JOURNAL OF SCIENCE EDUCATION AND RESEARCH (JSER)

Vol. 1 APRIL - MAY; 2025
ISSN ONLINE: 3092-9253

Editor in-Chief
PROF. PATRICK C. IGBOJINWAEKWU

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JOURNAL OF SCIENCE EDUCATION AND RESEARCH

(JSER), 1, APRIL - MAY; 2025

ISSN Online: 3092-9253

Published in April, 2025.

Printed in Nigeria in the year 2025 by:
Love Isaac Consultancy Services
No 1 Etolue Street, Ifite Awka, Anambra State, Nigeria
+234-803-549-6787, +234-803-757-7391

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EDITORIAL

Journal of Science Education and Research (JSER) is a peer-reviewed published Bimonthly. It aimed at advancing knowledge and professionalism in all aspects of educational research, including but not limited to innovations in science education, educational technology, guidance and counselling psychology, childhood studies and early years, curriculum studies, evaluation, vocational training, planning, policy, pedagogy, human kinetics, health education and so on. JSER publish different types of research outputs including monographs, field articles, brief notes, comments on published articles and book reviews.

We are grateful to the contributors and hope that our readers will enjoy reading these contributions.

Prof. Patrick C. Igbojinwaekwu
Editor-in-Chief

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TOWARDS UTILIZING INFORMATION COMMUNICATION TECHNOLOGY (ICT) TOOLS FOR TEACHING AND LEARNING OF BIOLOGY

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Abstract
The use of ICT tools in teaching and learning is presently prevalent in many schools in Nigeria. This study explored some of the ICT tools in this digital age that enhance the teaching and learning of Biology. It involves the integration of ICT tools into the classroom, its associated challenges and solutions. These devices offer opportunity for personalized learning through internet accessibility and global collaboration. These promote interconnectivity empowering teachers to create dynamic, engaging and constructivist learning environment. This in turn arouses the interest and participation of students for deeper understanding of instruction culminating to effective and meaningful learning. Suggestions for proper enforcement were made.

Keywords: Information Communication Technology (ICT) Tools

Introduction

The rapid paradigm to technological advancement and modern strategies is perspectives of teaching and learning leading to changes in our conventional classroom setting. The need for a response to the above statement will enable the country to surge forward in keeping pace with the process of modernisation as witnessed in the developed and developing countries of the world. The importance of biology in national development has necessitated the inclusion of its study in the curriculum of most nations of the world (Okafor & Okoli, 2020). The National Policy on Education (2014) has it that biology is one of the core subjects offered in secondary schools, its teaching and learning is one of the crucial aspect of science education.

Science is a process of search for truth. It involves observation, questioning, predicting, gathering and testing. Science is a field of study that comprises various branches of which biology is one. Biology is the study of living organisms involving both practical and theoretical work, of which knowledge is applied in various areas of human life portraying its importance for human survival. The teaching of every science subject, including biology, demands that learners are engaged in active process (Okafor & Okonkwo, 2019). This implies that the students are involved in activities that stimulate their interest and help their learning the content areas. Lack of innovative and imaginative approaches poses a notable challenge in maintaining students' active involvement in class (Baytak, Tarman & Ayas, 2021).

Information and Communication Technology (ICT) is an umbrella term that includes any communication device or application (Kola, 2013). It comprises radio, television, computers, satellite systems network, cellular phone, hardware and software with the various services and applications associated with them. Technology involves the utilisation of tools, crafts and materials to control and adapt to the environment. Technology is the scientific knowledge that can be applied in solving practical problems. According to Anyakora 1991 in Okafor & Okonkwo (2019) Information Technology is the use of man-made tools for the collection, generation, communicating, recording, re-management and exploitation of information; it includes application and commodity by which information is transferred, recorded, etched, stored, manipulated or disseminated. ICT is a range of technology for gathering, storing, retrieving, processing, analysing and transmitting information (Virkus, 2008). ICT education is an instrument, a device, or strategy in our education system aimed at achieving effective classroom instruction delivery in Nigeria. This can be achieved by actualization of self-realization, better human relationship, individual and natural efficiency, effective citizenship, scientific and technological progress.

