Issues in ICT Integration for Achieving the Goals of 21st Century Science Education

Laleye, A.M. (Ph.D)[1], Babafemi, G.T.[2].

Department of Science Education Faculty of Education Adekunle Ajasin University, Akungba-Akoko, Ondo State
Department of Science Education Faculty of Education Adekunle Ajasin University, Akungba-Akoko, Ondo State
Corresponding Author: Laleye, A.M. (Ph.D)

Abstract: *The 21st century is characterized by science and technology that is responsible for the development recorded today. This identified impact of Science and Technology necessitated the need for a improved science instruction. This paper examined the roles and constraints of ICT integration in science curriculum implementation in addition to ICT tools availability level. A number of literature ranging from secondary data; internet sources, journal publications and assertions of scholars were reviewed around the theoretical framework. Arousing science students' interest, promoting collaborative learning, enhanced participation and limitless access to information were identified roles of ICT integration. The paper further presents ICT and Science Education as inseparable but the non-availability of equipment in Nigerian schools is confronting this stand. Poor funding, inconsistent power supply, level of computer expertise among others were identified constraint of effective ICT integration. The paper recommends that Government should increase allocation for education to enhance the procurement of ICT tools needed for effective science education alongside the retraining of teachers.*
Keywords: ICT, ICT integration, Science Curriculum, Improvement

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I. Introduction

The 21st Century And Resources Availability

The rapidly changing world is characterized by constant advancement and development of materials and human resources to meet the daily challenges faced by the 21st century community. These challenges include and are not limited to environmental pollution, deforestation and ecological degradation, corruption, population explosion and increased resources consumption (EPA 2011a, World watch Institute 2011). Those challenges hinders such development, itself is predicated on adequate utilization of scientific skills and concepts to meet basic needs, solve daily problems and increase productivity (Tan, 2004; Kazeni 2005). Scientific skills, problem solving and critical thinking skills are life skills essential to adequately cope with societal problems. This can be achieved through observing, gathering information, formulating hypothesis and presenting rational explanations for events. These 21st century skills are needed for relevance in globalization and can be developed through ICT-viral based instructions in schools.

Objective of the study

The aim of this study is to identify the roles of ICT integration for effective science curriculum implementation. It further reveal the relationship between ICT and Science instruction, the state of ICT tools and facilities in schools and the possible constraints inhibiting ICT integration among science teachers.

Science Education: Objectives and Attainment

Science, a term used to describe the outcome of scientific investigation, also refers to the process through which the outcome is attained. The concept enjoyed several definitions from various scholars with the main focus being all that is related to scientific products, processes, attitudes and even scientific issues. Science was included into the curriculum with the aim of developing scientific attitudes, science possess skills, critical thinking, problem solving ability and scientific literacy. Science education deals with sharing of science content and process with individuals who are not considered traditional to be member of the scientific community (Kola, 2013). Science is very important not only for the well-being of the individual, but also for the society as a whole (Odubunmi, 2006). This is because of the observable impact of science and technology on the world of today

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and the future (Marginson and van der Wende, 2007) and the association between science and challenges encountered in society calls for an adequate science education.

Science education offers personal and social adjustment to its subscribers. Its goals are to produce scientist for national development and cultivate an enquiry mind in citizens of the Nigerian society (FRN, 2004). McPhearson, Gill, Pollack and stable (2008) further indicated scientific literacy as a necessary element of education in our modern science and technology driven community and that it is crucial to teach science to all citizens, not only for those who actively engage in careers in science. Science is not static but dynamic, indicating that a prominent science instruction is not to be rigid rather continuously employing techniques and strategies to achieve its goals. However the present day science education in Nigeria calls for an assessment in relation to poor learning outcomes (academic performance, interest and attitude) by students. A previous research by Bichi, Hafiz and Abdullahi (2007) revealed that students achievement in three science subjects were slightly above average which is not a very good stand point for the educational system.

A critical analysis of students' result in biology, chemistry and physics in WAEC examination revealed that the percentage of students that passed Biology at credit level and above (A1-C6) was consistently less than 40% from 2007-2012 with an increase to a range of 51% through 62% from 2013-2016. In physics, there was an inconsistent increase ranging from 43%-50% between 2007 -2012 with an increase to 57% and its environs between 2013 -2016. A similar pattern is observed in chemistry during the periods as reported by Badmus and Omosewo, (2018). The analysis presented above is not a poor one all-together but it comes short of expectations and therefore, improvement is needed.

