



Challenges and Prospects of Teaching Science, Technology, Engineering, Arts, and Mathematics (STEAM) Education Through ICT in Nigeria

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Abstract

Science, Technology, Engineering, Arts, And Mathematics (STEAM) education was evolved to serve as a way out for the present century challenges, where ICT played a significant role in changing the present world. It is recorded that ICT tools improve the quality and effectiveness of teaching and learning STEAM subjects. Unfortunately, there are many challenges affecting the use of ICT in Nigeria. In this paper, teachers' competency on ICT, ICT infrastructure, internet connectivity, electric power supply, sustainability and funds were discussed as major challenges militating the use of ICTs in STEAM teaching. Prospects are; effective and creative learning, producing responsible citizens, removing gender barrier and improving teacher-students relations. It is concluded that for the attainment of the aims of STEAM education in Nigeria, the traditional mode of teaching needs to be shifted to ICT pedagogical approach. The paper suggests the inclusion of ICT education in teacher training programs so that the upcoming STEAM teachers would be competent to utilized ICT tools as a mode of teaching.

Keywords: STEAM education, ICT, Teaching and Learning, Challenge and Prospect of STEAM Education

Introduction

The demand for science, technology, engineering, and mathematics as well as information and communication technology has been increased in this era. The recent Covid-19 pandemic is a piece of evidence where information and communication technology (ICT) replace normal life interaction especially in teaching the learning process and trading/business. This is one of the reasons some decades back, developed countries like United States of America (U.S.A), South Korea, United Kingdom (UK), China, and others developed an educational model that integrates Science, Technology, Engineering, and Mathematics (STEM), for the challenge of the current era. According to Wang, Xu and Guo (2018) one of the road map of China rapid development was STEM education. The main goal of STEM education is to prepare children with 21st-century skills for the jobs of the future, including the ability; to think smart and creatively, solve problems, persist and take risks, have strong digital skills and know how to collaborate effectively (Taylor, 2016).

With the acceleration of the 21st-century challenge, Art is integrated into Science, Technology, Engineering, and Mathematics, thus forming STEAM education to succeed STEM education (Taylor, 2016; Wang, Xu & Guo., 2018). Eshbekovich (2020) described STEAM education as a set of disciplines aimed at developing new technologies that address the need for high-technology, science and engineering for the current and future needs. Taylor (2016) pointed that Art was

integrated with (STEM) for the purpose of preparing young citizens with higher-order thinking abilities to deal with present global challenges/crises positively and productively, that influence and impress the economy and natural environment. It is affirmed by Kang (2019) that, the purpose of integrating Arts with STEM education is to produce well-rounded citizens, literate and qualitative workforce for a highly technology-based society. The researcher has revealed that the main purpose of integrating Art in STEM education is to cater with the twenty-first-century challenge, the biggest challenge was a continuation of innovation in technology as well as information and communication technology (ICT). The rapid growth and development of technology have reshaped not only the economy of the world but all the affairs that constituted human development. The role of technology in changing life activities in the current era cannot be overemphasized. Every angle of activity such as health, education, sport, architecture, transportation, means of communication, industries, business, and trading among others were penetrated and affected by technological innovation. Information and Communication Technology (ICT) played a significant role in changing the life setting of the present world. ICT is perhaps the vigorous factor shaping the educational landscape currently. A study carried out by Beri and Sharma (2019) affirmed that ICT component has influenced and altered the educational process of the present century. Research showed positive effect and impact of the use of ICTs in STEM subjects on teaching, learning, and

research (Muhammad, 2018; Agwagah, Arua & Abugu, 2019; Das, 2019; Savec, 2019; Lawal & Awofala, 2020;). STEAM education is the predecessor of STEM education, as the impact of ICTs in teaching and learning STEM were recorded, definitely, it will do the same to STEAM education. The need for ICT in raising the standard quality of STEAM education cannot be over emphasized. There is a number of ICT components that are pertinent in the teaching and learning process and promote the quality of STEAM discipline, as well as support ICTs based instructions. Among the component are; Computer, Hardware, Software, Internet, Projector, Video, Camera, Television, Radio, Satellite (Bature, 2016; Akogwu, Abugu, Okeke & Umakalu, 2019).