The rationale driving the need for the knowledge and utilisation of ICT in teaching and learning is to equip students with skills to engage and thrive in this information era, transform pedagogy for enhanced learning quality, resulting in skilled and flexible workforce. Also the COVID-19 pandemic has intensified the reliance on digital devices and catalysed innovations in digital education (Hodges, Moore, Lockee, Trust & Bond, 2020; Means, Bakia & Murphy, 2020). Wong, Goh, Hanafi & Osman (2010) revealed that in this information age, Nigeria as a developing country has a clear vision that ICT can transform conventional education system and bring advantages and benefits to the country especially to the younger generation. This enables teachers to provide new opportunities for students to manage and enhance new knowledge. Thus, the integration of computer studies in schools for students' learning activities to develop skills and knowledge required in this digital era. The use of ICT in education results to a constructivist learning as the students get actively involved with greater responsibility. Thus, Mikre (2011) opined that ICT has revolutionized the way students learn and transforming the education system. The teacher supports, advises and coach the students rather than merely transmitting knowledge as is the case with our conventional setting.

The utilization of ICT tools in classroom requires the teachers to develop digital literacy skills and pedagogical knowledge. According to Hinyard , Kreuter, Proctor, & Colditz (2016) teachers who receive proper training and support show increased confidence in using technological tools and demonstrate more student-centred teaching practices. The modern educational environment requires science teachers and science classrooms to be digital. Digital tools are programmes, websites or online resources that can make tasks easier to complete (Alordiah, Osagied, Omumu, Okokoyo, Emiko-Agbajor, Chenube & Oji, 2023). Thus, science teachers should be digitally proficient to utilize the technological resources which should be adequately provided in school.
Computer simulated labs in biology involve one or a combination of interactive activities (animations, interactive graphics and imagery) and virtual field trips (e.g. interactive maps, photographs, etc.) (Holmes, Roberts, Snow & Pujana 2020). Also some of the commonly used computer-simulation labs include those found on: Java-Programmes on Biology, MERLOT Simulation collection, General Biology Java Applets, Biology online labs, PhET Interactive Simulations, Open Science Laboratory, North America Network of Science Labs online and Biology Lab. Teachers adopt these tools to enhance students understanding of complex biological concepts in a more constructivist manner by exploration. Alec, et. al. (2020) revealed that digital tools allow for more efficient and effective assessment method leading to better tracking and

improvement of students' learning progress. Digital tools in biology education have become increasingly crucial for teachers to stay updated and enhance their professional skills (Nejati, Selehi & Akbarzadeh, (2020). The use of these tools enhances biology teachers' professionalism. Thus, Moeller(2020) opined that the online resources, simulations and virtual labs provide teachers with opportunities to stay current on advancements in the field, deepening their content knowledge.

Effective use of technology will enhance teaching and learning by digital Technology (Edinburg, 2016). Teaching various subjects as biology with ICT tools like video programming for instance helps students explore interactively (Bottage, 2009); construct knowledge from instruction which results in superior memory (Abubakar 2016) and assist the teacher in teaching the skills required in that topic (Peter, 2014). Digital technology is evident in education as Tinio(2015) opined that proper use of ICT tools in education expands access, enhances relevance to the digital workplace, improves quality and makes learning engaging. This proves that digital technology enhances effective learning and application.