Information and Communication Technology

ICT, the acronym for Information and Communication Technology, is one of the building blocks of the modern society (Daniel, 2002) and played a prominent part in reducing the world into a global village. This reduction is seen in the breakage of communication and geographical barrier by its components. ICT involves the use of computers and digital technologies in disseminating curriculum contents in order to better achieve the stated goals and objectives (Laleye, 2016). ICT elements and components includes computers, projectors, interactive white boards, slides, filmstrip, computer software, microfilms, flash drives, CD-ROMs, floppy disk among others. ICT in education involves the adoption of general components of information and communication technology in practical use in teaching and learning processes (Voogt and Pelgrum, 2005). Information Technology was defined by Kumar (2009) as the teaching associated with the creation, storage, selection, transformation and distribution of information of all kinds. Internet facilities have now become a notable way of storing and sending information or data. The aim of ICT is to help simplify and make easy the process of communication through the use of gadgets and software which enable one person at one end reach the other without physical contact. Video conferencing, social media, mobile phones among others are cogent in this wise.

The Role of ICT in Science Teaching

ICT has penetrated all spheres of human life. Education is not left out, as it plays a vital role in attaining the goals and objectives, contributing materials in scientific activities and contents and enhancing the evaluating techniques through its tools. Lately, ICT and Science teaching have become Siamese twins, which are inseparable, with each influencing and requiring the other to be fully explored. ICT provides certain tools which have helped simplify the medium of communication between the science teacher and the learner. There is a shift in learners' nature from passive and dependent learner to active and autonomous learner who engages in scientific endeavors using ICT tools and facilities, even in the absence of a physical teacher. The integration of information and communication technology in science teaching and learning serves:
i.   improve the quality of teaching (Garrison and Anderson, 2003),
ii.   arouse students' interest and makes learning interactive (Bell and Margaret, 2006; Sivapalan, Wan, and Ishak, 2009),
iii. inculcate inquiry minds,
iv.   improve hands-on activities,
v.   engage and inspire students (Becker, 2000),
vi.   promote collaborative learning (Melor, Salehi, and Chenzi, 2012),
vii. provide global access to knowledge (Bell and Margaret, 2006; Anthony, 2012) ; and
viii. connect learners, both students and science educators, to experiences that emulate how science is practiced in the real world (NRC 2012).

The science education curriculum is divided into: aims and objectives, contents, learning activities and evaluation. The ICT integration is discussed under the following:

Science Content Knowledge and ICT integration

ICT usage in science instruction has proved to help students better comprehend the content matter through presentation of concepts in texts, images, sounds, videos to mention a few. It provides a reservoir of multimedia resources necessary for knowledge enhancement. With the use of different search engines through internet access, students and teachers are not limited in the level of information accessible and also give room for individual learning styles in the classroom situation. The increase in students' achievement through ICT usage is corroborated by the research finding of Erdemir (2011) that discovered an improvement in students' learning of physics after exposure to power point slide instruction and (Yien, Hung, Hwang, and Lin (2011) that exposed game-based learning to students in a nutrition course and discovered that this approach was more effective in enhancing the learning and attitudes of students than traditional teaching and even influenced their dietary habits. Also, the storage facilities provided by ICT also give students the platform to easily carry resources in flash drives and CD-ROMs as against the traditional textbook which may be bulky and enormous to transport around. It further enhances the presentation of abstract concepts in physic, chemistry and biology thereby making them real.

Science learning activities and ICT integration

Scientific activities, the heart of science teaching, comprise of all the range of activities that students and teachers are involved in to understand or comprehend the subject matter. These also include the teaching strategy, the material resources, laboratory facilities and series of events directed towards goals attainment. The traditional method requires the physical presence of the teacher and aims at knowledge acquisition with limited effort on skill acquisition as against the ICT integration which is geared towards overall developments of life skills and can be used in the absence of a facilitator. ICT makes for complete engagement of students (Wood, 2004) through the provision of facilities such as virtual laboratory, where students repeat practical demonstration of what is not understood (Scheckler, 2003). Virtual labs allow repetition to foster mastery and reservation of available chemicals and materials. Similarly, virtual libraries also surmount the challenges of assessing, compiling and storing books.

Also in Science lesson delivery, several ICT related methods have proven to be more effective in improving students' performance and attitude towards science (Akingbemisilu and Ihekoronye, 2016; Raimi, Bolaji, and Adesina, 2016; Chang, 2000). Use of simulation, computer animation, Computer Assisted Instruction, Power point and Video platform are common instructional strategies that increase students' participation during learning. Furthermore, with continuous advancement in ICT, innovative instructional strategies which include flipped classroom and blended learning is fast gaining grounds in teaching and learning as they involves the combination of a variety of ICT methods thereby enhancing learning. Several social platforms such as Edmodo enable teacher and students to connect beyond the classroom with the teachers regulating the process.