In line with Damaševičius, Maskeliūnas & Blažauskas (2018), in today's world education has been shifted the essential skills from the acquisition of structured knowledge to the mastery of skills, so the need to shift the old method of teaching and learning to modern method supported by ICT. It is clearly stated in the National Policy of Education (NPE, 2014), teaching should be supported by ICTs technology, but it is unfortunately to most of the schools and teachers across Nigeria. Usman (2020) reported the Nigeria Minister of Labour and Employment saying, the national curriculum does not adequately impart employable skills to students in Nigeria. The minister vividly said, most of the fresh graduate do not have basic ICT skills and other critical soft skills needed for the job of this century, the viable solution to these problems is to teach STEAM education through ITC technology. STEAM education was to provide a solution to the challenge of this era, hence the need to ensure quality and effectiveness in its teaching.

Teaching STEAM education through ICT would be a better way of realizing its objectives. ICT is in better position to help students acquired 21st century learning skills. The twenty-first century learning skills are; critical thinking skills, logical reasoning skill, problem-solving skills, innovation and creativity skills. These are the major skills expecting students to acquire through STEAM education. ICT tools make teaching and learning fun, real situation and ease the cost of buying expensive materials needed for experiment as well as shorting or bridging a wide distance.

Information and Communication Technology (ICT)

According to Oduma and Ile (2014), Information and Communication Technology are the integration of two different technologies, these technologies are the communication and the computer technology.

The communication technology includes radio, television and telephone (including GSM, Android Smart phone, iPhone) technology, while computer technology includes computer, satellite, wireless and internet technology (Mohammadi, Sarvestani, & Nouroozi, 2020). Noor-Ul-Amin, (n.d) states that, the term 'computers' were exchanged with 'IT' (Information Technology) indicating the shift from focuses on computing technology to the capacity to store and retrieve information. Hence, the emergence of the term Information and Communication Technology (ICT). The combination of these two technologies is what has changed and interrelate the whole world today into what is known as global village. Nnaekwe and Ugwu, (2019) define ICT as a diverse set of technological tools and resources used to communicate, create, disseminate, store, and manage information. The implication of Information and Communication Technologies (ICTs) into the education sector has become a central focus of research globally.

ICT has virtually influenced all education sectors. It has changed so many aspects of teaching and learning, it has influenced the aspects it cannot change, improved the structures that it could and restructured those that it has to (Oduma & Ile, 2014; Beri & Sharma 2019). Nwoke, (2017) affirmed that for a nation to achieve the target of scientific and technological development, there is a need to change the method of teaching and learning from the traditional approach of "talk and chalk" to ICT pedagogical approach as the teaching and learning process of this era has being shifted from the acquisition of structured knowledge to the mastery of skills. Research revealed that ICT enhanced students' mastery of skills (e.g. Ratheeswari, 2018; Agwagah, Arua & Abugu, 2019). Mastery of skills boost and developed learners' creativity and innovation, problem-solving skills, logical and critical reasoning, these are the required learning skills for the current century and the main aims of STEAM education.

Benefit of Teaching and Learning through ICT

Many pieces of research carried out, within and outside Nigeria have recorded the benefit of teaching and learning through ICT. Kelly and McAnear as cited in Eyyam and Yaratan (2014) pointed out that, if ICT tools are effectively used in the teaching and learning process, students would become:

- a. Problem solvers and decision makers.
- b. Creative and effective users of productive tools.

- c. Communicators, collaborators, publishers, and producers.
- d. Informed, responsible, and contributing citizens.
- e. Capable information technology (IT) users.
- f. Information seekers, analyzers, and evaluators.

