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Impact of ICT Use on Secondary School Students' Academic Performance in Mathematics in Delta North, Nigeria

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Abstract
This study investigated the impact of ICT use on secondary school students' academic performance in Mathematics in Delta North Senatorial District, Nigeria, with the aim of addressing the gap in empirical evidence from semi-urban and rural settings. The study adopted a quasi-experimental research design. The target population comprised 5,850 Form Two secondary school students with a sample of 390 students selected from two intact classes in each of the 13 sampled public schools using a two-stage multistage sampling technique. Data was collected using two equivalent 20-item multiple-choice Mathematics achievement tests administered as the pre-test and post-test. Data was analyzed using an independent-samples *t*-test. The findings show that provision of ICT facilities alone is insufficient to significantly improve students' academic performance in Mathematics. Rather, effective ICT integration depends on complementary factors, such as teachers' pedagogical competence, students' digital literacy, active learner engagement and a supportive learning environment. The study therefore recommends that investments in ICT infrastructure be complemented by continuous teacher professional development, digital literacy enhancement for both teachers and students and adoption of student-centered pedagogical approaches to maximize the potential of ICT in improving mathematics learning outcomes.

Keywords: Assessment; academic performance; Information and Communication Technology; Mathematics.

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Introduction
Communication is useful in our everyday life as human beings. Through proper communication, ideas, feelings, thoughts and information can be shared and knowledge passed from one person to another. In the classroom, teaching and learning can be done more efficiently through proper communication between the teachers and the learners. Communication is more robust when using Information and Communication Technology (ICT) devices, such as computers, radio, television, projectors, internet and phones. These devices are powerful tools for effective teaching and learning. According to Adebayo et al. (2024), learners taught using ICT performed significantly better than those taught without ICT. When used appropriately, ICT stimulates the learner's interest, take care of a wide audience, provide meaningful sources of information, guarantees individualized instruction and make learning more concrete, real, immediate and permanent (Azmi, 2017).

Acording to Njoki et. al. (2016), communication is the process of transferring information from sender to receiver with the use of a medium in which the communicated information is understood by both the sender and the receiver. Technology is the systematic application of science and other organized bodies of knowledge to handle problems or practical tasks. When problems or practical tasks to be handled fall within the domain of education, then we we need to think of education technology (Ghavifekr & Rosdy, 2015).

Technology has transformed the world into a global village, enabling people to access and share information with unprecedented ease (Adeoye & Oluwafemi, 2020). In education, Information and Communication Technology (ICT) refers to the use of digital technologies and devices to support teaching, learning and assessment (UNESCO, 2018). As developing countries continue to embrace scientific and technological advancements, ICT is increasingly being integrated into educational systems to enhance instructional delivery and learning outcomes. Consequently, the use of ICT in schools has grown rapidly and is now regarded as a key factor in developing learners' competencies and improving academic achievement. This underscores the need for the effective integration of ICT into teaching and learning processes (Voogt & Roblin, 2012).

An increasing body of research has demonstrated the positive effects of Information and Communication Technology (ICT) on students' academic performance in Mathematics (Cheung & Slavin, 2013; Skryabin et al., 2015). Despite this growing evidence, important research gaps remain. Most previous studies (e.g., van Maarseveen, 2020; Zhao, 2024) have focused on urban or technologically advanced settings, while relatively few have examined rural or semi-urban contexts (Karaman Aksentijević et al., 2021; Walsham, 2017). This imbalance is significant because the infrastructural limitations and socioeconomic conditions characteristic of rural and semi-urban areas, such as the Delta North Senatorial District of Delta State, Nigeria, may influence ICT integration and its effectiveness in ways that differ from urban environments (Ololube, 2015; Olojede et al., 2012). Therefore, this study sought to address this gap.

Longitudinal and controlled experimental studies on the influence of ICT on students' academic performance, particularly in rural settings, remain limited. Most previous studies have relied on survey or correlational designs (Pérez-Sanagustín et al., 2017; Tamim et al., 2011), with few adopting quasi-experimental approaches. Moreover, existing research has focused largely on ICT use in teaching and learning rather than its direct impact on academic performance (Adewoye & Salau, 2021; Kihoza et al., 2016; Mensah et al., 2023; Valverde-Berrocoso et al., 2022). This study, therefore, examined the impact of ICT on academic performance of students in Mathematics in Nigeria using Quasi experimental design.

