Teachers' and Students' Difficulties and Strategies in the Teaching and Learning of Science Subjects using ICT in Nigeria.

Nwoye, Amarachukwu Nkechi
Department of Science Education, NnamdiAzikiwe University, Awka, Anambra State, Nigeria
Moses, John Billy
Department of Science Education, Niger Delta University, Wilberforce Island, BayelsaState, Nigeria

Abstract- The importance of ICT in the creation and dissemination of information have taken on magnified proportions globally. This is because ICT provides a means of scaling the knowledge creation and learning process and helps in improving accessibility. The teaching and learning of science subjects all over the world have being significantly improved in the countries that have adopted ICT in this crucial process. Evidence suggest that these countries have higher academic performance and have also experienced accelerated levels of development. While some of the benefits of integrating ICT with science education are being reaped in some cases in Nigeria, the countrywide situations still portend a low use of the technology with the attendant effect that science education in the country has relatively stagnated. Utilizing an analysis of past literature on the use and challenges of ICT in Nigeria, this paper discusses the difficulties faced by teachers and students in using ICT in Nigeria and some of the strategies that have being developed to combat these difficulties.

Keywords- ICT, Science Education, Science Subjects,

I.   INTRODUCTION

The quest for a fast pace of development in many countries of the world has led to the recognition of information and communication technology (ICT) as the transfer highway of knowledge that will fuel such development, According to Ghavifekr, Afshari and AmlaSalleh (2012), One of the major sectors that have being subjected to the paradigm changing impact of ICT is the education sector and most importantly the teaching of science subjects. Through a phenomenon that has being aptly described as the integration of ICT, information and communication technology has become an integral part of the instructional and learning process. Arnseth and Hatlevik (2012) noted that the integration of ICT into the educational process is revolves around the incorporation of computer-based technologies into the daily classroom instructional process. Other authors- Young (2003) and Albirini (2006) - have expanded the scope of the integration of ICT in education to include any kind of learning environment.

The relevance of ICT to the processes of teaching and learning is premised on a number of advantages which the technology confer. Arnseth and Hatlevik (2012) noted that ICT has the demonstrated capability of being able to provide a teaching-learning environment that is not only dynamic but proactive. This is particularly important in the 21st century's knowledge society where surviving and thriving is to a large extent dependent on adaptability and dynamism. The modern society is in a constant state of flux and demands that an individual be equipped with fitting knowledge, this consequentially has put at premium an educational system that stresses dynamism. Albirini (2006) also opined that the relevance of ICT to education is a function of ICT's ability to improve the accessibility, quality and cost efficiency of the process of delivering instruction to the learner.

Viewed form the context of the teaching and learning of science subjects in Nigeria, the integration of ICT into the educational process takes on a magnified proportion. According to Adebayo (2010), the Nigerian educational system is relatively ineffective as a key contributor in the achievement of national goals and objectives. Adeyemo (2010) contended that the system of science education is based on irrelevant curricula, out- dated pedagogies and generally inefficient learning methods. These two assertions portend a system in which there is a misalignment between the needs of the society and the educational curricula and methods. This is especially apparent in the teaching and learning of science subjects. Aina (2013) asserted that the teaching of biology, chemistry and physics in Nigeria has continually suffered from low levels of application of information technology to the learning process with the resultant effect that teachers are largely inefficient and ineffective and students are taught modules that are outdated while missing out on critical knowledge that is necessary for the careers and for coping in the knowledge society.

While there are different factors responsible for the relatively lower use of ICT in the teaching and learning of science subjects in Nigeria, it is important to point out that even in areas where efforts have being made to integrate ICT with the educational system whether through private initiative or public intervention, certain internal factors still hamper the gains that should have being made from such integration (Awolaju, 2010; Nguyen et al 2012). These internal factors informed the direction of this study.

