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**REVAMPING COMPUTER EDUCATION THROUGH SUSTAINABLE AND  
SECURE E-LEARNING INNOVATIONS AND COMPLIANCE**

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**Abstract**

*Educational establishments in Nigeria usually centered only on conventional learning methods, which adopt the typical physical student-teacher classroom interactions. Although there have been some academic systems incorporating e-learning in the country, that has specifically been designed to cover distance learning at most. The unprecedented emergence of a fatal virus known as Covid-19 has threatened the system of education globally as well as force education providers to switch to a virtual teaching and learning style spontaneously. This paper discusses the role of computer science education as a fundamental driver of e-*

*learning in terms of designing, implementing, educating, training, securing and sustaining the e-learning platform. The paper also explores the best ways of repositioning computer education in order to improve in the areas of pedagogical & curriculum framework design, ICT infrastructure, funding, manpower training, proper deployment and compliance monitoring. It also showcases the current state-of-the-art of e-learning in Nigeria, Innovative technologies that will aid e-learning deployment, security, compliance and control. Finally, recommendations and conclusions are made based on what is obtainable in the developed countries where e-learning is effective, which will usher in the best ways forward for revamping education to meet the needs and challenges of e-learning in Nigeria.*

**Keywords:** Revamp, E-learning, Education, Teaching, Learning, Computer.

E-learning is not a recent trend in some parts of the world in the way it enhances education. Now it is being used by some institutions in Nigeria to facilitate distance education (DE) and lifelong learning. E-learning according to Eze, Chinedu-Eze, and Bello (2018), is the use of electronic technology to deliver applications for education and training, track the performance of learners and evaluate the progress of the learners. It can also be described as a creative approach to providing electronically facilitated, well-designed, learner-centric and interactive learning environments to anybody, anywhere, at any time through the use of internet and digital technology in relation to the principles of instructional design (Simpson, 2013). It is all about learning with the use of computers. In this era, computer-based learning is simply virtual ways to acquire knowledge via the internet or the offline CD-ROM, DVD or Podcast. The use of a web browser requires an online presence. It can be in Audio, Video or Audio-Visual form (Ananchenkova & Kuznetsov, 2016).

E-learning applications and processes are distributed via the web, intranet/extranet, audio and/or video tape, satellite TV and CD-ROM (Mashhadi & Kargozari, 2011).

E-learning tools and delivery methods expanded with the introduction of the computer and internet in the late 20th century. In the 1980s, the first MAC PC enabled users to have computers in their homes, making it easier for them to learn about specific subjects and develop computing skill sets (Ruparel, 2014)

### **Brief Historical Development of E-learning**

In 1999, Elliott Masie first used the word "e-learning" in a technical context during Disneyworld's TechLearn conference. But the very first attempts at e-learning can be traced back to 1924, when the first electronic learning machine, the Automatic Teacher, was

created by Ohio State University professor Sidney Pressey. The PLATO is probably the most important invention in the online learning technology era. The PLATO is a computer system designed in 1960 by Donald L. Bitzer, and it has been revolutionary for its time (E-student.org, 2019). 20 years before the advent of the internet, the PLATO network could accommodate a large number of users at its peak, and most of the best instructional software of the generation across several educational disciplines was developed on PLATO (Kats, 2010; Rankin, 2018).

### **E-learning Development in Nigeria**

In Nigeria, However, the development of e-learning started with the development of telecommunications that started in 1886 when the colonial government in Lagos and their home office in London developed e-cable connections to relay messages and get feedback. By 1893, all government offices in Lagos were provided with telephone service for easy communication, feedback and access, and later all other parts of the country were provided with telephone services. Another opener to distance education in Nigeria dates back to the formation of information exchanges as a means of preparation of Students for a general education certificate (G.C.E), a precondition for a London admissions Exam. The first native distance learning program was the Nigeria Broadcasting corporations English by Radio, which came after independence in 1960 (Media Nigeria, 2018).

