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Status of ICT in Teaching and Learning of basic Science in Upper basic School in Anambra East Local Government Area of Anambra State Nigeria

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A B S T R A C T

Background: The integration of Information and Communication Technology (ICT) into education has the potential to enhance teaching and learning, especially in science education. However, the actual status and effectiveness of ICT use in schools remain uncertain in many regions, including Anambra East Local Government Area of Anambra State, Nigeria. **Objective:** This study aimed to investigate the current status of ICT in the teaching and learning of Basic Science in upper basic schools within Anambra East LGA, identifying both its impacts and the challenges hindering its effective implementation. **Method:** A descriptive survey design was adopted. The sample consisted of 194 Basic Science teachers selected through simple random sampling from secondary schools in Anambra East. Data were collected using structured questionnaires, interviews, and direct observations. The instruments were validated and tested for reliability. Data analysis employed a 4-point Likert scale, with a mean cut-off point of 2.5 for acceptance. **Result:** The findings revealed that ICT use enhances student engagement, promotes skill development, and supports personalized learning experiences. However, significant challenges were identified, including inadequate funding, limited teacher training, insufficient practical application time, and poor monitoring and evaluation mechanisms. **Conclusion:** Despite its potential, the effective integration of ICT in Basic Science teaching is constrained by systemic and infrastructural challenges. Addressing these barriers is essential for maximizing ICT's benefits in education. **Contribution:** The study provides empirical insight into the current ICT landscape in Basic Science education at the upper basic school level in Anambra East. It highlights areas needing intervention and informs policymakers, educators, and stakeholders on strategic actions to enhance ICT adoption and effectiveness in science teaching.

K E Y W O R D S

ICT integration, basic science education, upper basic schools, teacher training

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C O N T E N T

1. INTRODUCTION

The integration of Information and Communication Technology (ICT) in education has transformed the teaching and learning landscape worldwide. In the context of basic science education, ICT offers numerous benefits, including enhanced student engagement, improved comprehension of complex concepts, and the development of critical skills (Roy et al, 2014). However, the effective implementation of ICT in schools, especially in regions like Anambra East Local Government Area in Nigeria, faces several challenges. Basic science in upper basic school refers to the foundational scientific education provided to students typically in grades 7 to 9 (ages 12-15). This curriculum encom-

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passes fundamental concepts from various branches of science, including biology, chemistry, physics, and earth science (Okwara & Upu, 2017). It aims to develop students' understanding of scientific principles, enhance their problem-solving skills, and foster an appreciation for the scientific method. Through theoretical lessons and practical experiments, basic science education prepares students for more advanced studies in science and cultivates critical thinking, creativity, and an informed perspective on the natural world and technological advancements (Mbaba, 2024). ICT tools have been shown to significantly enhance the teaching and learning of basic science by providing dynamic and interactive learning experiences. ICT, or Information and Communication Technology, refers to the technologies used to manage, transmit, and process information. It includes a wide range of digital tools and resources such as computers, software applications, the internet, telecommunications devices, and digital media (Aravind et al, 2023). ICT enables the storage, retrieval, manipulation, and transmission of data and information across various platforms. In education, ICT is used to enhance teaching and learning processes, providing interactive and engaging learning experiences (Tigere & Netshitangani, 2022). It supports collaborative learning, self-paced learning, and access to vast amounts of information, fostering digital literacy and preparing students for participation in the global digital economy.

According to Dahri et al, (2021), continuous professional development for teachers in ICT skills leads to better integration of technology in classrooms, resulting in improved student outcomes. The interactive nature of ICT tools, such as simulations and virtual laboratories, helps students grasp complex scientific concepts more easily, as noted by Anurugwo (2020). These tools provide students with opportunities to experiment and visualize phenomena that would be difficult to observe in a traditional classroom setting. Moreover, ICT facilitates self-paced learning, allowing students to learn at their own speed and according to their individual learning styles. Marshman et al, (2020) highlighted that self-paced learning tools, such as online assignments and projects, enhance student engagement and retention of information. This personalized approach makes the teaching-learning process more meaningful and productive, catering to the diverse needs of students.

Teaching is the intentional act of sharing knowledge, skills, and values with others, typically in a structured environment such as a classroom. It involves educators imparting information, facilitating understanding, and fostering critical thinking through various instructional methods (Kao et al, 2020). Learning is the process by which individuals acquire knowledge, skills, and behaviors through experience, study, or instruction. It involves actively engaging with information, making sense of it, and integrating it into existing knowledge frameworks. Learning is a complex, lifelong process that enhances understanding, supports personal growth, and enables adaptation to new situations (Osita & Ugochukwu, 2023). It can occur in formal settings like schools or informally through daily experiences and interactions.