Statement of the Problem

ICT tools when incorporated in biology learning makes it more relevant as digital transformation results in sustainable and successful development of a country. This will enrich education by providing interactive learning experiences, personalized learning paths, access to diverse resources, collaborative learning opportunities, real-world applications, enhanced assessment and feedback. Utilizing technology in teaching makes the lesson fun, easy and joyful for the students as they can learn at their pace, anywhere and anytime accessing the desired content and advancing towards excellence. The contemporary science teacher of which biology is a branch needs to possess essential knowledge and digital skills for the 21st century to captivate the attention of the learners and utilize their digital potentials (Ates-Cobanoglu & Cobanoglu, 2021: Agbawe, 2018). The science teaching methods to captivate the attention of the learners rely upon variables emerging from the teacher, student and the classroom learning climate (Olatunde-Aiyedun & Ogunode, 2021). Thus, Youssef & Dahmani (2022) opined on the need for the science teacher and the classroom to be digitalized for the teachers to effectively fulfil their pedagogical functions.

In Abania, the study by Kromidha and Toro (2015) revealed that some schools were equipped with ICT tools but they are underutilized. Also study in Zimbabwe also showed low utilization of the ICT tools in schools (Sibanda, Mapenduka & Furusa,

2016). It is therefore imperative to note that it is not just the availability of these tools that matter but the utilisation that will reflect the benefits, hence this study.

Purpose of the Study

The purpose of the study was to explore the integration of ICT tools in the teaching and learning of biology.

Specifically, the study sought to;

1. Highlight on the various ICT tools available and their impact in the teaching and learning process.
2. The challenges involved in the utilization of these tools and how to combat it.
3. Suggestions for further improvement.

Some ICT tools for teaching and learning of Biology

According to Ainsworth & Khan (2021) the various digital tools biology teachers should utilize in their teaching to enhance their professionalism include:

1. **Microscopy Apps**: Mobile apps like MicroLab Viewer allow students to connect their smartphones to microscopes, capturing and analysing images on their devices.
2. **Social media for Learning**: Platforms like Twitter chats allow students to connect with the scientists and scholars.
3. **Simulation Software**: Tools like PhET Interactive Simulations and Labster provide students with virtual laboratory experiences.
4. **Educational Games and Gamified Learning Apps**: Platforms like Quipper and Kahoot offer interactive games and quizzes for friendly competitions among students.
5. **3D Printing and Modelling Software**: tools like Tinkercad allow students to design and print 3D models of biological structure like DNA models or anatomical structures.
6. **Virtual Labs**: Platforms like explore Life by National Geographic aid learning.
7. **Data Analysis and Visualisation Tools:** These include software like Excel and Google sheets.
8. **Educational YouTube Channels:** Examples like Crash Course Biology and Amoeba Sisters provide entertaining and informative video lectures.
9. **Online Resources:** Websites like National Geographic Education, HHMI Bio-Interactive and Khan Academy offer extensive collections of articles, interactive activities, video lectures and problems that can supplement classroom learning.

10. **Virtual Field Trip Apps**: Apps like Google Expeditions can transport students on virtual field trips to diverse ecosystems, research labs or historical biological landmarks, enriching their learning experience beyond the classroom walls.

PhET simulation and animation can be applied in the teaching of Natural Selection in biology. Natural selection is the process by which populations of living organisms adapt and evolve over time in response to environmental pressures. According to Darwin's (1859) theory of evolution, natural selection occurs when individuals with certain traits that are better suited to their environment are more likely to survive and reproduce, passing those traits on to their offspring. It is also known as "survival of the fittest", where 'fitness' refers to an organism's ability to survive and reproduce in its environment. This is an adaptation process as these traits help an organism survive and reproduce. This leads to the gradual increase in the frequency of advantageous traits within a population over time.

Here, the biology teacher uses motion pictures of the same animal of different species denoted by their colour (white, and black) and bodily features (stout, lean with long and short ear) in teaching. The teacher with ICT tools pops up and create terrestrial habitat consisting of sheep of different species roam, live and interact with each other in the area of land. Motion pictures depicting climatic factors such as rain, sunshine, wind, humidity will be made to fall and reflect on the area. Afterwards the white long eared sheep will be made to be more in the area while the dark short eared sheep will have a reduced population. This invariably denotes the adaptation of the white long eared species over the other and which on extreme condition might lead to the extinction of the other. With the above illustration for the students, they will be able to easily understand the descriptive concept of natural selection in evolutionary biology by which populations of living organisms adapt and evolve over time in response to environmental pressures.