Originally, four private telecommunications providers (Mtel, Econet-Now Airtel, MTN, and Communication Investment Limited - CIL) were approved to provide the GSM communications. The license for CIL was later transferred to Globacom Nigeria (Bose, 2013). According to Russon (2020) in BBC News, this advancement led to certification of more internet service providers, which led to improved access by Nigerians to the internet. In 2000 the country had less than 11 ISPs, but by 2006 these had risen to over hundred and many have been linked to the global network content via VSAT broadband link.

### **Advent of E-learning in Nigerian Educational System**

In educational institutions, the commonest type of e-learning introduced is in the form of lesson notes on CD-ROM which can be played at learners' convenience (Aboderin, 2015). Some schools have embraced the use of intranet infrastructure; nevertheless, due to constant power issues and higher cost of operating generating sets, this is not well managed. Many learners in Nigeria use cyber café, but a multimedia interactive cannot be done because there are people of diverse intensity on the net at the same time plus the bandwidth and traffic bottlenecks. Few universities, such as UI, O.A.U, UniBen, UniAbuja, UniLag and NOUN have proper e-learning facilities (Oludotun, 2020). The number appears quite small

when compared to other parts of the world. The importance of e-learning in promoting educational delivery across the globe will only gain more significance. There is no doubt about the magnitude of responsibility shouldered by computer science education in fostering the virtual and digital forms of teaching and learning. ICT centers powered by computer science education departments are being institutionalised to forestall the long negligence of the role of the discipline as the driver of e-learning as long as content, capacity and sustenance are concerned (Mutula, 2010).

### **The Importance of Computer Education as a Fundamental Driver of E-learning**

Recently, debates on the use of computers in the curriculum have moved to a much greater emphasis on computing and Computer Science, increasingly concerned with programming purposes and development, and core concepts of problem-solving and invention (Passey, 2016). Computers and computer technologies already have a background within education, and their roles in education is widely known. While the subject of computer science education appeared in some levels of education curriculum in the late 20th century, a very wide spectrum of in-depth research and innovative implementation was quickly pursued (Hubwieser, 2012).

In 1962, the first departments of computer science were founded by Purdue and Stanford Universities in the U.S.A; the first Doctor of Philosophy (PhD) in computer science was awarded by the University of Pennsylvania in 1965, also in the United States, according to Tatnall and Davey (2016). At the University of Belgrade, in Serbia, a robotic hand was created the same year. The introduction of computers into schools began after just a very short period of time; they can also be traced back to the 1980s or earlier, when single computing devices, initially executing programs from tape cassettes, were incorporated in schools in various countries worldwide (Caeli, & Bundsgaard, 2019).

### **The Widening Gap in Computer Science Education**

Computational thinking skills and computer science expertise are needed in virtually every career area on the labour market. What's more, employment in computer science, IT and related fields reflect a wide and rising business field. By 2020, out of 9.2 million jobs in the scene related field, as many as 4.6 million are in computing. The fields of science, technology, engineering and mathematics (STEM) will be computer-related according to the ACM (2019). According to the United States Agency for Labour Statistics, the overall average salary for employments in computer science and IT was \$81,430 in 2015; however, for a Computer Science profession in Nigeria, the average monthly salary of a Computer Scientist is N198, 000 per month (Salahudeen, 2020).

The United States, however, is not on track to meet labour market demand in the fields of computing. Code.org estimates that the US will have 1 million more computer jobs to fill by 2020 than eligible individuals. Meeting demand in these innovation-intensive fields would require that states broaden and diversify their college-graduate computing workforce considerably (Rainie & Anderson, 2020). Developing countries like Nigeria, as part of the global economy, will experience worse scenarios due to shortage of personnel, infrastructure and emigration of skills (Kushnir, Manzhula & Valko, 2013). In 2015 and 2016, the Commission on Computer Science and Information Technology of the Southern Regional Education Board in the US met to decide how states can help more youth - especially girls, black and Hispanic students, and students from low-income families - learn computer science, pursue exciting computing careers, and for some, begin journeys into those careers while in high school (Isaac, 2018).