It was concluded that, if ICT were effectively utilized in teaching process, teachers would find teaching easy at all cost (Bature, 2016). The research of Shamim and Raihan (2016) shows that ICT has the capability of improving teaching learning process; quality and accessibility of education; learning motivation, learning environment and ICT usage as well as academic performance. ICT in STEAM education allowed teachers to teach effectively and dynamically as it is more visual, interactive and stimulating. ICT affect the delivery of education and enable wider access to the same. ICT has the capability to reinforce students' skills required for STEAM education. ICT bridge the gap between classroom and students' environment, it also enhanced students' academic achievement (Khalifa and Ahmad, 2018; Bawa, 2018; Saparwadi, Sa'dijah, As'ari & Chandra, 2019).

Nwoke, (2017) and Lalduhawma (2018) noted that teaching through ICT component like Computer Hardware and Software, motivate and arose students' interest and enhanced their academic achievement, it also seen as good instructional media when gender is considered. Teaching through ICT also focuses student's thinking ability and make student's ideas reasonable and tangible. Nwoke, further describe the nature of ICT as interactive materials which provides opportunities for students to interact, assimilate, collaborate and take control of the learning process and allowing female students to work independently. ICT also covers all those devices that deal with the processing of information for better and effective communication. Generally, in education communication takes place between teachers, students, management and administrative personnel which involves adequate data to be stored for retrieval as and when required, to be disseminated or transmitted in the desired format (Nnaekwe and Ugwu, 2019). However, the utilization of computer technologies for processing and storing data were focused as the major component of ICT today. The computer technology include hardware and software has numerous influence and application in teaching and learning process. This bring a lot of changes in education process, which required serious consideration for the successful attainment of the objectives of education and STEAM subjects in particular.

ICT's in Nigerian Secondary Schools

The world has experience a rapid scientific and technological development that dramatically change all the human endeavors. As stated earlier in the introduction, education sectors has been absolutely influenced by these technological advancement. There are so many challenges in the present century (21st century), which include continuous innovation in ICT. In order to cater with the challenges, emphasis was given to "four Cs" (4Cs). The 4cs are, Creative and Innovation, Critical thinking, Communication and Collaboration, these are the referred to as essential and core learning skills of the 21st century (Chuku, 2018), these are reason/aims behind STEAM education, which can be achieved by integrating ICT into teaching and learning processes. Also, it was stated by Taylor (2016), the main aims of STEAM education were to prepare children with these 21st century skills for the jobs and occupation of the future. So, utilizing ICT in teaching and learning could raise the quality standard of STEAM education and improve the student's digital skills in secondary schools, these would help to achieve the educational objectives of the century.

For secondary school's students in Nigeria, to compete with its counterpart in the country and the world at large, ICT should be fully funded and supported in its schools. Umar (2013) reported Senior Special Assistant (SSA) on ICT to the Executive Governor of Kano State, mentioned that, the education and technology (ICT), are sharp weapons for Nigeria to compete with rest of the world to bring socio-economic process. The SSA further conclude that, the rapid growth and expansion of ICT in education is more important than our technology investments in the country (Nigeria).

Both governmental and non-governmental organization intervened in providing schools with ICT tools to support the integration of ICT into education system, across all level of education in Nigeria. Such organizations are NCC, NNPC, TETFund MTN, Airtel, CITAD etc. With all these, more than two-third of the public secondary schools in Nigeria has no access to ICT facilities, talk less of computer laboratory. For the schools that has the ICT labs, it would be found that the labs are not functions due to some factors. There is also, inconsistence in the ratio of students per ICT tools (say computer) for schools that has the computers due to large number of students in a class (Fabunmi, 2020). It is very difficult to found fifty (50) computers in a single school, as computer is one of the most popular ICT tool. By experience,

educational software that could be used in teaching and learning processes is another challenge to almost all the schools across Nigeria. Clearly, for the attainment of 21st century learning skills and STEAM education in Nigeria, there is need to modernized teaching and learning processes to the new generation of students by making ICT facilities available, this would improve students learning, offer flexible learning opportunities and improve the efficiency of student's skills.

Challenges of Teaching STEAM Education through ICT's in Nigeria

Teaching STEAM education through information and communication technology (ICT) is a means of ensuring quality in the system, and process of attaining the STEAM education objectives. Nkomo (2013) point that there are two important reasons for teaching through ICT: students will become conversant with the use of ICT's as the present and future jobs in the society depend on it; and in order to improve the effectiveness and quality of teaching. However, there are many challenges confront the use of ICT in teaching and learning. In this paper, teacher's ICT competency, ICT's infrastructure, internet connectivity, electric power supply, sustainability, and funding are discussed.