II.   PURPOSE OF THE STUDY

The advantages of integrating ICT with the educational system and incorporating ICT in the teaching of physics, chemistry

and biology have being demonstrated in different studies (Albrini, 2006; Adebayo, 2010; Adeyemo, 2010; Aina, 2013, Obaydullah and Abdur Rahim, 2019). Other studies also touched the various barriers to this incorporation or integration (Bingimlas, 2009; Gotkas et al, 2009; Buabeng- Andoh, 2012). This study will be investigating the difficulties experienced by teachers and students in the teaching and learning of science students using ICT and the strategies that have evolved to resolve these difficulties within the context of the Nigerian educational system. This will be achieved through the following objectives;

1. Identify the applications of ICT in the teaching and learning of science subjects in Nigeria.
2. Examine the difficulties in the use of ICT for teaching and learning in Nigeria.
3. Examine the strategies used by teachers and students in combatting the difficulties faced in the use of ICT for teaching and learning in Nigeria.
4. Identify the potential opportunities for the use of ICT for teaching and learning science subjects in Nigeria.

III. RESEARCH QUESTIONS

As derived from the objectives which are stated above, the following are the research questions which this study seeks to address;

1. What are the applications of ICT in the teaching and learning of science subjects in Nigeria?
2. What are the difficulties experienced in the use of ICT for teaching and learning in Nigeria?
3. What are the strategies used by teachers and students in combatting the difficulties faced in the use of ICT for teaching and learning in Nigeria?
4. What are the potential opportunities for the use of ICT for teaching and learning science subjects in Nigeria?

IV. MATERIALS AND METHODS

The findings of this study were informed by the thematic review of selected documents relating to each objective and research question. Ertmer (2005) have defined such method as deriving from a documentary analysis of written materials which contain information about the facts and events targeted for investigation. This study is based on a qualitative survey of past literature at the nexus of ICT and education in Nigeria, in the dimensions of application, constraints, contributory factors and potential opportunities. The sources of information are majorly journals. A list of all cited works is provided in the references section.

V. THE USE OF ICT IN THE TEACHING AND LEARNING OF SCIENCE SUBJECTS

The importance attached to science subjects all over the world have spurred the application of science and technology in the teaching of the subjects. The realization that science education plays a cardinal role in ensuring technological development on one hand, and the demonstrated capability of ICT to scale any phenomenon to which it is applied have also served to accelerate the application of ICT to the teaching and learning

of science education. According to Aina (2012) and in support of earlier assertions by Akinloye and Ilori (2010), the use of ICT in promoting science education is prevalent in the developed countries of Asia, Europe and North America because teachers and students have a generally positive attitude towards electronic learning and other IT competencies. Ajayi and Ojo (2010) and Nguyen et al (2012) further noted that the use of ICT in science education is premised on the ability of the technology to provide access to information and promote a networking that cannot be restricted by culture, physical boundaries and language.

Another dimension of this relevance is the fact that the trend towards the use of ICT as invaluable tools in the maintenance of the social and political framework of the society provides a ready- made source of learning for students as ICT enables the transfer of knowledge from one sphere to another. The strong linkage that ICT weaves between the different facets of the society has served to enable the easy and faster flow of knowledge in the developed countries and has in these countries led to the emergence of an educational system that is not archaic unlike what is commonly obtained in sub Saharan African countries (Dawodu and MacGregor- Odusanya, 2010).

In the realm of science education, the applications of ICT are to a large extent dependent on the aims and knowledge of the users and on the context within which learning is taking place. Nguyen et al (2012) provided a classification of ICT in learning and this revolves around the use of ICT as learning resources, and for the instructional organization of communication. Aina (2013) on the other hand explained that the use of ICT in the teaching and learning of science subjects can be classified according to utilization type and this include Computer Aided Design (CAD), Computer Assisted Instruction (CAI) and Library Computer Systems (LCS). This classification is premised on the use of ICT for the creation and design of new information, transmitting such information and finally archiving and retrieving it. Other authors have classified the use of ICT in science education based on specific usage in the basic domains of physics, chemistry and biology.