### **Ubiquity of Computer Education and Computer Technology Facilities**

The speed of change brought about by the new computer technologies have had significant effects on the way people live, study, work, and play across the globe. New and emerging computing technologies challenge the traditional process of teaching and learning, and the way education is deployed. Although an important field of science education in its own right, Information computer science education has a significant influence on all education areas (Kolade, 2011). Seamless connectivity globally offers immediate access to a wide variety of data, which challenge assimilation and critical thinking skills. Rapid communication, as well as increased access to computer technologies at home, at work and in educational institutions, may lead to learning being a truly life-long activity, an activity in which the rapid pace of technological advancement demands constant evaluation of the situation in teaching and Learning processes (Meier, 2012).

Specifically, Computer-based technologies improve teaching and learning through its creative, interactive, versatile and engaging content. It offers real individualized learning opportunities. Moreover, such technologies have the ability to improve, expand and broaden skills; to inspire and involve students in learning; to better link school experiences to work practices; helping to build economic prosperity for the workers of tomorrow (Oni, 2012); leading to progressive school changes; improving education and creating resources for school-to-world connections. Digital technology's omnipresence has led to rapid technical, social, political and economic change in a network culture organized around and powered by computer science technologies (Lane, 2019). The implementation of computer science policies, therefore, makes educational organizations more effective and profitable, thereby providing a range of tools to improve and promote the pedagogical practices of the teachers.

For example, e-learning is becoming one of the most popular ways of using computer technologies or ICT to provide on-and-off-campus education to students through online teaching hosted via web-based systems (Huang, Kinshuk & Price, 2016).

### **Internet-Based Teaching and Learning is No More a Choice, But a Requirement**

Owing to the extreme outbreak of this global Covid-19 pandemic, a significant part of the world is in quarantine and hence many cities have turned into phantom cities and its impact can be seen in schools, colleges and universities. We may consider e-learning the panacea for the crisis. The Corona Virus has made schools turn from offline to online pedagogy design (Dhawan, 2020). This crisis would make the institutions, which previously were unable to adapt, embrace the new e-learning technology. This tragedy would show us the rewarding value of teaching and learning electronically. We can lecture a large number of learners at any time and in any corner of the world with the aid of the online teaching models. Every academic organization will have to scramble for various online pedagogical methods and strive to use technology more appropriately. Many universities across the world have digitized their operations entirely, recognizing this current situation's desperate need (Cathy-Li, 2020).

In the midst of this turmoil, online learning emerges as a victor ludorum. Hence, at this point, the quality improvement of online teaching – learning is crucial. After the Covid-19 outbreak, online education in academic institutions exponentially expanded. There was a change from conventional classrooms into e-classrooms overnight; that is, educators changed their whole pedagogical approach to addressing emerging learning dynamics and adjusting to changing circumstances. The question during this difficult period is not whether online teaching-learning methods can provide quality education, but how academic institutions should embrace online learning in such a massive way (Carey, 2020).

### **Pre COVID 19 E-learning Preparedness in Developed Countries**

In the last century, we passed from the industrial age through the information age and now the knowledge age. The ability to acquire, assimilate, and apply the right relevant knowledge will become a crucial attribute in the next century. Training is the secret to making our full potential come true. In reality, our survival as individuals, organisations, and nations in the 21st century will depend on our ability to learn and apply what we have learned to our everyday lives (Oye, Salleh & Iahad, 2011; Mynbayeva, Sadvakassova & Akshalova, 2018).

### **The United Kingdom**

In the United Kingdom the Quality Assurance Agency (QAA) has a code of practice, one aspect of which is collaborative implementation and scalable distributed learning (including e-learning). The UK has a long history of educational creativity. Their Open University and distance learning was a blueprint for many other institutions concerned with open and distance learning (ODL) (Clark & Barbour, 2015). The British Educational Communications and Technology Agency, established in 1998 and redefined in 2003 to support all four UK education initiatives, realizes the need to organize and share knowledge among states' initiatives Departments in their strategic ICT projects, promoting knowledge sharing to promote innovation and change, and adding coherence and cohesion to innovations around the UK. In February 2000 the UK Government launched the e-University programme (Uskov, Howlett & Jain, 2019). It is run by the Higher Education Funding Council for England, England's largest public higher education funder operating in collaboration with the UK's Higher Education Institutions and other HE funding agencies. Its goal is to develop a new vehicle to provide a higher UK production globally, internship preparation services. In the Higher Education sector, e-learning is now well known. E-Learning is used in some way or another by all educational institutions of higher learning. This primarily includes the use of intranets, often using 'in-house' materials. Before the pandemic, E-learning was extending to post primary and primary schools (Coverdale-Jones, 2012).