1. Teacher's Competency on ICT: Adomi and Kpangban (2010) affirmed that, everyone needs ICT competency to survive in this technology-driven age, so for teachers to teach STEAM education effectively using ICT. Unfortunately, one of the driven-force that hinder the use of ICT in teaching and learning not only STEAM education in Nigeria, is the teacher's competency in utilizing the ICT tools. Literatures shows that most of the teachers in Nigeria, have limited or lack experience and expertise about ICTs in education (Oduma and Ile 2014; Umate, Hamza, & Aminu, 2018). The teacher's ICT competency is not only to operate or manipulate the ICT tools, but to: know when to apply or develop a particular skill using ICT's; be aware of the reasons for using it and its effect educationally; and have a critical and confident attitude toward teaching and learning with the ICT (UNESCO 2018).

2. ICT Infrastructure: ICT infrastructure are the necessary requirement and facilities for successful implementation of ICT. Baquero, Aguilar & Ayala (n.d.) pointed that, the deployment of ICT infrastructure in schools, should be synchronized with the objectives for transforming the educational system. Hence,

ICT infrastructure amount the availability and suitability of the ICT tools like hardware, software and peripheral equipment available in schools for the attainment of the objectives of STEAM education (Mosesa, Abu Bakar, Mahmud & Wong, 2012).

It is very unfortunate that, most of the school has no ICT tools not even the ICT labs. For those that has the Labs, it would be found that the labs are dilapidated with no or poor electric wiring, poor ventilation system and no cooling system which in turn damaged the available tools due to hot weather. Apart from the insufficient number of computer equipment and lack of Internet accesses, and other ICT facilities, most of the available ones were oldfangled. On the other hand, most of the teachers lack ICT skills and there is no technical staffs. To cut it short, it is hard to have a school with standard ICT infrastructure that support teaching and learning in Nigeria.

3. Internet Connectivity: some authors and researchers consider internet connectivity as part of the ICT infrastructure, of course it is, but in educational system internet can be considered as independent ICT tool because of the significant role usually played, not only as a library but for pedagogical approach of teaching and learning, and for education administrators.

Despite the important of internet connectivity in educational development, it is very unfortunate that, the internet connection is very poor in Nigeria. Oduma and Ile (2014) noted that lack of or limited access to internet is among the factors hindering the use of ICT in teaching and learning in Nigeria. Categorically, there are no or limited internet (network) facilities in various parts of the country. These make it difficult to integrate ICT not only for teaching STEAM education but all other angles of educational affairs. This poor internet connection is not restricted to certain region, but all over the country.

4. Electric Power: the demand of electricity in this modern life cannot be overemphasized. In one way or the other, no one can live without electric power in today's life. The need for electricity in the development of human endeavor influenced every nooks and corner of the present world.

However, standard electric supply is one of the major challenge in Nigeria. Both urban and rural secondary schools in Nigeria have no means of electric power supply, neither the boarding no the day schools. More than 65% schools in Nigeria have no electric power (UNDESA, 2014; World Bank, 2017), they are living in

dark. Teaching through ICT facilities would be very difficult in a school where there is no standard electric supply. So, lack of standard electric power will not allow effective utilization of ICT's in secondary schools which in turn affect the aim of STEAM education and Digital skills (ICT knowledge) in the country as the world turn into ICT based.

5. **Sustainability:** one of the problem affecting most developing country is lack of sustainability in most of their programs. The literary meaning of sustainable is continuation from the present to indefinite future. Sustainable ICT integration in schools refers to continues fulfillment of the ICT needs in education with its application in teaching and learning process, so that these needs can be met not only in the present but in the indefinite future. Evoh as cited in Adomi and Kpangban (2010) observes that most countries in the Africa lack resources for a sustainable integration of ICTs in education.