ICT has proved to be useful in the teaching and learning of physics in the developed countries of the world and in some developing countries. The realization that physics is treated as a difficult and abstract subject with little practical implications has over time dampened interest in the learning of physics (Adeyemo, 2010). However, the emergence of ICT as an important tool in the teaching and learning of physics has proved that the subject is not inherently boring, rather teachers are usually not equipped with the skillset and tools to make it more interesting. Aina (2013) expressed that the proliferation of educational software aimed at explaining the complex aspects of physics have served to trigger interest in the subject. Ertmer (2005) also noted that software now exist that can be used to explain the complex mechanisms involved in the functioning of various physical systems. Another important use of software in physics is that it helps in simulating such

novel aspects as relativity, quantum mechanics and nuclear energy which hitherto have being taught using complex explanations that have accelerated the loss of interest in physics.

One of the major applications of ICT in the field of chemistry relates to the tremendous impact it can have on improving classroom and laboratory safety. A key component of the chemistry curriculum all over the world relates to the conduct of scientific experiments (Omosewo, 1999). The reactions of chemicals in enclosed environments can sometimes lead to explosions and the diffusion of dangerous gases. ICT provides a graphical means of simulating these experiments and thus reducing laboratory accidents. Also, the traditional pedagogy of chemistry often rely on verbal explanations of sub- atomic, atomic and molecular relationships and interactions. According to Obaydullah and Abdur Rahim (2019), the use of ICT allows for a visual display of such interactions and improve the knowledge retention rates of students as ICT promotes the multi- sensory learning. Aina (2013) also reported the demonstration of this application by noting that ICT enables the design and use of animations and videos of complex molecular structures, ionization and electrochemical processes.

ICT is also applicable in the teaching and learning of biology. Dawodu and Mac- Gregor (2010), maintained that the use of ICT has being instrumental in visualizing micro- organisms and biological reactions at the micro- level. Also, ICT helps in aligning biological education and environmental sustainability (Aina, 2013). This is because the use of ICT for simulation and visualization reduce the expense in terms of financial resources and number of animals needed for experimental specimens. Biology software also provide a viable means for studying dangerous microbes including infectious viruses which can be transmitted if not handled carefully. ICT provides a means for such studies in a controlled environment.

Generally, ICT have overall positive impact on the teaching and learning of science subjects. The design of various learning interfaces have allowed for interaction of students with virtual systems that can coach them in specific areas where they need academic help. According to Ertmer (2005), such interfaces also facilitate teamwork in the resolution of tasks and assignments. On a larger scale, ICT has lend itself as a platform for collaboration between teachers and researchers, this important process helps in increasing the stock of academic knowledge and as such help in ensuring that students are exposed to up-to-date information. Obaydullah and Abdur Rahim (2019) mentioned that ICT aid the processes of analyses and computing. This makes the work of teachers and students easier and frees up time that can be used for other academic enhancement purposes. Lastly, Aina (2013) asserted that one of the relevance of ICT in the teaching and learning of science subjects is that it helps in improving the costs of education. Digital devices such as PDAs and Tablets have vast memory that can be used in storing textbooks, trial assessments and other instructional materials. This vastly reduces the amount of money spent on buying textbooks and learning materials and thus increase the level of funding available for other purposes.

VI. DIFFICULTIES AND STRATEGIES IN THE USE OF ICT FOR TEACHING AND LEARNING SCIENCE SUBJECTS IN NIGERIA

Despite the demonstrated advantages of ICT in the teaching and learning of science subjects, the use has being laden with a number of challenges in Nigeria. Such difficulties are experienced by both the teachers and the students. There are difficulties that are however common to both groups. According to Olugbenga and Adebayo (2010), one of the major factors militating against the use of ICT for science education in Nigeria is the inadequacy of funds. Implementing a comprehensive ICT for science education is an expensive undertaking. Huge capital expenditure is required for such items like computers, routers, internet stations, tablets, PDAs and projectors. The large population of the country have led to the emergence of a public education system made up of significant proportion of resource poor students, as such the financial burden of the use of ICT for science education often falls on the government which is in itself often faced with fiscal constraints. The consequence of this is that accessibility to ICT devices is low among students and teachers. The inadequate levels of ICT devices in the country can also be attributed to the fact that the UNESCO recommendation of 26% of total fiscal budgetary expenditure on the education sector (Akindutire, 2010).

