VHL), 3.50–4.49 = High Level (HL), 2.50–3.49 = Moderate Level (ML), 1.50–2.49 = Low Level (LL) and 0.50–1.49 = Very Low Level (VLL). Inferential statistics were used to test the hypothesis. Regression analysis was employed to determine the predictive strength of hardware assistive technology on the academic performance of science students with learning disabilities. This method was considered appropriate given the study's predictive correlational research design, which sought to examine the extent to which the independent variable (hardware assistive technology) predicted the dependent variable (academic performance). The regression analysis tested the formulated null hypothesis at a 0.05 level of significance to determine whether a statistically significant predictive relationship existed between hardware assistive technology use and academic performance.

Presentation of Results

Data Analysis and Presentation of Results

One research question was answered using descriptive statistics of mean and standard deviation. One null hypothesis was formulated and tested at a 0.05 level of significance using linear regression analysis.

Research Question 1: What is the level of the use of hardware assistive technology by science students with learning disabilities in Adamawa State?

Table 1: Mean and Standard Deviation of Level of the Use of Hardware Assistive Technology by Science Students with Learning Disabilities in Adamawa State

S/N	Item (n = 133)	Mean	S.D	Remark
1	Use of Braille keyboards enhances reading and writing performance	3.77	1.31	HL
2	Use of keyboard and mouse support improve computer driven learning	4.02	1.21	HL
3	Manipulation with computer navigates students with learning	3.85	1.26	HL
4	Students have access to libraries that improve learning	4.05	1.17	HL
5	Students with learning disabilities use talking Calculators	3.90	1.19	HL
6	Digital audio players are used for revision purposes during learning	3.99	1.15	HL
	Grand Mean	**3.93**	**1.21**	**HL**

The results in Table 1 indicate that the level of use of hardware assistive technology among science students with learning disabilities in Adamawa State is high, with a grand mean of 3.93 and a standard deviation of 1.21. The relatively moderate standard deviation suggests some variability in responses, but overall consistency in the perceived high usage. All items were rated high level (HL), with access to libraries (Mean = 4.05, S.D = 1.17) and use of keyboard and mouse support (Mean = 4.02, S.D = 1.21) ranking highest. Other tools such as Braille keyboards (Mean = 3.77, S.D = 1.31), talking calculators (Mean = 3.90, S.D = 1.19), and digital audio players (Mean = 3.99, S.D = 1.15).This implies that hardware assistive technologies are widely and reliably utilized.

H_{01}: There is no significant prediction of hardware assistive technology on the academic performance of secondary school science students with learning disabilities in Adamawa State.

Table 2: Summary of Regression Analysis Results for the Prediction of Hardware Assistive Technology on the Academic Performance of Secondary School Science Students with Learning Disabilities in Adamawa State

Model	Sum of Squares	df	Mean Square	F	Sig.	
1	Regression	4290.029	1	4290.029	44.935	.000
	Residual	12506.783	131	95.472		
	Total	16796.812	132			

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a. Dependent Variable: performance
b. Predictors: (Constant), Use of Hardware-Assistive Technology

The result in Table 2 revealed that hardware assistive technology significantly predicts the academic performance of secondary school science students with learning disabilities in Adamawa State, as indicated by $F(1,131) = 44.935$, $p < 0.05$. This implies that the regression model is statistically significant and that hardware assistive technology has a significant influence on science students' academic performance.

Discussion of Findings

The finding of the study revealed that hardware assistive technology is highly used among science students with learning disabilities in Adamawa State (Grand Mean = 3.93, S.D = 1.21) and significantly predicts their academic performance, $F(1,131) = 44.935$, $p < 0.05$. The null hypothesis was rejected, confirming that hardware assistive technology is a significant predictor of academic performance. This finding suggests that students in the study area have considerable access to and are actively utilizing hardware-based assistive tools such as keyboards, audio devices, Braille equipment, and other physical learning aids. It further implies that these tools are not merely available but are functionally integrated into the learning process in a way that enhances students' ability to engage with instructional content. The high level of usage observed for various hardware tools, particularly access to libraries (Mean = 4.05) and keyboard/mouse support (Mean = 4.02), suggests that schools in Adamawa State have made some investment in providing basic hardware resources. However, the moderate standard deviation (1.21) indicates that while usage is generally high, there is still some variation among science students, which may reflect differences in school resources, individual access, or personal preferences.

