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Integration Of ICT Tools In Teaching Basic Science In Secondary Schools In Nigeria

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Abstract:
This research examines the integration (availability and utilization) of Information and Communication Technology tools in Nigerian secondary schools in with particular interest on the disparities between public/private school and rural/urban school. The use of ICT tools in schools are recognize for improving learning outcomes. However, the level of availability as well as level of utilization into the Basic science teaching has become a pressing challenge. The survey questionnaires were administered to 112 junior secondary three (3) students from two schools (public and private) in two locations (rural and urban). A reliability coefficient of 0.76 was determined through the utilization of the Pearson product moment correlation on a sample of thirty students not included in the study. The research questions were address through percentage analysis, while the significant differences were evaluated using the chi-square test. Key findings revealed that ICT tools are inadequate regardless of school type or location and teachers lack training in ICT integration is a key obstacle. The study suggests that the Nigerian government should ensure better provisioning of ICT resources and provide comprehensive teacher training. It also calls for private school owners to take responsibility for teacher professional development.

Key Word: *Basic science; ICT tools; ICT integration; instructional sessions; secondary school students.*

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I. Introduction

The integration (availability and utilization) of Information and Communication Technology (ICT) into all sectors and particularly in the educational environment in teaching and learning has emerged as a transformation tool for enriching teaching and learning outcomes on a globally. ICT adoption in education has been shown to foster greater student engagement, improve knowledge retention, and modernize teaching practices (Bottge, 2009; Abubakar, 2016). These ICT advancements are particularly needed in developing countries where educational infrastructure and resources are often limited. In Nigeria for instance, despite government efforts to promote ICT integration in the Education sector, there are still significant barriers that includes inadequate technological infrastructure, limited access to ICT resources, and insufficient professional development for teachers (Federal Ministry of Education, 2018). Studies have highlighted that while ICT tools such as videos, interactive applications, and digital resources are shown to enhance academic success (Bottge, 2009; Abubakar, 2016) the full potential of these ICT tools remains untapped, especially in the teaching of Basic Science subject. This is especially evident in the poor performances of students at the junior secondary certificate examinations at the end of the 9-year basic education programme that runs from Primary one to junior secondary three (Federal Ministry of Education, 2018). These factors are also central to the broader adoption and effective use of ICT in education in Nigeria, particularly in rural and public schools (National Information Technology Development Agency, 2017). Previous research also suggests that while urban and private schools have better access to ICT tools, rural and public schools lag, contributing to a widening educational divide (Amesi & Yellowe, 2018; Olafare et al., 2020). Recent studies emphasize the need for targeted interventions to address these disparities, including improved teacher training and more equitable distribution of ICT resources (Adomi & Kpangban, 2019). Despite these challenges and recommendations from previous studies, the potential for ICT to enhance Basic Science education remains significant. Since most of the previous studies were before the advent of covid-19, this study investigates the extent to which ICT tools are integrated (available and utilized) into Basic Science teaching in Nigerian secondary schools since after Covid-19, with a focus on the moderating effects of school type and location.

Theoretical Framework

Over time, numerous theories have been postulated to elucidate the integration of technology across various fields and sectors, offering a more comprehensive comprehension of technology acceptance (Venkatesh & Davis, 2000). In 2003, Venkatesh et al. embarked on formulating a unified theory of technology acceptance

by amalgamating pivotal concepts that forecast behavioural intentions and usage. This theory was constructed upon the Technology Acceptance Model (TAM) by Davis (1989) and the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al. (2003). The TAM emphasizes that the decision to integrate technology is influenced by two primary factors: Perceived Usefulness (PU) and Perceived Ease of Use (PEU). Perceived Usefulness pertains to the conviction that utilizing a specific technology will enhance job performance, while Perceived Ease of Use concerns the belief that employing the technology will necessitate minimal exertion. Conversely, UTAUT underscores four key factors that impact technology adoption and usage: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), and Facilitating Conditions (FC). Performance Expectancy denotes the belief that utilizing the technology will augment performance, Effort Expectancy is the perception that utilizing the technology will be uncomplicated and straightforward, Social Influence signifies the extent to which others advocate for the utilization of a specific technology, and Facilitating Conditions indicates the provision of resources and assistance essential for utilizing the technology effectively.