Literature Review

Various studies have pointed out the increasing role of ICT in secondary education. The integration of ICT tools, such as computers, digital simulations, educational software and online resources can significantly enhance the quality of teaching and learning. For example, Awoleye et. al. (2012) in Nigeria found that ICT tools positively impact teachers' effectiveness by facilitating interactive learning and making abstract concepts more accessible to students.

Tondeur et al. (2007) found that students who engaged with ICT-based interactive simulations achieved better performance in Mathematics. However, in the Delta North Senatorial District, both teachers and students possess varying levels of ICT competence. Many teachers have only basic to moderate ICT skills and lack the advanced technical and pedagogical expertise needed to effectively integrate interactive multimedia tools into Mathematics instruction (Ibáñez et al., 2020). Similarly, many students have limited competencies in data processing and the use of e-learning platforms (Ivwighreghweta & Eireyi-Fidelis, 2022).

The study pointed out that teachers' familiarity and comfort with technology can positively affect teaching and learning in Mathematics classrooms. Luhamya et. al. (2017) opined that lack of proper training and inadequate resources hinder effective ICT usage in Nigerian secondary schools. The study further reported that if ICT is effectively integrated, it will improve students' problem-solving skills and enhance their critical thinking in Mathematics.

Impact of ICT on Mathematics Education

In teaching and learning Mathematics, ICT plays numerous roles that make the teaching and learning of Mathematics more efficient. Baker and Feng, (2017) pointed out that ICT tools, such as computer

simulations and virtual laboratories, help in making complex Mathematics concepts and tools easier, which aids students in understanding concepts better. Lawrence and Tar (2018) Tar (2018) emphasized the need to integrate Information and Communication Technology (ICT) into the teaching and learning of Mathematics. The study argued that the effective use of ICT enhances learners' understanding of mathematical concepts by making instruction more interactive, engaging, and meaningful.

Similarly, Maharjan et al. (2022), in their study conducted in Lagos and Osun States, found that integrating ICT into the teaching and learning of Mathematics significantly improved students' academic performance, reinforcing the view that ICT enhances Mathematics learning outcomes. A study conducted by Basri et al. (2018) highlighted the positive impact of ICT tools, particularly interactive content and online resources, on students' motivation to learn Mathematics. The study found that when students utilized digital simulations to grasp Mathematical concepts, their academic performance improved significantly. A study by Mtebe (2015) on ICT implementation in Tanzanian schools revealed that collaborative tools, such as forums and discussion boards, enhanced students' meaningful engagement, ultimately enriching their collaborative learning experiences with peers.

However, effective integration of ICT in Mathematics teaching faces several obstacles, particularly among secondary schools within the Delta North Senatorial District. Research by Bayuo et al. (2022) and Mensah et al. (2024) identified key challenges, including inadequate infrastructure, lack of teacher training on modern technology, limited access to ICT resources, educators' resistance to change, insufficient institutional support and poor internet connectivity, especially in remote areas.

The importance of ICT in enhancing students' academic performance has been widely documented. Haleem et al. (2022) established a positive relationship between ICT utilization and improved academic achievement, reporting that students who used ICT in learning Mathematics attained higher test scores and demonstrated a deeper conceptual understanding than those taught through traditional instructional approaches. Similarly, Sailer et al. (2021) found that integrating ICT into the teaching and learning process improved students' performance not only in Mathematics but also in other science subjects, particularly when ICT was used to facilitate interactive and experiential learning. This study filled the gap by investigating the impact of ICT on academic performance of senior secondary school mathematics students in the rural area of Delta North Senatorial District, Delta State, Nigeria.

Methodology

Design

The study employed a quasi-experimental design involving two intact classes from each selected school. Intact classes were used to avoid disrupting the schools' normal teaching and learning activities. One class received Mathematics instruction using ICT facilities (experimental group), while the other was taught using conventional methods without ICT (control group). A pretest was administered to both groups to establish baseline Mathematics achievement and determine their comparability before the intervention. Following the instructional period, a post-test was administered to assess the effect of the two instructional approaches on students' academic performance in Mathematics.

Population and Population

The study population comprised 5,850 students from 177 public secondary schools in the Delta North Senatorial District of Delta State. A two-stage multistage sampling technique was employed. In the first stage, 13 public secondary schools were randomly selected from the district. In the second stage, two intact classes were selected from each sampled school, yielding a total sample of 390 students. The number of students selected from each school varied according to the size of the intact classes.