In Nigeria at large, many programs were initiated to integrate ICT in to educational system not only for teaching and learning, but the sustainability of such programs is the problematic. Politics, government, policy maintenance, teachers and students interest, ICT tools, funding, etc. were among the factor that affect sustainable ICT integration in most schools in Nigeria.

6. **Funds:** it was reported by Umar (2013), Senior Special Assistant (SSA) on ICT to Kano state governor by then, mentioned that, to integrate ICT in education requires large capital (funding) investments. Also, Musa, Munkaila & Bello (2020) affirmed poor funding as the major course of the setback in Nigerian education not only to integrate ICT. The budget allocation to educational sectors by both federal and state government clearly indicate the underfunding of education (Fabunmi, 2020), this contribute to poor school infrastructure, poor or lack of ICT infrastructure, quality education, unequal access to education and so on. There is no way to provide schools with ICT equipment without enough funding. Apart from the cost of the technological tools, maintenance is another problem that require funds, while the schools are poorly funded. Popoola (2020) pointed that the budget usually allocated to education in Nigeria will guaranty that the government consider education sector as social service rather than investment tool for national development.

Despite the role of ICTs in improving education and national development, ICTs remain a low

financial priority in most educational systems in the developing world (Adomi & Kpangban, 2010). For Nigeria as a country to achieve its developmental goals, need to invest huge sum of funds in to STEAM education and ICT, this will cater with the need of the 21st century challenge and ensure scientific and technological development in Nigeria.

Prospect of Teaching STEAM Education through ICT's in Nigeria

1. Attainment of STEAM education goals: Teaching STEAM education through ICT will lead to successful implementation STEAM education in Nigeria, this would enforce engineering, medicine, arts, mathematicians and computer careers.
2. Effective and Creative Learning: effective utilization of ICT in teaching STEAM education would encourage student's unity, collaboration and cooperation among global STEAM communities to communicate their discoveries.
3. Provide ICT users: Teaching STEAM education through ICT become essential to the development of knowledge-based society. This would lead to the production of citizen with the necessary digital skills and knowledge.
4. Provide Entrepreneurial indigene: effective teaching of STEAM education would inculcate students with entrepreneurial skills and knowledge that will enable the students to achieve independency after school by being a goal driven individual that can be employable or employ others. This will secure the society from any form of danger (social-vices) and realized the industrial and domestic need of the nation in general.
5. Effective Teaching: ICT utilization in the process of teaching and learning, makes teaching flexible, open access, less abstract, as well as improve achievement and retention among students. It will also help in developing self-efficacy and self-confidence in both teachers and students.
6. Encourage Gender Equality: ICT was gender friendly, so teaching STEAM education through the ICT would provide equal opportunity for both gender on the benefit of the aims of STEAM education in Nigeria.
7. Provide Students with 21st Century Learning Skills: teaching STEAM education through ICT will enhanced student critical thing, collaboration, communication and creativity which are the required skills needed for the workforce of the present century.

Conclusion

The study concluded that there is a need for ICT in raising the standard quality of STEAM education. Also, STEAM education is an essential tool for the solution of the present era and the future challenge as the world had turned to scientific and technological base. There is a number of challenges affecting the use of ICT in teaching and learning STEAM subjects. STEAM teachers' competency in utilizing ICT material to teach, ICT infrastructure, and electric power supply are major problems associated with teaching the STEAM subject through ICT.

Suggestion

Based on the study it is suggested that STEAM Teachers and education administrators, should be training and retraining on the required ICT skills and knowledge for teaching, learning and educational administration. For Nigeria to meet the challenge of the 21st century, schools should be provided with ICT infrastructure/labs for STEAM purposes, this will, in turn, reshape and boost the economic status of the country. The paper also, suggests that the government, NGOs, communities, and Individuals should join hands in providing STEAM schools' with solar and wind energy as an alternative source of power supply to the public schools, this will help and ease the use of ICT tools. Nigeria's government should consider STEAM education and ICT as essential tools for national development, not social service which require capital investment. A strong educational body (like TETFund) should be formed for the integration and support of ICTs in both primary and secondary schools across the country.

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