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Enhancing Learning Independence through Assistive Technology: A Controlled Experimental Study in Nigerian Special Education

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ABSTRACT

This research examined the effectiveness of assistive technology in special education, particularly in enhancing learning independence among students with disabilities. It was a controlled experimental research with two groups - the control and the experimental groups. This study involved 100 participants, with 50 randomly assigned to the experimental group using assistive technology and 50 to the control group, which received instruction in a traditional classroom setting. Descriptive statistics, specifically the mean and independent T-Test were employed to address research questions and study hypotheses. The findings of this study showed that participants in the experimental group had higher improvement scores in learning independence and also reported higher motivational and engagement scores. The findings show that using assistive technology improves learning independence among students with disabilities The results of this study contribute significantly to other related studies that focus on integrating technologies in special education within the context of Nigeria.

Keywords: assistive technology; learning independence; students with disabilities, special education, learning outcomes

1. Introduction

The significance of education in societal growth and development cannot be overstated. It serves as the foundation upon which a nation's progress is built, influencing individuals' perspectives, attitudes, and behaviors through their interactions with their surroundings (Offor & Offiah, 2021). By acquiring knowledge, skills, and potential, individuals are empowered to reach their full potential and contribute to the growth of their communities. Within the educational system, special education plays a vital role in catering to the unique needs of students with disabilities. This specialized field focuses on providing tailored instruction, adapted resources, and accessible environments to promote independence and success among individuals with special needs (Aldawood et al., 2024). Students with physical disabilities, such as physical impairments, paralysis, or visual impairments, require individualized support and accommodations to achieve academic success. These physical challenges can be congenital or acquired due to various factors (Al-Shaharani, 2022). Effective instruction for students with physical disabilities necessitates careful consideration of their maturity, background experience, and individual needs. The strategic integration of assistive technologies is also essential in special education centers, particularly in contexts like Nigeria (Alzaharani, 2023). By offering personalized support and accommodations, educators can empower students with special needs to overcome challenges and attain academic excellence.

The integration of assistive technology (AT) is crucial in supporting individuals with disabilities or elderly populations, promoting independence, inclusion, and an enhanced quality of life. Various AT devices, including Braille machines, wheelchairs, electronic communication tools, pencil grips, and computers, significantly impact the learning experiences and outcomes of students with disabilities. According to research, the utilization of AT enables students to develop greater autonomy and control over their learning, thereby enhancing their confidence and sense of competence (Chary & Perumal, 2022). Furthermore, AT facilitates students' access to information, participation in learning activities, and effective communication with others (Alsolami, 2022). Despite the benefits, the incorporation of AT into special education presents challenges, such as addressing the complex needs of students, ensuring the availability of high-quality digital resources, and providing teachers with effective training (Coryton, 2022). In the Nigerian context, students with disabilities encounter substantial obstacles in accessing quality education, highlighting the necessity for innovative solutions such as AT (Azogu, 2020). This investigation seeks to examine the impact of AT on learning independence among students with disabilities, with a focus on exploring the benefits and challenges to inform strategies for promoting inclusive education and supporting diverse needs. The strategic deployment of AT and related strategies can enable educators to create learning environments that are more inclusive and supportive, thereby empowering students with disabilities to achieve their full potential.

Statement of the Problem

The integration of assistive technology in Nigerian special education is hindered by a critical issue: a lack of comprehensive understanding regarding its impact on learning outcomes and teaching practices. This knowledge gap is compounded by the scarcity of empirical research, which limits the development of informed policies and practices. Furthermore, the inconsistent adoption of assistive technology across educational institutions exacerbates existing disparities in access to quality education for students with disabilities. Several factors contribute to this problem, including limited resources, inadequate technical support, and poor infrastructure, all of which hinder the effective utilization of assistive technology. Moreover, educators often lack the necessary training and confidence to integrate assistive technology into their teaching practices, which can compromise the quality of instruction provided to students with disabilities. The absence of ongoing technical support and professional development opportunities further affects the quality of education for these students. To ensure the effective integration of assistive technology into special education and promote inclusive education for students with diverse needs, it is essential to address these gaps. By doing so, educators can provide high-quality instruction that meets the unique needs of students with disabilities, ultimately enhancing their learning outcomes and overall educational experience.