### **The U.S.A**

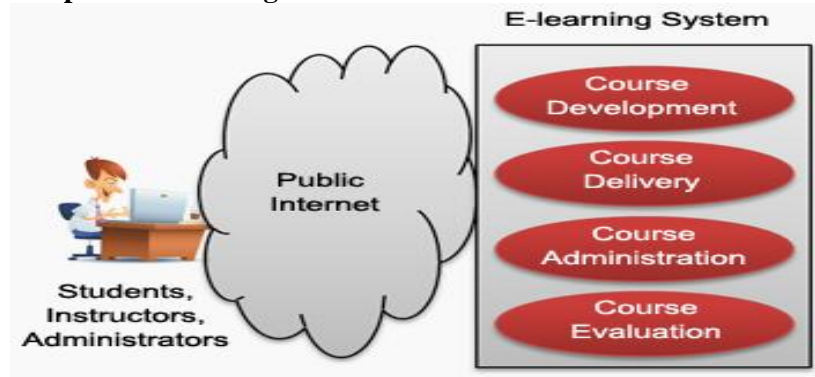
Online education in the United States is no longer a trend, but mainstream. Of the 18.2 million students enrolled in higher education in the fall of 2007, 3.9 million (21.4%) were enrolled in at least one online course. By fall 2010, the number of higher education students had risen to 21 million, and 6.1 million of those (29.0%) were enrolled in an online course (DiPerna & Shaw, 2018). This represents an 18.8% average increase in the number of students enrolled in online education during that time period. Between 2010 and 2012, the growth rate leveled out somewhat, showing an average annual growth of roughly 4.9%. Still, as of fall 2012, of 20.6 million higher education students, 6.7 million (32.5%) enrolled in online courses. That represents a staggering one-third of higher education students enrolled in online courses. With enrollments in online courses still growing and the realization that they are here to stay, educational institutions are challenged to meet the demand while continuing to provide quality education (ICEF Monitor, 2018). So, e-learning platform implementation, usage and compliance is high in the United States for both higher education and key stages.

## E-learning Approaches, Components and Architecture

### E-learning Approaches

There are two general approaches to e-learning: self-paced and facilitated/instructor-led. Self-paced learners are alone and completely independent, while facilitated and instructor-led e-learning courses provide different levels of support from tutors and instructors and collaboration among learners. Often, e-learning courses combine both approaches, but for simplicity it is easy to consider the two separately (Raghavan, 2018).

### Self-paced E-learning



### Instructor-led and Facilitated E-learning



(Ruby-Spencer, 2017)



### **E-learning Components**

Different types of e-learning components include:

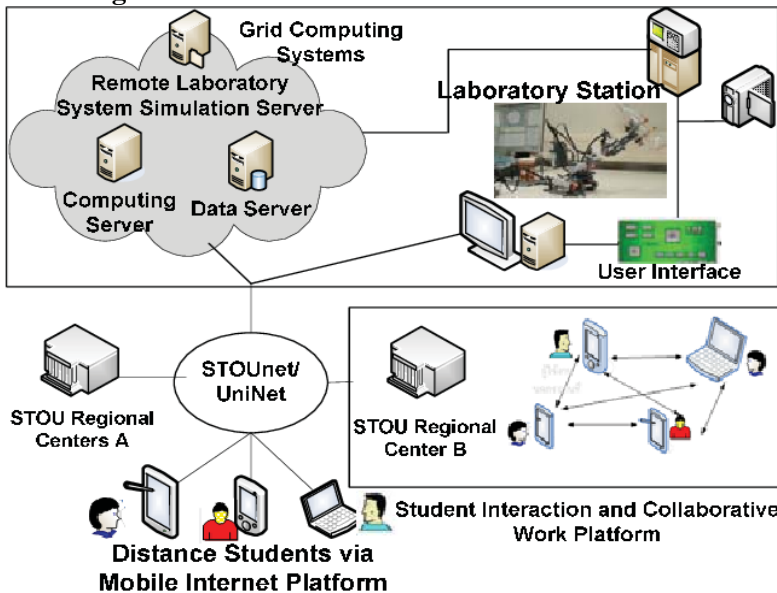
**E-learning Content:** E-learning content can include simple learning resources, interactive e-lessons. Electronic simulations and job aids.