Evaluation in Science Education and ICT integration

The outcomes of the teaching processes are obtained through assessment either during or after lesson that is formative and summative evaluation. Assessment is unavoidable and a check of the achievement of the stated objectives. it involves construction of test, which may be multiple choice or essay type, as well as the determination of a means of scoring or quantifying the test items to reveal students' performance. According to Sonnichsen (2000), Evaluation is a study designed and conducted to assist some audience to assess an object's merit or worth, thereby revealing the extent of the goal attainment. ICT integration in science teaching results in a paradigm shift from paper and pencil test to the use of electronic gadgets which helps to reduce the workload of the science teacher. With the development of Computer based Examination, students can be evaluated with little stress and in the absence of the invigilators who can be replaced by CCTV camera. Aside computer based test, Video clips and simulation can also help to make the testing process friendly and flexible. This form of testing also plays a major role in motivating the students and enable them self-regulate their learning process through quick or immediate response or feedback. Furthermore, specimens and materials needed to augment for real objects during examination are easily available on the internet. Interactive platform can also serve as a means of quizzing beyond the classroom.

Availability of ICT Facilities in Nigerian Schools

Having identified the different roles of ICT tools and gadgets in science education curriculum implementation, the availability level of these facilities may impede or assist their effective integration. This section presents the level of ICT facilities as revealed by previous studies conducted in the Nigerian situation. Availability of ICT facilities refers to the number and readiness of the ICT gadgets such as computers, projectors, printers, scanners, internet and software among others for effective communication of curriculum content. A study conducted by Ajayi and Ekundayo (2009) on the application of information and

communication technology in Nigerian secondary schools revealed that ICT facilities such as computers, radio (tape recorders), television sets, video disc players, bullet boards were available in schools while some facilities like projectors, electronic notice boards, internets, film strips are scantily available. Similarly, Aladejana (2007) discovered that 20% (5 out of 25) of the schools that was surveyed had one or two computers which children have access to and only 4% (1 out of 25) have more than two computers for children's use. None of the schools had a laptop, LCD projector, video-recorder, talking books, sensors, database software, spreadsheet, or floor robots. Only one school (4%) had an overhead projector.

Furthermore, Fakeye (2010) discovered in his study in Ibadan, Oyo state, Nigeria that a large portion of schools studied do not have PCs and therefore are not associated with the web (Internet). Umeh, Tukura and Anaih (2013) reported that computers, email, internet, printer and browser phones were fairly available while Digital camera, scanner, video equipment and data processor were not available in Niger State College of Education, Minna, Nigeria. The internet, projector, fax machine, computer set, video tapes, digital camera, scanner, telegraph, radio, printer, CD-ROM and DVD were found not to be available in schools in Niger state, Nigeria (Abdulkadir, Ibrahim and Ma'aji 2014) Abubakar (2016) reported same in the northeastern part of Nigeria. His research on the assessment of the use of ICT in teaching and learning in public secondary schools and reported that presentation software had a mean score (M=1.67), overhead projectors (M=1.33), CBT software (M=0.36), smart/white boards (M=0.65) and LAN or internet (M=0.52) which are all below the average mean score of M=1.73 indicating their non-availability in the schools. These studies revealed that ICT facilities in Nigerian schools have not been present to the advantage of the educational system and this unavailability can affect the level of usage for positive response. This unavailability of ICT facilities is associated to certain constraints which may not be unconnected to inability to preserve the science education practiced in the country in favour of the future generation.

Constraints of ICT integration in Science Teaching

The roles of ICT integration in successfully implementing the science curriculum are enormous and evident in goal accomplishment. However, the usage of these ICT facilities has not been adequately explored by science educationist in the Nigerian situation because of the identified constraints/impediments. Previous research findings revealed the following as possible constraints affecting ICT integration in teaching and learning includes:

i.   Large class size (Aladejana, 2007)
ii. Attitude towards ICT (Drent and Meelissen, 2007)
iii. Poor Funding (Yusuf, Afolabi and Loto, 2013; Laleye and Onasanya 2016)
iv. Inconsistent power supply (Laleye and Onasanya, 2016)
v.   Computer expertise and technological self-efficacy (Laleye and Onasanya, 2016)
vi. High cost of ICT gadget (Yusuf, Afolabi and Loto 2013)

The above identified constraints prevent the one child- one laptop policy and reduced the level of interaction between the teacher and the students. Negative attitude towards the ICT and wrong perception by teachers will hinder the level of ICT integration into teaching. Furthermore, inadequate supply of fund to procure and maintain ICT equipment determines to a large extent, the number of ICT tools available as well as accessible for learning. This is because the presence of these gadgets may interest the teachers towards its application. Interested teachers may become stranded if they lack the technological know-how of operating the gadgets, which may be the case of a well-planned curriculum in the hand of an unskilled teacher.

Way Forward

ICT integration in science teaching and learning has been revealed to be an essential requirement in practicing a sustainable science education where students can adequately acquire the necessary skills to compete optimally in the 21ˢᵗ century. Limitless access to knowledge and information, increased interest, developments of team spirit and interrelationship skills to mention a few are benefits open to students through ICT aided teaching. Students' current achievement will be enhanced with proper ICT usage in instruction and their availability in schools. It was recommendations that Government should increase allocation for education to enhance the procurement of ICT tools needed for effective science education; teachers may also be motivated and trained in manipulating these gadgets to avoid their redundancy.

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