Drawing from the TAM and UTAUT models, the theoretical framework for this study can be depicted as follows:

Availability of Information and Communication Technology (ICT) Tools → Perceived Usefulness (PU) → Intention to Utilize ICT Tools

Availability of Information and Communication Technology (ICT) Tools → Perceived Ease of Use (PEU) → Intention to Utilize ICT Tools

Performance Expectancy (PE) → Intention to Utilize ICT Tools

Effort Expectancy (EE) → Intention to Utilize ICT Tools

Social Influence (SI) → Intention to Utilize ICT Tools

Facilitating Conditions (FC) → Intention to Utilize ICT Tools

Intention to Utilize ICT Tools → Actual Utilization of ICT Tools.

The theoretical model encompasses an array of interconnected concepts that converge in a sophisticated framework. It expounds on how users, specifically Basic science educators and students, formulate intentions to interact with a technology and how these intentions translate into practical usage. This model can be customized to elucidate how Basic science teachers and learners can embrace and integrate novel technologies. For instance, upon the introduction of an innovative technology such as employing a projector to exhibit a lesson on the Circulatory systems of the body from a laptop, the educator may aspire to master all its functionalities. In such a scenario, applying this framework would offer a systematic approach to proficiently learn and utilize the projector and laptop. It functions as a guiding beacon for educators to navigate the realm of technology in lesson presentations.

II. Literature Review

The integration of Information and Communication Technology (ICT) in education is widely recognized as a catalyst for enhancing learning outcomes, academic performance, and the overall educational experience (Tinio, 2015). ICT facilitates interactive learning environments, offers a plethora of educational resources, and cultivates critical thinking and problem-solving abilities (Sibanda et al., 2016). Recent research underscores that the effective integration of ICT in teaching methodologies can also enhance teachers' instructional approaches and inspire students to participate in the curriculum more actively (Alharbi, 2013, Iji, et al. (2021). Nevertheless, despite the acknowledged advantages, the adoption of ICT remains uneven globally, particularly in developing nations where obstacles such as inadequate infrastructure, limited technological resources, and insufficient teacher training impede the full potential of ICT in education (Kromidha & Toro, 2015).

Within the Nigerian context, studies consistently reveal disparities in the integration of ICT in education between urban and rural areas, as well as public and private schools. Research by Aduwa-Ogiegbaen and Iyamu (2013) and Eyiolorunshe (2018) indicates that urban and private schools tend to have better access to ICT infrastructure, while rural and public schools encounter significant challenges in procuring and maintaining such technologies. This digital divide is further exacerbated by systemic issues like inadequate electricity, funding, and insufficient teacher training programs (Olafare et al., 2020). Recent literature also suggests that even when ICT tools are accessible, their utilization remains suboptimal due to ineffective integration into the teaching process, especially in science subjects like Basic Science that is a core science subject running form primary one to junior secondary three (Gambari et al., 2016, Okebukola, 2013).

Current studies underscore the pivotal role of teacher readiness and training in overcoming barriers to ICT adoption, a study by Adomi and Kpangban (2019) revealed that insufficient in-service training for teachers significantly hampers the utilization of ICT tools, resulting in their under-utilization in classrooms. The lack of

continuous professional development opportunities for teachers remains a major impediment to ICT integration in Nigerian schools (Oye et al., 2020).

Despite a growing body of literature on ICT in education, studies specifically focusing on its integration into Basic Science education in Nigeria are limited. This gap is substantial, given that science education stands to benefit from ICT through interactive simulations, access to diverse scientific resources, and the promotion of problem-based learning. Recent research suggests that when effectively implemented, ICT can enhance students' comprehension of complex scientific concepts and boost their performance in subjects like Basic Science (Aduwa-Ogiegbaen & Iyamu, 2013; Gambari et al., 2016). However, the efficient use of ICT in science education remains an area necessitating further exploration, particularly within the Nigerian context where contextual factors such as school type and location significantly influence the extent of ICT integration.

In conclusion, while the potential advantages of ICT availability and integration in education are well-documented, substantial barriers persist, particularly in developing nations like Nigeria. The discrepancy in ICT access between urban and rural schools, as well as public and private institutions, remains a pressing issue. There are still conflicting results about ICT distribution across location and school types in Nigeria. Additionally, teacher preparedness and continuous professional development are critical components in ensuring the successful integration of ICT in education. This study aims to delve into these issues within the realm of Basic Science education, contributing to the expanding knowledge base on ICT adoption in Nigeria, based on location and school types.

Research Questions

1. Are there significant differences in the availability of ICT tools for teaching Basic Science between public and private, rural, and urban schools?
2. Are there significant differences in the integration levels of available ICT tools in teaching Basic Science between public and private, rural, and urban schools?