Research Aim

This study aims to evaluate the role of assistive technology in enhancing learning independence among students with disabilities, compared to traditional instructional methods. This study provides valuable insights into the design and implementation of effective assistive technology-based interventions that support the learning needs of students with disabilities in Nigeria.

Research Questions

The following research questions guided the study:

1. To what extent does the utilization of assistive technology enhance learning independence among students with disabilities compared to traditional instructional methods?

2. What are the challenges and limitations of integrating assistive technology into special education settings to support learning independence among students with disabilities?

Hypothesis

H1: Students with disabilities who use assistive technology will demonstrate significantly higher levels of learning independence compared to those who receive traditional instruction without assistive technology.

Significance

The findings of this study will have far-reaching implications for various stakeholders, including students with disabilities, educators, policymakers, and researchers. By exploring the effective use of assistive technology, this research will empower students with disabilities to take ownership of their learning, leading to improved academic experiences and outcomes. Additionally, the study's insights will enable educators to refine their teaching practices, creating a more inclusive and supportive learning environment that caters to diverse needs.

The study's results will also have practical applications, informing the development of targeted training programs for educators. These programs will equip educators with the skills and confidence needed to effectively integrate assistive technology into their teaching practices. Furthermore, policymakers will benefit from the study's evidence-based insights, which will inform the development of policies and initiatives that promote the adoption and utilization of assistive technology in special education settings.

The study's contributions to the existing body of knowledge will also benefit researchers in the field of special education and assistive technology. By providing new perspectives and insights on the effective use of technology to enhance learning independence among students with disabilities, this research will advance the field and inform future studies. Ultimately, this research has the potential to drive positive change in the lives of students with disabilities, educators, and the broader education community, promoting a more inclusive and supportive learning environment for all..

2. Literature Review

The integration of assistive technology (AT) in special education has revolutionized the learning experience for students with disabilities. According to Esther and Kerich (2025), AT encompasses a wide range of devices and services, including basic tools like text-to-speech software and sophisticated technologies such as speech-generating devices. These technologies have the potential to significantly enhance the learning experiences and outcomes of students with disabilities, enabling them to access information, participate in learning activities, and communicate more effectively. Research has consistently shown that AT can promote learning independence among students with disabilities. Frei-Landau et al. (2022) note that AT provides students with greater autonomy and control over their learning, thereby enhancing their sense of competence and confidence. By leveraging AT, educators can create more inclusive and supportive learning environments that cater to the diverse needs and abilities of students with disabilities. The

application of AT in special education is widely recognized as a valuable tool for promoting learning independence. Gomes et al. (2024) highlight that AT devices and services can help students with disabilities overcome significant barriers to learning, such as difficulties with writing, reading, and communication. For example, text-to-speech software can assist students with reading difficulties in accessing written information (Kamran & Bano, 2024). Similarly, speech-generating devices can enable students with communication challenges to express themselves more effectively. By integrating these technologies into special education, educators can create services that are more accessible and engaging for students with disabilities.

The integration of assistive technology (AT) in special education has revolutionized the learning experience for students with disabilities. By providing students with greater autonomy and control over their learning, AT can enhance their sense of competence and confidence (Ross, 2022). Research has consistently demonstrated that AT can significantly enhance the learning experiences and outcomes of students with disabilities, enabling them to participate more fully in educational activities and achieve their academic objectives (Macheque et al., 2024). The benefits of AT are multifaceted. AT can boost academic engagement, motivation, and self-esteem among students with disabilities (Oyedokun et al., 2024). Additionally, AT can promote academic achievement by enhancing learning outcomes, improving academic performance, and increasing student motivation and engagement (Pappadà et al., 2021). To successfully integrate AT into special education, educators must receive comprehensive training in the effective use of AT, and students must have access to high-quality digital resources and technical support. By addressing these challenges, educators can create more inclusive and supportive learning environments that cater to the diverse needs and abilities of students with disabilities. The effective use of AT has the potential to foster learning independence among students with disabilities. By providing students with the tools and resources they need to succeed, educators can empower students to take control of their learning and achieve their full potential. To realize this potential, educators must carefully consider the complex needs and abilities of students with disabilities and develop high-quality digital resources and effective teacher training programs (Şahin, et al.). By doing so, educators can create more inclusive and supportive learning environments that cater to the diverse needs and abilities of students with disabilities.