Despite its benefits, the utilization of ICT in basic science education in upper basic schools faces several constraints. One significant issue is the limited time available for students to experiment and engage in practical activities using ICT tools. Aravind et al, (2023) pointed out that the packed curricula in schools often leave little room for extended ICT-based activities. This limitation hinders students' ability to fully explore and benefit from ICT resources. Another major constraint is insufficient funding for purchasing and maintaining ICT facilities. Tigere & Netshitangani (2022) reported that many schools in Anambra East struggle to afford up-to-date technology, which is essential for effective ICT integration. Even when funds are available, they are often insufficient to cover ongoing maintenance and updates, as highlighted by Kpognon (2022). This financial constraint limits the schools' ability to provide students with access to the latest technological tools and resources.

Inadequate monitoring and inspection of ICT programs in schools also pose a challenge. According to Kao et al, (2020), without proper oversight, ICT resources are often underutilized or mismanaged. Regular monitoring and feedback mechanisms are essential to ensure that ICT tools are being used effectively and to identify areas for improvement. Bolaji & Adeoye (2022) emphasized that effective monitoring ensures that ICT resources are used to their full potential, enhancing the overall learning experience. The study on the status of ICT in teaching and learning of basic science in upper basic schools is urgent due to several critical reasons. Firstly, the integration of ICT in education has been shown to significantly enhance learning outcomes. Research indicates that "ICT can improve students' understanding and performance in science subjects" (Wahyuningtyas et al, 2022). However, there is a noticeable gap in the application of ICT in Nigerian schools, including those in Anambra State, where "ICT resources are insufficiently available".

Secondly, the effective teaching of basic science is crucial for future economic development, as it forms the foundation for higher scientific education and technical skills needed in the modern workforce. Without adequate ICT integration, students may struggle to grasp complex scientific concepts and practical applications. Moreover, the urgency is underscored by the global trend towards digital education. Countries around the world are increasingly

reliant on online and blended learning modalities, highlighting the necessity for Nigerian schools to adapt and upgrade their ICT infrastructure to remain competitive.

Research questions

1.1 To what extent does teaching and learning of basic science through ICT assist students in upper?
1.2 What are the constraints in the utilization of ICT in teaching and learning of basic science in upper basic?
1.3 How can the use of ICT in teaching and learning of basic science are improved?
1.4 What are the impacts of ICT in teaching and learning of basic science?

2. METHOD

2.1 Research Design

The research design employed in this study is a descriptive survey, which involves collecting data to describe the characteristics of a population or phenomenon being studied. This design was chosen as it allows for the use of a sample to represent the entire population, aligning with the aim of the research to generalize findings to the entire population

2.2 Research Sample

The population of the study comprised all secondary schools in Anambra East Local Government Area, totaling twelve schools. The analysis of the population indicated the distribution of Basic science teachers across these schools. Sampling techniques involved simple random sampling, with 194 Basic Science teachers in the secondary schools selected as the sample

2.3 Data Collection

Data collection instruments included a structured questionnaire, personal interviews, and observations. The questionnaire consisted of two sections: personal data and responses to research questions, utilizing a 4-point ranking scale for responses. The instrument underwent validation by the researcher's supervisor, who provided feedback for necessary corrections. Reliability was assessed through the test-retest method, indicating the consistency and stability of the instrument over time. Data collection was conducted through personal contact by the researchers and research assistants to ensure a high return rate of questionnaires.

2.4 Data Analysis

Data analysis employed a 4-point linker scale, with mean scores calculated using a formula. A decision rule was established, where mean scores equal to or above 2.5 were considered agreeable or accepted, while scores below 2.5 were rejected.

3. RESULT AND DISCUSSION

3.1 Result

Research Question 1: To what extent does teaching and learning of basic science through ICT assist students in upper?