This finding agrees with the finding of Miller and Williams (2021), who reported that hardware-based assistive technologies significantly improved academic outcomes among students with learning disabilities. In their study conducted in Victoria, Australia, they found that hardware devices such as voice recognition software and reading tools led to significant academic improvements, with post-test scores averaging 74% compared to pre-test scores of 60%. The consistency of findings across different geographical contexts suggests that the benefits of hardware assistive technology are not culturally or contextually bound but are universally applicable. The finding is also in tandem with that of Miller and Stone (2019), who found that e-readers enhanced reading comprehension, thereby improving performance among students with learning disabilities in California. Their study reported that students using e-readers achieved mean post-test scores of 72% compared to pre-test scores of 55%, a significant improvement that supports the present study's findings regarding the effectiveness of reading-related hardware tools. In a similar vein, the finding corroborated that of Baker and Hall (2019), who observed that assistive tools such as graphic organizers improved students' writing performance in Canada. Their study found that students using graphic organizers achieved post-test scores of 74% compared to pre-test scores of 55%, reinforcing the idea that hardware tools supporting writing tasks can significantly enhance academic outcomes. Furthermore, the finding is consistent with the findings of Harris and Evans (2020) and Mitchell and Davis (2021), who established that interactive tools and augmented reality technologies significantly enhanced students' academic achievement. Harris and Evans reported post-test scores of 75% compared to pre-test scores of 58%, while Mitchell and Davis found post-test scores of 72% compared to pre-test scores of 50%, both demonstrating the positive impact of hardware-based interactive learning tools. This finding aligns with previous research emphasizing the importance of resource-rich learning environments for students with disabilities (Parette & Scherer, 2015; Kemp & Rogers, 2018). The high usage of keyboard and mouse support (Mean = 4.02) indicates that computer-based learning is prevalent in the study area, and adaptive input devices are being utilized effectively. This is encouraging, as computer-based learning offers multiple advantages for students with learning disabilities, including the ability to work at their own pace, access digital content, and utilize various software applications that support learning. However, the slight variability in the use of these different tools (standard deviations ranging from 1.15 to 1.31) suggests that not all students have equal access to all types of hardware. This may be due to cost constraints, limited availability, or lack of awareness among teachers and students about the available tools. This finding highlights the need for more equitable distribution of hardware assistive technologies across all special education centres and for ongoing awareness campaigns to ensure that students and teachers are aware of and can effectively utilize the available resources. The moderate level of academic performance observed among students with learning disabilities in this study (Mean = 62.25, S.D = 11.280) indicates that while progress is being made, there is still significant room for improvement. The noticeable variation in performance suggests that some students are benefiting

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more from available supports than others. This underscores the need for more targeted and individualized interventions that take into account each student's specific needs and learning profile.

Conclusion

This study concludes that hardware assistive technology is a critical determinant of academic performance among secondary school students with learning disabilities in Adamawa State. The hardware technological support and enhancing learning outcomes. The high level of usage of hardware assistive technology among students with learning disabilities in the state indicates that there is awareness of the importance of these tools, and efforts are being made to provide them.

The findings underscore that when students are provided with appropriate hardware tools, The predictive strength of hardware assistive technology on academic performance (accounting for 25.5% of the variance) confirms that these tools are not merely supplementary but are meaningful contributors to student achievement. Furthermore, the finding that all six hardware items were rated at a high level suggests that there is a comprehensive provision of hardware supports in the study area. This is encouraging and indicates a commitment to inclusive education principles. However, the moderate level of academic performance observed (Mean = 62.25) suggests that while hardware assistive technologies are impactful.

Recommendations

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

1. Provision and Upgrading: Schools should provide and regularly upgrade hardware assistive technologies to improve students' academic performance.
2. Equitable Distribution: The Ministry of Education should ensure equal access to hardware assistive technologies across all special education centres.
3. Teacher Training: Teachers should be trained to effectively use and integrate hardware assistive technologies into classroom instruction.

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