Theoretical Framework

Under the theoretical framework, two theories were reviewed and related to the study more particularly, Technology Acceptance Model (TAM) and Self Determination Theory

This study is grounded in two key theoretical frameworks: the Technology Acceptance Model (TAM) and Self-Determination Theory (SDT). The Technology Acceptance Model, developed by Fred Davis in 1989, provides a valuable framework for understanding how individuals adopt and utilize technologies. According to TAM, two primary factors influence people's decisions to use technology: perceived ease of use and perceived usefulness. Perceived usefulness refers to the extent to which an individual believes that technology will enhance their performance, while perceived ease of use implies the degree to which an individual believes that using technology will be effortless.

The relevance of TAM to this study lies in its ability to help researchers understand how students with disabilities perceive the ease of use and usefulness of assistive technology in promoting their learning independence. By applying TAM, educators can identify the factors that influence the adoption and use of assistive technology among students with disabilities and develop strategies to promote its integration and acceptance.

Self-Determination Theory, developed by Deci and Ryan (2000), provides another relevant framework for understanding the role of assistive technology in enhancing learning independence among students with disabilities. SDT posits that human behavior is motivated by three innate psychological needs: autonomy, competence, and relatedness. Assistive technology can support these needs by providing students with disabilities with greater autonomy and control over their learning, enhancing their sense of competence through improved performance, and facilitating relatedness through social interactions.

The combination of TAM and SDT offers a comprehensive understanding of how assistive technology can be designed and implemented to support the learning needs of students with disabilities. By developing autonomy-supportive technology, educators can enhance user motivation and engagement, ultimately promoting more effective learning experiences for students with disabilities.

Gap Identification

A thorough examination of existing literature highlights a significant void in research regarding the efficacy of assistive technology in fostering learning independence among students with disabilities in Nigeria. Despite the increasing amount of research on the benefits of assistive technology, there is a notable lack of experimental studies that have explored the impact of assistive technology on learning outcomes for students with disabilities within the Nigerian context. This gap in research presents a considerable challenge for educators and policymakers, as it hinders their ability to make informed decisions about the adoption and implementation of assistive technology in special education settings. The current study seeks to address this knowledge gap by investigating the effectiveness of assistive technology in enhancing learning independence among students with disabilities in Nigeria. By doing so, this research aims to provide valuable insights into the design and implementation of effective assistive technology-based interventions.

Methodology

Research Approach/Paradigm/Method

This study employed a quantitative research approach to investigate the effectiveness of assistive technology in enhancing learning independence among students with disabilities. The research paradigm underlying this study is positivist, which emphasizes the use of scientific methods to test hypotheses and establish cause-and-effect relationships between variables. By employing a quantitative approach, this study aimed to provide objective and generalizable findings that can inform educational practice and policy. The quantitative research approach allowed for the collection and analysis of numerical data, which enabled the researcher to identify patterns and trends in the data. This approach also enabled the researcher to test hypotheses and establish cause-and-effect relationships between variables, providing a deeper understanding of the effectiveness of assistive technology in enhancing learning independence among students with disabilities.

Research Design

The study utilized a controlled experimental design, featuring an experimental group and a control group. The control group received traditional instruction, while the experimental group used assistive technology to support their learning. This design allowed for the comparison of outcomes between the two groups, enabling the researcher to determine the effectiveness of the assistive technology intervention.. By controlling for extraneous variables, this design enabled the researcher to isolate the effect of the assistive technology intervention on learning independence among students with disabilities.