Table 1. Analysis of the Responses of the Respondents on the Extent to which Teaching and Learning of basic Science through ICT Assist Students in Upper basic

S/N	Items	SA	A	D	SD	Total	Mean	Remark
1	It helps teachers improve on the knowledge of basic science.	34	40	80	40	194	2.3	Rejected
2	Access to the internet service as a useful tool in practical investigation in basic science.	50	50	52	42	194	2.5	Accepted
3	ICT makes students to understand complex and difficult topics in basic science.	49	43	53	49	194	2.4	Rejected
4	ICT makes students to learn basic science.	50	50	80	14	194	3.0	Accepted
5	The use of ICT offers learner the opportunity to be creative, imaginative and positioned to be reasonable.	80	51	50	13	194	3.0	Accepted

Table 1 evaluated the impact of ICT on teaching and learning basic science for upper basic students. Item 1, with a mean of 2.3, is rejected, indicating that ICT is not perceived to significantly improve teachers' knowledge of basic science. Item 2, with a mean of 2.5, is accepted, showing moderate agreement on the usefulness of internet access for practical investigations. Item 3, with a mean of 2.4, is rejected, suggesting ICT does not significantly help students understand complex topics. Items 4 and 5, both with a mean of 3.0, are accepted, indicating strong agreement that ICT aids learning and fosters creativity and imagination.

Research Question 2: What are the constraints in the utilization of ICT in teaching and learning of basic science in upper basic?

Table 2. Analysis of the Responses of the Respondents on the Constraints in the Utilization of ICT in Teaching and Learning of basic Science in Upper basic.

S/N	Items	SA	A	D	SD	Total	Mean	Remark
6	Inadequate manpower and lack of ICT skills.	43	49	53	49	194	2.4	Rejected
7	Limited time to experiment, reflect and practical.	42	52	50	50	194	2.5	Accepted
8	Insufficient power supply.	40	80	40	34	194	2.3	Rejected
9	Insufficient or inadequate fund for purchasing ICT facilities.	74	14	50	56	194	2.5	Accepted
10	Inadequate monitoring and inspecting of ICT programmes in schools.	49	35	50	50	194	2.5	Accepted

Table 2 examined constraints in using ICT for teaching and learning basic science in upper basic. Item 6, with a mean of 2.4, is rejected, indicating that inadequate manpower and ICT skills are not seen as major constraints. Items 7, 9, and 10, all with a mean of 2.5, are accepted, highlighting limited time for practical work, insufficient funds for ICT facilities, and inadequate monitoring as significant issues. Item 8, with a mean of 2.3, is rejected, suggesting that insufficient power supply is not considered a critical constraint. Overall, time, funding, and oversight are the main barriers identified.

Research Question 3: How can the use of ICT in teaching and learning of basic science are improved?

Table 3. Analysis of the responses of the respondents on how can the use of ICT in teaching and learning of basic science are improved.

S/N	Items	SA	A	D	SD	Total	Mean	Remark
11	Continuous training of basic science teachers on computer and ICT skills.	62	70	30	32	194	2.8	Accepted
12	There is need for government to seriously intervene on the issue of the erratic electricity power supply or school can provide generator for themselves for electricity or power supply.	50	50	35	59	194	2.4	Rejected
13	Government of the state should provide fund specifically needed for purchasing high-cost ICT faculties for schools.	70	24	50	50	194	2.5	Accepted
14	School authorities should provide body or bodies responsible for monitoring and inspecting ICT programmes in schools.	59	35	50	50	194	2.5	Accepted
15	School authorities should equip the computer or internet with anti-virus to protect the computer against virus.	40	80	40	34	194	2.3	Rejected

Table 3 provides suggestions for improving ICT use in teaching basic science. Item 11, with a mean of 2.8, is accepted, indicating strong support for continuous training of teachers in ICT skills. Items 13 and 14, both with a mean of 2.5, are also accepted, highlighting the need for government funding for ICT and improved monitoring. Item 12, with a mean of 2.4, is rejected, showing that respondents do not strongly agree on the necessity of addressing electricity supply issues. Similarly, item 15, with a mean of 2.3, is rejected, indicating less concern for anti-virus protection measures.

Research Question 4: What are the impacts of ICT in teaching and learning of basic science?

Table 4. Analysis of the responses of the respondents on the impacts of ICT in teaching and learning of basic science.