III. Material And Methods

This study employed a descriptive survey design. The study was conducted in 2021. The population consisted of 504 Junior Secondary students across two schools in Delta State, Nigeria. A stratified random sampling method was used to select a sample of 112 students from both urban and rural, public, and private schools. The criteria for selection of sample were students from two intact classes that picked a “yes” in the simple ballot test conducted for all the classes in the J3 arms. A 20-item questionnaire was developed to assess the availability and integration of ICT tools in Basic Science education. The researcher obtained permission from the school authorities before administering the questionnaire to the students who were also given assurance that the information obtained will treated with strict confidence.

The reliability of the instrument was confirmed through a Pearson’s product-moment correlation (0.76). Data analysis involved percentage analysis for descriptive statistics, and chi-square tests were used to assess the differences in ICT availability and integration. In analysing the data for availability, students who ticked Eleven (11) ICT tools or more out of the twenty items in the questionnaire were counted under High availability level of ICT tools. The number of students who ticked less than 11 ICT tools were counted and used for low availability. Their percentages were used for answering the research questions. Also, the number of students who wrote more than ten “F” (for frequently used), more than ten “S” (for sometimes used) and more than ten “N” (for never used were counted) and the data used for calculating percentages. The chi-square test was selected to analysed categorical data related to availability and frequency of ICT tool use, while ANOVA or t-tests were not employed in this present study because mean integration levels across schools were not compared. The data analysis was done using SPSS statistics.

IV. Result

Answer to Research Questions

Research question one

Are there significant differences in the availability of ICT tools for teaching Basic Science between public and private, rural, and urban schools?

Table 1: Summary Table Showing students responses on ICT tools available and not available.

Subjects	Respondent	Private School		Public school		Chi-square stat.			
Availability	All students	urban	rural	urban	Rural	df	x-cal	X-cri	Remark
Available	48(42.9%)	17	10	14	07				No Sign.
Not available	64(57.1%)	18	21	11	14	3	2.349	7.815	diff found
Cell total	112(100%)	35	31	25	21				
Group total		66		46					
Grand total		112					P=0.938	>0.05	

From Table 1, a total of 112 students underwent a survey to evaluate the availability of ICT tools for the teaching of Basic Science. Out of the participants, 42.9% (48 students) affirmed the availability of ICT tools, while a greater 57.1% (64 students) stated the non availability of such tools. The availability of Information and Communication Technology (ICT) in Education, particularly in the teaching of scientific subjects like Basic Science, has been recognized as a promising approach to enriching the educational standard. Although the descriptive data highlighted differences in availability, the primary research question addressed in this study delves into assessing whether there were significant differences in the availability and non availability of the ICT tools required for teaching Basic Science among public and private institutions, as well as rural and urban schools.

A Chi-square test was utilized to evaluate if significance differences are found in ICT availability across different school types and locations, yielding the subsequent results: Chi-square statistic (x-cal) = 2.349, Critical value (x-cri) = 7.81, P-value = 0.938. Given that the p-value (0.938) exceeds 0.05 and the computed Chi-square value (2.349) falls below the critical value (7.81), answer to research question one was no significant difference occurred in ICT tool availability between public and private, rural, and urban schools. This conclusion indicates that neither the geographical location nor the school type significantly impacts the availability of ICT tools for teaching Basic Science. In all the cases the ICT tools were not readily available.

Research question two

Are there significant differences in the levels of integration of the available ICT tools in teaching Basic science with respect to location and school type?

Table 2: Level of integration /utilization of available ICT Tools

Subjects	Respondent	Private School		Public school		Chi-square stat.			
Level of Integration	All students	urban	rural	Urban	rural	df	X cal	X -cri	remark
AFU	29(60.42%)	13	06	07	03	6	3.407	12.59	Accept
ASU	14(29.17%)	03	03	05	03		P=0.7	0 .05	No Sign.
ANU	05(10.41%)	01	01	02	01		566		diff found
Group total	48(100%)	17	10	14	7				
Grand total		48							

The data presented in Table 2 indicates that the greater percentage of students (60.42%) reported the presence of ICT tools as "Available and Frequently Used" (AFU), with 29.17% of students noting them as "Available and Sometimes Used" (ASU), and 10.41% stating them as "Available but Never Used" (ANU). This highlights that more participants, regardless of their geographical location or school category, actively interact with the available ICT tools. Nonetheless, a minor segment expressed that despite the availability of these tools, they remained untapped, signifying a prospect for enhancing utilization strategies.

Upon examining the difference between different school types (public versus private); and locations (urban versus rural), it was discovered that there were differences in the frequency of ICT tool utilization. However, this difference did not exhibit statistical significance. The computed Chi-square value (3.407) was lower than the critical Chi-square value (12.59) at a significance level of 0.05. Furthermore, the p-value of 0.756 exceeds 0.05, leading to the answer that there are no significant differences in the levels of integration of the available ICT tools in teaching Basic science with respect to location and school type.