Parameters Employed in Pretest and Post-test

The pretest and post-test assessments evaluated participants' learning independence using a validated instrument with high-reliability coefficients. The assessment parameters included learning independence scale, task completion rate, and assistance required. These parameters provided a comprehensive understanding of participants' ability to complete tasks independently and their level of learning independence. The learning independence scale measured participants' ability to complete tasks without assistance, while the task completion rate evaluated the percentage of tasks completed by participants. The assistance required parameter assessed the level of assistance required by participants to complete tasks, providing insight into their level of learning independence.

Participants

The study involved 100 students with learning disabilities, aged 18-22 years, with varying levels of learning independence. Participants were randomly assigned to either the experimental or control group using a stratified randomization procedure based on their pre-existing learning independence levels. This ensured that the groups were equivalent in terms of participants' characteristics.

Sampling Technique

The study employed a stratified random sampling technique to select 100 participants. This technique was chosen because it allows for the representation of different subgroups within the population, ensuring that the sample is representative of the population's diversity. The stratified random sampling technique involved dividing the population into subgroups based on their level of learning independence and randomly selecting participants from each subgroup. This ensured that the sample was representative of the population's diversity and allowed for more accurate and generalizable findings.

Control of External Factors

The study was conducted in a controlled environment, and both groups received instruction from the same teacher. The study was designed to minimize disruptions and ensure that participants in both groups received consistent instruction and support throughout the study period. By controlling for external factors, this study ensured that the results were due to the assistive technology intervention and not to other extraneous variables. This increased the internal validity of the study and provided more accurate and reliable findings.

Validity and Reliability of Instruments

The learning independence assessments used in this research were validated through face validity, content validity, and reliability testing. The instrument demonstrated high-reliability coefficients, with a Cronbach alpha of 0.85 for the pre-test and 0.88 for the post-test. The face validity of the instrument was established through expert review and feedback, ensuring that the instrument was relevant and clear. The content validity was ensured by covering all aspects of learning independence, providing a comprehensive understanding of participants' ability to complete tasks independently. The reliability of the instrument was demonstrated through high-reliability coefficients, indicating that the instrument was consistent and accurate in measuring learning independence. The assistive technology software used in this study was also developed and certified by experts in the field, ensuring its validity and effectiveness.

Ethics Committee Approval

This study was approved by the Human Research Ethics Committee of Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. Approval was obtained before the commencement of the study, and all participants provided informed consent before participating. The ethics committee approval ensured that the study was conducted in accordance with ethical principles and guidelines, protecting the rights and welfare of participants. The informed consent process ensured that participants were aware of the study's purpose, risks, and benefits, and provided their consent voluntarily.

Research Context

The study was conducted in a special education school in Awka South Local Government Area, Anambra State, Nigeria. The school provides education and support services to students with learning disabilities, and the researcher selected this particular school due to its reputation

Procedure

The study employed an 8-week intervention program. During this period, the experimental group used the assistive technology tool for 30 minutes, three times a week, to support their learning independence. The control group attended traditional classes in line with a lesson plan and standard curriculum. Pre-tests and post-tests were used to assess participants' learning independence, and surveys were administered to gather feedback and perceptions on the effectiveness of assistive technology in enhancing learning independence.

Data Analysis

Statistical methods were used to compare the learning independence of participants in the control and experimental groups. An independent t-test was used to compare the mean scores of the experimental and control groups on the pre- and post-test, enabling the researcher to determine if the assistive technology tool had a significant effect on learning independence over time. Descriptive and inferential statistics were also used to analyze survey data, providing insights into participants' attitudes and perceptions regarding the effectiveness of assistive technology in enhancing learning independence.

4. Results

Table 1. Comparative Analysis of Pre-test and Post-test Scores in Learning Independence

Group	No.	Pre-test Mean	SD	Post-test Mean	SD	T	P	Remark
Experimental	50	55.23	8.12	75.56	7.56	3.45	.001	Significant
Control	50	54.56	8.45	65.45	8.92			

Source: author's development

The results of the study indicate that both the experimental and control groups showed improvement in learning independence from pre-test to post-test. Notably, the experimental group demonstrated a greater improvement in learning independence compared to the control group. Statistical analysis using an independent t-test revealed a significant difference between the two groups ($t = 3.45$, $p < .001$), suggesting that the assistive technology intervention had a positive effect on enhancing learning independence among participants. This finding highlights the potential benefits of incorporating assistive technology in educational settings to support students with learning disabilities.