**E-tutoring, E-coaching, E-mentoring:** Services which provide human and social dimensions can be offered to learners to support them through the learning experience (Tamm, 2019).

**Collaborative Learning:** Collaborative activities range from discussions and knowledge-sharing to working together on a common project. Social software, such as chats, discussion forums and blogs, are used for online collaboration among learners.

**Virtual Classroom:** A virtual classroom is the instructional method most similar to traditional classroom training, as it is led completely by an instructor (Ghirardini, 2011).

### **E-learning Architecture**



**The Grid Computing System:** Grid computing is the use of widely distributed computer resources to break down larger problems into smaller, independent, often similar parts that can be executed simultaneously by multiple processors communicating via shared memory, the results of which are combined upon completion as part of an overall algorithm.

**Laboratory Station:** A virtual laboratory is an on-screen simulator or calculator that learners use to test ideas and observe results. They allow the learner to “tinker” with laboratory equipment that behaves in almost the same way as it would in a real environment. Learners perform a series of experiments that yield authentic results (Lujara, 2010).

**STOU Regional Centers:** These are Regional Centers for Students of Universities, which foster remote Education of the students with the aim of delivering facilities to grassroots and also maintain contact with students. They ensure that, though education instruction is self-guided, students are not left without vital personal contact while pursuing their chosen study programs. Students can have **Interactive and Collaborative work** in a classroom manner via the Regional Centers (IGI Global, 2019).

**Distant Students via Mobile Internet Platform:** Remote students who are on the go can hook up to the e-learning platform using their mobile devices.

## **Functional Roadmap and Procedures for Revamping Computer Education for Sustainable E-learning Innovations in Nigeria**

### **Develop state computer science standards for Students at all levels**

1. Work in partnership with secondary and postsecondary educators, experts and industry leaders to develop computer science standards that include the essential concepts and practices students should master in school.
2. Adopt standards-based, developmentally appropriate computer science curricula that appeal to diverse all learners.
3. Require all high schools to offer students access to rigorous, standards-based computer science courses, such as Exploring Computer Science and Advanced Placement Computer Science Principles.
4. Provide funding at the state, district and school levels to support expanded computer science learning opportunities in schools (Hismanoglu, 2011).

### **Lay the Groundwork for Learning Computer Science**

1. Throughout the school period, integrate and teach the essential literacy skills that students need to master in computer science standards.
2. Integrate and teach the essential math concepts and skills that students need to master.

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3. Provide targeted interventions and readiness courses to students who need extra help for success in computing fields (Salehi, Shojaee & Sattar, 2014).
4. Support students' academic and computer science teachers in designing interdisciplinary, project-based instruction and assignments that engage students in applying literacy, math and computational thinking skills to solve problems.

**Create clear pathways to computing careers.**

1. Charge a state career pathway advisory council with developing pathways that meet identified workforce needs in computing fields.
2. Build career pathways consisting of four or more courses that connect seamlessly to postsecondary programs in high-demand career fields, such as cyber security, informatics and software development.
3. Include computer science and computer science-related career pathways in state accountability and funding systems (Federal Ministry of Education, 2020).

**Prepare great computer science teachers**

1. Recruit teachers with the content knowledge, interest, passion and willingness to learn and explore computer science alongside their students.
2. Create clear pathways to teacher certification and licensure to ensure that all teachers, regardless of their backgrounds, have the appropriate skills needed to teach standards based computer science and IT curricula (Yadav, Gretter, Hambrusch & Sands, 2016).
3. Leverage federal, state, foundation and private sector funds to support intensive, ongoing professional development on computer science and IT

**Educate communities about computer science and computing careers**

1. Embed career advisement and exploration across all levels as a means of educating students, parents and communities about computer science and computing careers.
2. Encourage employer partners to invest in the IT workforce of the future.
3. Enact legislation to recognize communities that improve computer science education and meet workforce needs in computing fields (Google, 2019).