Instrument

The study employed two equivalent multiple-choice objective tests. Each instrument consisted of 20 multiple-choice items with four response options (A–D). The use of two equivalent forms minimized test-wiseness and practice effects between the pretest (trial test) and the post-test, thereby enhancing the validity of the assessment.

Statistical Treatment of Data

After administering the test, the marks obtained were subjected to a statistical treatment of two independent mean to test the hypothesis.

Findings and Discussion

This section presents the findings and discussion, guided by a research question with subsequent hypothesis.

Research Question: Is there a difference in academic performance in Mathematics by students taught with ICT facilities and those taught without ICT facilities?

This research question called for testing of the following hypothesis: There is no significant difference in the performance of students taught using ICT facilities and those taught in the ordinary classroom system.

From Table 1, students taught without ICT Facilities had a preliminary mean score of 7.8 and the post-test mean of 13.13, which shows an increase of 5.33 points, representing 68.3%. Students taught with ICT Facilities had the preliminary mean of 7.33 and the post-test mean of 12.62, which shows an increase of 5.29 points, representing 72.2%. The results indicate that the mean academic performance of students taught using ICT facilities was lower than that of students taught without ICT facilities, suggesting that, on average, the ICT group obtained lower scores than the non-ICT group. However, the observed difference was not statistically significant, as the p-value (0.308) exceeded the 0.05 level of significance. Therefore, the null hypothesis was not rejected, leading to the conclusion that there was no statistically significant difference in the academic performance of students taught Mathematics with ICT facilities and those taught without ICT facilities.

Table 1: T-Test Analysis Experiment of Students Taught with ICT Facility and without ICT Facility

Method		Pre-Test		Post-Test		% Increase in Performance	Df	t	p-value	Decision
	N	$\bar{X}$	SD	$\bar{X}$	SD					
Without ICT Facility	195	7.8	1.29	13.13	2.27	68.3	388	-1.026	0.308	Accept H_o
With ICT Facility	195	7.33	1.48	12.62	2.45	72.2				

Level of Significance = 0.05

This study is consistent with the findings of Davis and Tearle (2009), who reported that although technology has the potential to enhance teaching and learning, factors such as effective teaching methodology and active student involvement play a more critical role in improving academic performance than the mere availability of ICT facilities. Similarly, Comi et al. (2017) found that computer-based teaching and learning are effective only when accompanied by meaningful student engagement and awareness. They further argued that the use of appropriate pedagogical approaches, rather than technology alone, is essential for enhancing students' academic achievement.

Likewise, Chiu (2022) observed that effective ICT integration depends on factors such as teacher preparedness, professional training, institutional support and student-centred instructional practices. Without these supporting conditions, the impact of ICT on students' academic performance is likely to remain limited. In the same vein, Vargas et al. (2023) reported that the use of ICT for learning does not automatically produce positive effects on reading and Mathematics achievement across different regions unless it is complemented by other instructional and contextual factors.

The findings indicate that the provision of ICT facilities alone is insufficient to significantly improve students' academic performance in Mathematics. Effective ICT integration depends on complementary factors, including teachers' technological and pedagogical competence, active student engagement and a supportive learning environment, as also emphasized by Ertmer et al. (2012). Furthermore, limited ICT skills among teachers and students, coupled with inadequate infrastructure in many rural schools, are likely to constrain the educational benefits of technology integration (Joshi & Khatiwada, 2024). Therefore, investments in ICT infrastructure should be

accompanied by continuous teacher professional development, digital literacy enhancement for both teachers and students and adoption of student-centred pedagogical approaches to maximize the potential of ICT in improving mathematics learning outcomes.

Conclusions

Based on the findings, it can be concluded that the integration of ICT alone into mathematics teaching and learning is insufficient to improve students' academic performance. Its effectiveness may depend on complementary factors, such as teacher professional development, conducive learning environment and continuous institutional support.

Recommendations

Based on the conclusions, the following recommendations are proposed: The Ministry of Education should strengthen continuous professional development programs to enhance teachers' ICT and pedagogical competencies. Teachers should recognize that ICT alone is unlikely to improve students' academic performance in mathematics. Instead, ICT should be integrated with effective teaching strategies, teacher–student collaboration and a conducive learning environment to maximize learning outcomes.

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