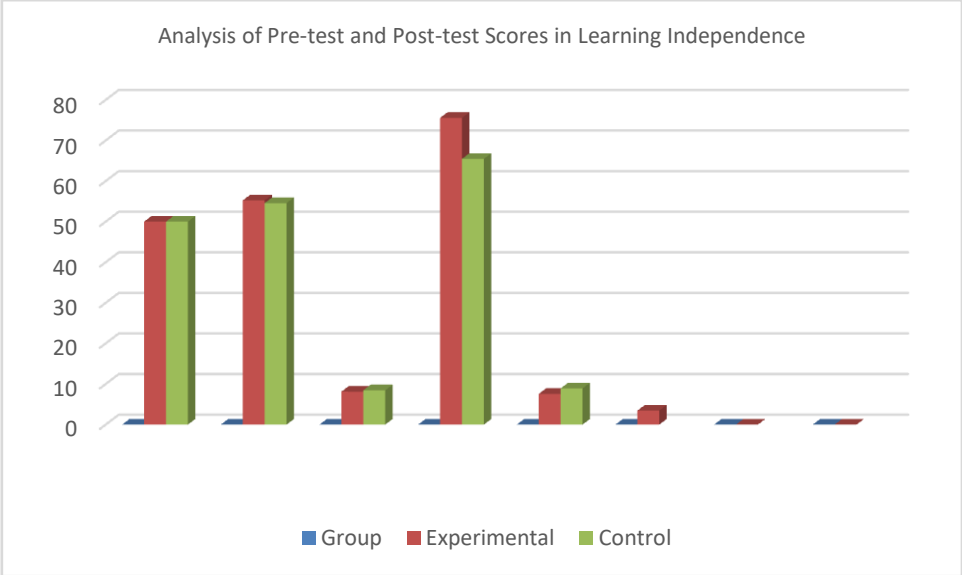

Fig 1: Pre-test and Post-test Scores in Learning Independence

Table 2. Test of Hypothesis 1

Hypothesis	No.	T	df	P	Alpha level	Remark
H1	100	3.45	98	.001	0.05	Supported

Source: author's development

The independent t-test analysis showed a statistically significant difference between the experimental and control groups, with the experimental group exhibiting higher levels of learning independence ($t = 3.45$, $p < .001$). This finding supports the hypothesis that students with disabilities who utilize assistive technology tend to demonstrate greater learning independence compared to those who receive traditional instruction without the aid of assistive technology. The results suggest that the integration of assistive technology can have a positive impact on promoting learning independence among students with disabilities.

Table 3. Challenges and Limitations Associated with Assistive Technology

Theme	Frequency	Percentage
Technical Issues	40	40
Limited feedback	30	30
Lack of human interaction	24	24
Insufficient training	20	20

The data presented in Table 3 highlights several challenges that impact the integration and effectiveness of assistive technology in promoting learning independence. Notably, technical issues emerge as the most significant problem, followed by limited feedback, lack of human interaction, and insufficient training. These findings underscore the need to address these challenges to optimize the potential of assistive technology and enhance the learning experience for students with disabilities.