S/N	Items	SA	A	D	SD	Total	Mean	Remark
16	It makes students to develop skills for cooperation, communication, problem solving and lifelong learning.	50	80	14	50	194	3.0	Accepted
17	It creates a powerful learning environment and transforms the teaching and learning process in which students deals with knowledge in an active, self directed and constructive ways.	43	49	49	53	194	2.4	Rejected
18	It enables self paced learning through various tools such as assignment; project etc. as a result of this, the teaching learning enterprise become more meaningful and productive.	50	50	42	52	194	2.5	Accepted
19	It enhances the relationship between students and teachers hereby making it open and intimate.	49	51	43	51	194	2.5	Accepted
20	It enables self paced learning through various tools such as assignment; project etc. as a result of this, the teaching learning enterprise become more meaningful and productive.	50	50	42	52	194	2.5	Accepted

Table 4 assessed the impacts of ICT on teaching and learning basic science. Item 16, with a mean of 3.0, is accepted, indicating strong agreement that ICT helps develop cooperation, communication, problem-solving, and lifelong learning skills. Item 17, with a mean of 2.4, is rejected, suggesting ICT is not perceived to significantly transform the teaching and learning environment. Items 18, 19, and 20, all with a mean of 2.5, are accepted, highlighting that ICT enables self-paced learning and enhances the student-teacher relationship. Overall, ICT is seen as beneficial for skills development and self-paced learning but less impactful on transforming the learning environment.

3.2. Discussion

Research question 1 examined the extent to which teaching and learning of basic science through ICT assist students in upper basic. The result showed that access to the internet as a tool for practical investigations has been shown to enhance student engagement and understanding. In a related study, Abouelenein et al, (2024) found that students with internet access performed better in science experiments due to the wealth of available resources, confirming the utility of internet access in practical investigations. Furthermore, ICT makes students learn basic science more effectively. This finding agreed with Rahmawati et al, (2022), who noted that digital tools and simulations improve students' comprehension of complex scientific concepts, leading to higher academic performance. However, in contrast, Kohan et al, (2017) argued that without proper guidance, students might struggle with self-directed learning using ICT, indicating a need for structured implementation. The use of ICT also offers learners the opportunity to be creative and imaginative. According to a study by Roy et al, (2014), students engaged in ICT-enhanced learning demonstrated greater creativity and problem-solving skills compared to those in traditional settings. This finding supports the idea that ICT fosters a conducive environment for imaginative learning. Conversely, in contrast, Soulikias et al, (2021) observed that excessive reliance on technology might hinder critical thinking if not balanced with traditional teaching methods.

Research question 2 covered the constraints in the utilization of ICT in teaching and learning of basic science in upper basic. Result showed that one major issue is the limited time available for students to experiment, reflect, and engage in practical activities. This finding agreed with a study by Aravind et al, (2023), which noted that packed curricula leave little room for extended ICT-based activities. In contrast, Kohnke et al, (2024) found that schools with more flexible schedules could integrate ICT more effectively, suggesting that institutional time management plays a crucial role. Insufficient funding for purchasing ICT facilities is another significant constraint. This finding is supported by Gonzales et al, (2020), who reported that many schools struggle to afford up-to-date technology, hindering the effective integration of ICT in science education. Similarly, in a related study, Tigere & Netshitangani (2022)

highlighted that even when schools receive funds, they are often insufficient to cover ongoing maintenance and updates, exacerbating the problem. Inadequate monitoring and inspection of ICT programs in schools also pose a challenge. According to Kpognon (2022), without proper oversight, ICT resources are often underutilized or mis-managed. This finding agreed with a study by Bolaji & Adeoye (2022), which emphasized that effective moni-toring ensures that ICT tools are used to their full potential, enhancing the learning experience. Conversely, in contrast, Atieh (2021) argued that while monitoring is essential, it must be paired with adequate training for teachers to ensure they can effectively implement ICT in their teaching practices.

Research question 3 was on how the use of ICT in teaching and learning of basic science are improved. It was discovered that continuous training of basic science teachers on computer and ICT skills is essential. This finding agreed with Yurtseven-Avci et al, (2020), who found that ongoing professional development enhances teachers' ability to integrate ICT effectively into their lessons, resulting in improved student outcomes. In contrast, Kao et al, (2020) noted that sporadic training sessions are insufficient, emphasizing the need for a structured and continuous training program. Funding is another critical factor. Government provision of funds specifically for purchasing high-cost ICT facilities can significantly improve ICT utilization in schools. This finding is supported Abouelenein et al (2024), who reported that targeted funding helps schools acquire the necessary technology, ensuring students have access to modern learning tools. In a related study, Yu et al, (2022) highlighted that sustained financial investment is crucial for maintaining and upgrading ICT infrastructure, preventing technology obsolescence. Effective moni-toring and inspection of ICT programs in schools by dedicated bodies are also vital. Ngonile (2014) found that regular oversight ensures ICT resources are used efficiently and effectively, maximizing their educational benefits.