Another constraint which pose as a general difficulty for both students and teachers is the inadequacy of human resources available for developing local content for science education. Obaydullah and Abdur Rahim (2019) stressed that while science is a universal phenomenon with globally standardized conventions and measurements, there is a need to develop content that fits into local context of education in the country while exposing students to global standards. The implication of this is that teachers only have access to software which were developed for other countries and other local educational contexts. This difficulty is also experienced by students who have to make sense of digital materials designed for students in other countries.

Another set of teachers' difficulties in the teaching of science subjects using ICT is the low level of digital illiteracy of teachers in Nigeria. Albrini (2006) reported that teachers in the developed countries of the world have as a requisite skill for the performance of their job, the ability to use computer technology and other digital skills. In some other developed countries of the world, teachers interact with students online and provide extra- tutoring for those students who need help in their academics. Olugbenga and Adebayo (2010) also described the use of advanced technologies for such tasks as preparation of lecture notes, marking of assignments and recording and collating and marking of examination scores. The situation is however different in a developing country like Nigeria. Ajayi and Ojo (2010) mentioned that majority of

teachers in Nigeria are digitally illiterate. A number of factors have contributed to this high level of illiteracy. These include the fact that while digital skills were not emphasized during the training of these teachers, their skills were not updated through seminars, workshops and refresher courses. Aina (2013) also explained that the digital illiteracy among teachers became prevalent due to the high level of poverty in the country. The author noted the point succinctly when he stated that 'many teachers do not have a personal computer because of their low income and because some of them do not see the need for it'.

Another difficultyfaced in the application of science to the teaching and learning of science subjects which also affects teachers and students revolve around the epileptic power supply in the country. The situation is magnified because ICT depends on electricity to function. Adebayo (2010) noted that the unreliable power supply in the country poses a continual threat to education by increasing the costs associated with the use of ICT. What obtains in most schools where ICT is available is that such infrastructure lay largely unused or underused due to epileptic power supply. Related to this is a poor maintenance culture in the country which have continually subjected available ICT infrastructure to damages and in the long run increase the costs of using such technology (Aina, 2013).

There are other teacher- and student- specific difficulties. One of the major problems faced by teachers even when there is sustained interest to use ICT for teaching science subjects is the relative lack of pedagogical models that can readily align with ICT usage. According to Dawodu and MacGregor-Odusanya (2010), the pedagogies used in Nigeria are designed mainly for a teacher- centered approach to learning and as such devoid of the necessary interaction that ICT requires. On the part of the students, a major difficulty lay in the relatively high number of students who want to use the same ICT facilities. This problem stems from the over- population of Nigerian schools and is aggravated by the fact that eve when students cannot access ICT facilities in the school because of high demand, they also cannot access it at home because they often lack the resources to procure such devices (Olugbenga and Adebayo, 2010; Nguyen et al, 2012).

In coping with the difficulties elucidated above, Nigerian teachers and students had made use of a number of strategies. To curb the difficulty of digital illiteracy, teachers now regularly attend computer training classes in order to bolster their skillset and ensure their ability to use digital devices (Dawodu and MacGregor- Odusanya, 2010). The proliferation of many self- taught digital literacy programs have also being taken advantage of by these teachers. In responding to the inadequate number of digital devices available for teaching and learning, the rate of ownership of digital devices among teachers is on the increase because teachers now take advantage of cooperative societies in the procurement of funds to buy such devices. The increased training of teachers in the use of digital technology is also having the effect of encouraging the design of course materials which reflect the local context of education in Nigeria. This is similar to what obtains in countries like Bangladesh and China where teachers take a lead role in the development of digital content that can be distributed and used for a number of purposes (Obaydullah and Abdur Rahim, 2019). While being an example of a strategy that requires collaboration between teachers and the management and sometimes the Parents- Teachers Association (PTA), the alternative provision of electricity using fuel-powered generators has gone a long- way in ameliorating the effects of an epileptic power supply.