V. Discussion:

The availability and utilization of various digital tools helps to aid teaching and learning of the subjects taught in secondary school, it improves education by bringing out the relevance to the digital world and making learning to be of high quality and full of fun and real-life experience. The `no significant´ difference between school types and locations in terms of ICT availability could be due to increasing accessibility of mobile devices and low-cost technologies, which may have allowed rural and public schools to catch up with urban and private institutions in terms of access. Furthermore, government initiatives or non-governmental organization (NGO) efforts to improve ICT infrastructure in schools could have narrowed the disparity between rural and urban schools, leading to a more even distribution of ICT tools as observed in the study carried out by Oluwaseun, and Okonkwo (2022), however, the findings of this present study align with studies such as Miller et al. (2015) and Li & Ni (2016), suggesting that increased affordability and distribution of ICT infrastructure might be contributing factors to the more uniform access observed in the present study. Despite this, the gap in availability of these tools remains across school types and location.

The findings from this study agrees with previous studies while contrasting with other studies in terms of the impact of school type and location on ICT utilization in education. Studies (Kumar & Kaur, 2020, Hennessy et al., 2010) have indicated that ICT utilization in classrooms is more frequently reported in urban schools compared to rural ones. Similarly, research by Aduwa-Ogiegbaen and Iyamu (2013) and Eyiolorunshe

(2018) that indicates that urban and private schools tend to have better access to ICT infrastructure, while rural and public schools encounter significant challenges in procuring and maintaining such technologies, this is attributed to better infrastructure and more access to resources in urban areas. Contrarily, Miller et al. (2015) found no significant differences in ICT usage between urban and rural areas, which is in line with the findings of the current study.

Moreover, the no significant difference may be explained by the fact that the integration of ICT tools in education is becoming more uniform across different regions due to the increasing availability of affordable technologies and mobile devices. Li & Ni, (2016) noted that the distinction between rural and urban schools has become less pronounced as digital literacy programs and technology infrastructure have improved in many regions globally.

A potential explanation for the high percentage of students indicating that ICT tools are frequently used (AFU) could be the growing emphasis on technology integration in education systems worldwide, especially following the Covid-19 pandemic, where digital platforms became essential for teaching. West et al. (2018) emphasized that post-pandemic educational systems are increasingly integrating technology into regular teaching practices, thus ensuring that ICT tools are not only available but also frequently used.

While the findings show no significant statistical difference, it is important to note that the acceptance of no significant difference does not imply that ICT integration cannot be improved. The small proportion of students who report that tools are "Available but Never Used" (ANU) highlights a gap in effective utilization. Factors such as teachers' proficiency in ICT, the lack of structured training, or insufficient pedagogical strategies for integrating ICT into teaching and learning are responsible for lack of use of ICT tools (Mumtaz, 2000).

VI. Conclusion:

This research examined the integration (availability and utilization) of Information and Communication Technology (ICT) tools for the purpose of digital transformation in secondary schools in Nigeria. The focus was on the extent of ICT tool integration for the teaching of Basic Science, specifically considering school categories and geographical locations in Nigeria. The findings indicate a lack of significant difference in the availability and utilization of ICT tools between urban and rural areas or between private and public-school categories, suggesting a trend towards standardized ICT utilization across diverse settings. Nonetheless, the modest utilization of available ICT tools in certain instances highlights the necessity for more tailored teacher training and enhanced pedagogical methodologies. Subsequent studies could delve into the specific obstacles to ICT utilization in schools and explore the impact of teacher proficiency in optimizing the capabilities of these tools. In summary, while the results of the current study show no significant difference in the integration of ICT tools across school types and locations, it contrasts with much of the existing literature, which typically emphasizes greater ICT access in urban and private schools.An intriguing aspect of this study is its conduct post the Covid-19 pandemic in early 2022, distinguishing it from earlier research outcomes.

VII. Recommendation:

It was recommended that for proper integration of ICT in terms of availability and utilization:

1. The Nigerian government and private non-governmental organizations should ensure sufficient provision of ICT tools.
2. All Basic science subject teachers across various school types and locations should receive training on the use of ICT tools.
3. Measures need to be in place to ensure increased in integration by teachers.
4. Obstacles hindering the utilization and integration of available ICT tools, such as power supply shortages and data insufficiency, should be promptly addressed.
5. Both teachers and students should be encouraged to utilize the existing ICT tools for educational purposes.

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