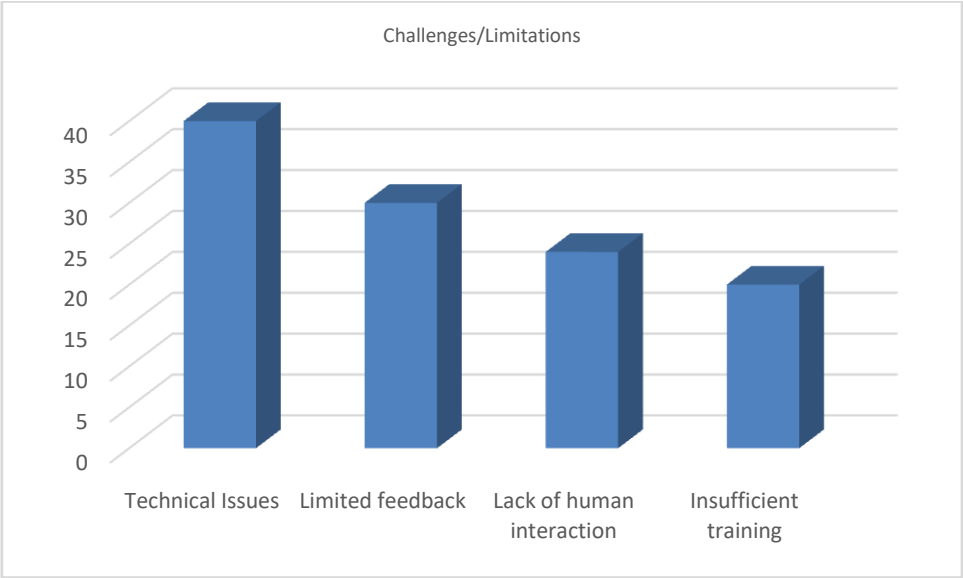

Fig 2: Problems affecting the integration and effectiveness of assistive technology

The findings of this study support the use of assistive technology to enhance learning independence among students with disabilities. The results show that students who used assistive technology demonstrated significantly higher levels of learning independence compared to those who received traditional instruction without assistive technology. However, the study also highlights the challenges and limitations associated with integrating assistive technology into special education settings.

5. Discussion

The findings of this study highlight the transformative potential of assistive technology in promoting learning independence among students with disabilities. The superior performance of the experimental group compared to the control group, which received traditional instruction, underscores the benefits of assistive technology in fostering self-directed learning. The interactive and personalized nature of assistive technology allows students to

learn at their own pace, receive instant feedback, and develop a sense of autonomy and control over their learning process. These findings are consistent with previous research, such as Viner et al. (2020) and Zabala (2020), which emphasizes the efficacy of assistive technology in enhancing learning outcomes for students with disabilities. However, this study also reveals several challenges associated with integrating assistive technology into special education settings, including technical issues, limited feedback, lack of human interaction, and inadequate training and support. To overcome these challenges, educators, policymakers, and technologists must collaborate to ensure that students with disabilities have access to the necessary support and resources. Meticulous planning, implementation, and evaluation are essential for the successful integration of assistive technology into special education settings. This study has several limitations. The relatively small sample size of 100 participants may not be representative of the entire population of students with disabilities. Additionally, the short intervention period may have limited the thorough evaluation of the effectiveness of assistive technology compared to traditional teaching methods. Furthermore, inadequate access to technology, such as internet devices and connectivity, may have impacted the study's results. The study's findings have significant implications for practice, policy, and future research. For educators, the study highlights the need for targeted training programs that focus on practical applications and pedagogical integration of assistive technology. For policymakers, investing in digital infrastructure and teacher training programs is crucial to supporting the effective use of assistive technology in special education settings. For curriculum designers, the study suggests that assistive technology can be used to enhance existing curricula and learning outcomes. By addressing the challenges associated with assistive technology and leveraging its potential, educators and policymakers can work together to create more inclusive and supportive learning environments that cater to the diverse needs of students with disabilities.

6. Conclusions

This study investigated the impact of assistive technology on promoting learning autonomy among students with disabilities. The results showed that students who utilized assistive technology demonstrated higher levels of learning autonomy compared to those who received traditional instruction. This finding suggests that integrating assistive technology into conventional teaching methods can create a more effective and personalized learning environment for students with disabilities. The study's findings have significant implications for special education in Nigeria. Successful integration of assistive technology requires educators and policymakers to develop targeted professional development programs that focus on practical applications and pedagogical integration. Moreover, ensuring equitable access to digital resources is essential to bridging the gap in digital literacy and infrastructure. By incorporating assistive technology into existing curricula and learning outcomes, educators can maximize its effectiveness. This study provides a foundation for future research and development in the field of special education in Nigeria. Future studies can build upon this research by examining the long-term effects of assistive technology on learning outcomes and exploring optimal ways to integrate these tools into special education programs. By continuing to explore the potential of assistive technology, educators and policymakers can collaborate to create a more inclusive and effective education system that supports the diverse needs of all students.

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