VII. POTENTIAL OPPORTUNITIES FOR THE USE OF ICT FOR TEACHING AND LEARNING SCIENCE SUBJECTS IN NIGERIA

The prospects of using ICT as a tool for the teaching and learning of science subjects in Nigeria are best defined in terms of the potential opportunities which the integration of ICT into the educational system holds. A recurrent educational problem is the quest of getting students to be interested in a subject- this is because learning is faster and more effective if interest is readily stimulated. Chien et al (2014) noted that ICT provide a viable means of sustaining this interest. This assertion is premised on the fact that the new generation of students already have a high level of exposure to ICT and social media and most times define their social life by their proficiency in the use of various aspects of these tools. As such, integrating ICT into the curriculum provides a ready-made base upon which learning can be built. Another opportunity lay in what can be achieved if teachers can be trained on how ICT can be used as a tool to help in the learning process and also provide solutions to real- life problems. Cuban (2001) expressed that instilling such knowledge in students help in accelerating technological development in any country as it provides a sustained program of awareness on the usefulness of ICT and the role which it plays in economic development.

Another potential opportunity which the incorporation of ICT into the teaching and learning of science subjects provides is that it allows for the educational process to be scaled in an inexpensive way. Ghavifekr et al (2012) noted that ICT provides a relatively cheaper and more accessible education in the long run because it provides a structure through which classes can be recorded, transmitted and accessed at anytime and anywhere depending on the framework of the technology being used. This is especially important in a developing country like Nigeria where the budgetary burden of the conventional education has produced an educational system that is largely ineffective in contributing to the achievement of national development and economic goals. ICT provides a means for scaling education and making it accessible even in the remote areas where it is deemed uneconomical or not feasible to site a school.

Lastly, another opportunity offered by the integration of ICT into the teaching of science subjects is that such relationship have being demonstrated to be a trigger for the development of creativity and advanced problem solving skills on the part

of students (Albrini, 2006; Cassim and Obono, 2011). These skills are relevant in the context of surviving and thriving in the 21st century and the knowledge society that has emerged from it. The use of ICT in the teaching and learning of science subjects provide a valuable foundation for interacting and managing knowledge by the student and these are valuable work- related skills necessary for the future. Cox and Marshall (2007) have also shown that the use of ICT in the teaching and learning of science subjects have helped in increasing the efficacy, competence, confidence and attitude of teachers and this in the long run aids the development of the science education system as a whole.

VIII.   CONCLUSIONS AND RECOMMENDATIONS

The importance of ICT in the modern learning environment cannot be over- emphasized. Asides from its demonstrated effects on improving the rate of knowledge retention, the use of ICT have also being shown to provide a valuable foundation for the development of the skills which are necessary for success in the 21st century with the consequential effect of playing a key role in spurring national development. This is especially important in a country like Nigeria where the need for development in combatting the many ills of poverty, disease and illiteracy is dire. This paper have examined the impact of ICT on education, the difficulties and strategies related to its use as experienced by teachers and students and the potential opportunities it offers. Nevertheless, reaping these benefits and mitigating the identified difficulties can be aided through the recommendations below;

1. There is a need for co- opting the private sector as a partner in the provision of ICT to schools. This recommendation is premised on the logic that the organized private sector stands to gain tremendously from an educational sector where the study science subjects is based on the use of ICT.
2. There is a need to integrate into the teaching of science subjects and evaluation of the ability of the teacher to use ICT in the collation and dissemination of knowledge.
3. Ensuring that maximal gains are made from the integration of ICT with science education is based on the guaranteed accessibility of students to ICT devices which can facilitate learning, there is a need for the government and the organized private sector to work on the development of simply- designed devices embedded with the learning functionality and inexpensive to produce, this would increase the rate of accessibility to such devices.
4. Lastly, there is a need for a more vigorous approach to the development of local content, this is essential in order to tailor the an ICT- assisted learning process to the local context of the country and the identified needs of national development.
5.

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