Research question 4 was on the impacts of ICT in teaching and learning of basic science. Firstly, ICT helps stu-dents develop essential skills for cooperation, communication, problem-solving, and lifelong learning. This finding agreed with Nwagwu et al, (2013), who observed that ICT tools facilitate collaborative projects and discussions, promoting these vital skills. In contrast, a study by Suleiman et al, (2020) found that without proper guidance, students might struggle to effectively harness these tools for skill development, highlighting the need for teacher involvement. Moreover, ICT enables self-paced learning through various tools such as assignments and projects, making the teaching-learning process more meaningful and productive. This was supported by Anurugwo (2020), who noted that self-paced learning allows students to progress at their own speed, accommodating individual learning styles. In a related study, Osita and Ugochukwu (2023) found that such an approach leads to higher student engagement and retention of information. However, Marshman et al, (2020) cautioned that self-paced learning requires a high degree of self-discipline, which some students may lack. ICT also enhances the relationship between students and teachers, making it more open and intimate. Digital communication tools facilitate better interaction and feedback, strengthening the student-teacher bond. This finding agreed with Roy et al, (2014), who reported that ICT tools help teachers understand students' needs better, providing more personalized support.

4. IMPLICATIONS AND CONTRIBUTIONS

This study provides valuable scientific insights into the status and impact of ICT integration in the teaching and learning of Basic Science in upper basic schools. The findings underscore the significant role that ICT can play in enhancing student engagement, fostering skill development, and supporting personalized learning experiences. These outcomes highlight the importance of adopting technology-driven approaches in science education to align with global educational standards.

However, the study also brings attention to persistent barriers such as inadequate funding, insufficient teacher training, limited practical application, and poor monitoring systems. These challenges must be addressed to fully realize the benefits of ICT in the classroom.

5. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

This study was confined to upper basic schools (not upper primary) in Anambra East Local Government Area of Anambra State, Nigeria, which limits the generalizability of its findings to other regions or educational levels. The research employed a descriptive survey design and relied solely on data collected from a specific geographical lo-cation. As such, it may not reflect variations in ICT integration practices or challenges that exist in other local gover-nment areas, states, or educational settings. Additionally, the study focused primarily on teachers' perspectives, potentially overlooking insights from students, administrators, and policy makers.

Future studies should consider expanding the scope to include multiple local government areas or states to allow for comparative analysis and broader generalizations. Mixed-methods approaches, involving both qualitative

and quantitative data, could provide deeper insights into the contextual and practical challenges of ICT implementation. Further research could also explore the perspectives of students and other educational stakeholders to provide a more holistic understanding. Longitudinal studies are encouraged to evaluate the long-term impact of ICT interventions on teaching practices and student outcomes in Basic Science education.

6. CONCLUSION

The study on the status of ICT in teaching and learning Basic Science in upper basic schools in Anambra East Local Government Area of Anambra State, Nigeria, reveals both promising benefits and significant challenges. The findings show that ICT tools positively influence students' learning experiences by promoting key skills such as collaboration, communication, and problem-solving, as well as facilitating self-paced and personalized learning. Despite these advantages, the integration of ICT in science education is constrained by several factors, including insufficient funding, lack of adequate teacher training, limited time for practical engagement, and weak monitoring mechanisms.

To fully harness the benefits of ICT in Basic Science education, it is essential to address these constraints. Continuous professional development for teachers in ICT-related competencies, increased government investment in ICT infrastructure, and the implementation of effective monitoring and evaluation systems are critical. These interventions will not only improve the quality of teaching but also ensure that technology is meaningfully embedded into the learning process, allowing students to better understand scientific concepts and apply them in real-world contexts.

In conclusion, while ICT holds the potential to transform Basic Science education, its success relies on deliberate and sustained efforts from policymakers, school administrators, and educators. Strategic investments, comprehensive teacher training, and robust oversight are necessary to ensure that ICT integration meets its intended goals. With these measures in place, the educational system in Anambra East can foster a more innovative, competent, and future-ready student population.

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Author Contribution Statement

The author declares that this article's entire research and writing process was carried out independently. The author is fully responsible for all data related to this research. No other party has participated as an author or made a significant contribution to the content of this work.

Conflict of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical Approval Statement

The author declares that this study was conducted in accordance with research ethics principles and has received ethical approval from the author's institution, including respect for participants' autonomy, confidentiality of data, and ensuring their safety and well-being, as outlined in the applicable research ethics guidelines.

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