Other ICT tools that can be utilized in the teaching and learning of biology include:

Laptop Computer: This is a portable computer that is small and light to be used on one's lap. It has an integrated keyboard and track pads.

Desktop Computer: A computer of a size designed to be used on a desk or table. It consist of a monitor, CPU, keyboard and mouse with high processing power, connectivity and storage space ideal for gaming, video editing, graphic design and programming.

Tablet Devices: These are hand-held, light, compact, portable computer characterized by a tablet form factor and a touchscreen interface. They are used for web browsing, email, reading e-books and other related functions.

Smartphones: These are touch-screen pocket-sized mobile phones with more advanced features and greater computing capacity. Their feature include cameras, cellular connectivity, entertainment, productivity, apps for communication and more.

Microsoft Teams: This is a hub for teamwork in office which brings everything together where people can work in a team by cooperating and collaborating. It includes chatting, the use of emojis, gifts and stickers. Microsoft Teams is a place where omline documents, announcements, favourite websites, discussion, grade books and the videos can be found by students easily (Williams, 2020).

Zoom Classrooms: This is a web-based video conferencing and digital classroom system allowing face-to-face, two-way video and audio where up to 100 people can join.

Easy class: This is a free and simple online learning management system. Here, biology teachers can create online courses for the students which they can access at any time and pace. Teachers can share materials, files and make announcement in a well-organized and systematic manner.

Near pod: This is a platform which offers teachers an east-to-use tool for creating interactive lesson plans, presentations, assessment and digital content.

Others tools include: Google classrooms, YouTube videos, Google Hangout Meets etc.

Difficulties Encountered in the Utilization of ICT tools

- **Digital divide and disparity to accessibility**: There is limitation in the usage of ICT tools and participation in digital learning especially among rural students due to the differences in the access to technology and internet (Ainsworth, 2022; Warschauer, (2017).
- **Cultural stereotypes and biases**: Unconditional biases, negative stereotype, feminism marginalize students of colour and discourage girls from pursuing ICT (Archer, De-Witt & Willis, 2015).
- Lack of confidence, negative attitude, resistance to change as individual characteristics impede successful ICT utilization (Nwagbo & Ugwuanyi, 2012).

- **Socio-Economic Disparities**: It is obvious that students from low-income earning families lack access to ICT tools resulting gaps (Reardon et. al., (2018).
- **Poor teacher training and support**: Many teachers lack the pedagogical knowledge and skills to effectively utilise digital tools in instruction delivery (Lee & Hannafin, 2016; Voogt et. al. 2013).
- **Special needs for access and use**: Digital platforms often lack features to accommodate diverse learning needs creating barriers for students with disabilities (Bull, Brophy & Maher, 2016).
- **Ethical Concern**: Data privacy, security and algorithmic bias in educational technologies abound. Schools face challenges in ensuring student data privacy and security when utilizing online platforms and digital resources. There is need for the establishment of policies and regulations to safeguard students' information as we reap the benefits of technology integration (Bennett & Mattern, 2018; Selwyn, 2016; Warschauer, 2017).

- **Cost and Infrastructure**: Equipping schools with the necessary hardware, software and high-speed internet access can be a significant financial burden for some nations. Additionally, on-going maintenance and technical support for this infrastructure requires consistent investment (Warschauer & Matuchniak, 2010).

Solutions to Limitations Encountered in ICT Utilization

1. **Bridging the Digital Divide**: The study by the International Telecommunication Union (2023) suggests a combination of infrastructure investment, subsidized devices and low-tech alternatives like mobile learning apps to ensure equitable access.
2. **Enhancing Teacher Training Support**: A study by Mishra, Koehler and Mishra (2022) explores the importance of professional development programs in equipping teachers with the skills to integrate technology effectively.
3. **Sustainable Funding and Infrastructure Development**: Warschauer and Matuchniak (2010) stressed the potential of public-private partnerships to address the financial challenges of technology integration in education.

Roles and Implications of ICT Integration in classroom

The utilization of ICT tools in the teaching and learning of biology is of immense benefit in education. According to Smith (2020), the integration of computers, interactive boards, and high-speed network connectivity in schools has revolutionized the way education is delivered and experienced; thus viz:

1. **Access to Global Connectivity**: High-speed internet enables schools to connect to online learning platforms and educational websites beyond their classrooms facilitating knowledge sharing, communication and collaboration.
2. **Enhanced Learning Resources:** Teachers access a wide range of digital resources such as multimedia presentation, educational software and online database.
3. **Interactive Teaching Methods**: Interactive boards offers the teacher an engaging and interactive session as s/he incorporates multimedia content, interactive quizzes and visual simulations. This improves active participation and cooperation among students enhancing critical thinking, problem solving and creativity.

Other benefits that accrue from digital integration in classroom include- Remote Teaching Opportunities and Collaborative Project Research. Also Alajmi, Kamaludin and Sharafi (2017) highlighted on these benefits as;

- Promotion of high effectiveness in knowledge acquisition
- It is applied in the instruction of variety of discipline
- It ensures learning opportunities for all students and creativity
- It promotes increase in learning interest among students.

According to Cheng and Tsai (2014) other benefits include;

- **Improved Student Outcome**: When teachers are equipped with effective teaching strategies and digital resources; they can create engaging and stimulating learning environments that foster deeper student understanding and higher academic achievement.
- **Innovation and Workforce Development**: A strong foundation in biology is essential for nurturing future scientists, researchers and healthcare professionals.
- **Enhanced Scientific Literacy:** A scientifically literate population is crucial for national development.

It is worthy to note that there are other benefits which accrue from the use of ICT tools as we manipulate with them, thus;

- It promotes the mastery and deepening of the content knowledge as we stay abreast with the novel advancement in our field and discipline. This is possible because we have access to various online materials which exposes us to wide available knowledge.

- It enables us as teachers to collaborate and cooperate with other colleagues online sharing teaching experiences for effectiveness.
- It provides us access to communications opportunities with people around the globe for information and feedback for learning.
- It provides flexibility in self-directed learning as teachers strive for personal professional development at one's pace with priority and focus on area with lapses and need for improvement. Also, it allows for personalized learning experiences tailored to individual student needs, preferences and learning styles.
- It enables teachers to develop pedagogical skills as we introduce and experiment with innovative teaching methods we surf online into our classroom lessons.
- It's use captivates interest and motivates both the learner and the teacher as novel knowledge is welcomed.
- It prepares us for the Digital Age.

Conclusion

Biology is one of the core subjects offered in secondary schools which is also a course offered in science education at the university. This course in our present era utilizes ICT tools which had transformed the process students learn. This is because of its integration into the classroom thereby altering the conventional method of instruction delivery by the teachers. These tools enable the teachers to meet up with the objectives of the lesson as they stimulate students' interest resulting in meaningful learning.

Suggestions for improvement

The following would aid proper utilization of ICT tools in teaching and learning of Biology;

1. In-service training in the form of workshops and seminars should be organised for teachers for acquisition of the technological knowledge to be abreast with the digital era in addition to the mastery of subject content.
2. Curriculum planners and education policy makers should ensure the use of these digital tools are included in the syllabus where needed to keep-up with the technological age.
3. Governments and relevant education sponsors should ensure the provision of sufficient fund for the purchase of needed ICT tools for teaching and learning.
4. The steady supply of power for the utilization of these tools should be ensured by the government and other necessary agencies.

5. Monitoring team should be constituted to enforce the appropriate use of these tools and guard against their vandalization and stealing.

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