**Implement secure online exam systems with strong authentication schemes by ensuring that there is**

4. Secure Browsers which prevent exam candidates from opening other windows

5. Remote Proctoring (invigilating exams from a distance), which uses Image Capturing at intervals or Video Streaming for initial and continuous authentication
6. Data Encryption that avoids unauthorized access to questions banks and result
7. Audit Logging, where activities like Login, Logout, Exam Access, Question Navigation, Answer Responses, are recorded for future references
8. IP-based Authentication & Authorization that restricts access and operations to specified IP addresses.

## Conclusions

Digital divide challenges developing countries, notwithstanding the fact that all countries compete in the globalised market. In terms of computer/IT technology policies, infrastructure, content, capacity, manpower development, funding, implementation and compliance monitoring, Nigeria is at the crossroad of poor e-learning utilisation. It is a matter of national emergency, which needs the revamping of computer science education by proactive and continuous improvement in the area of funding, teacher education, stimulus package, infrastructure provision, students enrolment, pedagogical curriculum innovations, awareness creation and catch-them-young schemes. These will facilitate the repositioning of computer science education in playing its roles in building, deploying and sustaining e-learning in the Nigerian realities of the new normal as necessitated by the global COVID19 pandemic.

## Recommendations

The government and other stakeholders will revamp computer education by helping to:

1. Provide Strong funding base by budget increase and private donations
2. Build free Digital learning management systems for education providers
3. Facilitate the building of portable e-learning Systems for use on mobile devices
4. Design systems with off-line functionality to cater for students without internet data
5. Build Massive open online courseware and virtual classrooms in all neighbourhoods
6. Build e-learning Products of self-directed and interactive e-learning
7. Develop applications and support for Mobile Reading Software
8. Platforms for collaboration with support for light video conversion and delivery
9. Design and implement frameworks for developing interactive learning material
10. Subsidise ISPs for students to access free internet and subscribe for data at low cost.

### References

- Aboderin, O. S. (2015). The Challenges and Prospects of E-learning in National Open University of Nigeria. *Journal of Education and Learning (EduLearn)*, 9(3), 207. doi:10.11591/edulearn.v9i3.1728
- ACM (2019). ACM Annual Report for Fiscal Year 2019. New York: ACM's Publications.
- Ananchenkova, P., & Kuznetsov, M. (2016). The E-Learning Technologies Used in the Educational Process of Jobless Citizens. doi:10.15405/epsbs.2016.12.20
- Bose, S. (2013). Integrated teacher education programme for open distance learning: A model for development and implementation. *Open Learning: The Journal of Open, Distance and E-Learning*, 28(2), 120-134. doi:10.1080/02680513.2013.814534
- Caeli, E. N., & Bundsgaard, J. (2019). Computational thinking in compulsory education: A survey study on initiatives and conceptions. *Educational Technology Research and Development*, 68(1), 551-573. doi:10.1007/s11423-019-09694-z
- Carey, K. (2020, March 13). Everybody Ready for the Big Migration to Online College? Actually, No. Retrieved from <https://www.nytimes.com/2020/03/13/upshot/coronavirus-online-college-classes-unprepared.html>
- Cathy-Li, H. O. (2020, April 29). The COVID-19 pandemic has changed education forever. This is how. Retrieved in September 5, 2020 from <https://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid19-online-digital-learning/>
- Clark, T. A., & Barbour, M. (2015). *Online, blended and distance education in schools: Building successful programs*. Stylus Publishing.
- Coverdale-Jones, T. (2012). Success Factors in the Implementation of e-Learning in a UK Higher Education Institution. *Post-Secondary Education and Technology*, 111-125. doi:10.1057/9781137037770\_6

- Dhawan, S. (2020). Online Learning: A Panacea in the Time of COVID-19 Crisis. *Journal of Educational Technology Systems*, 49(1), 5-22. doi:10.1177/0047239520934018
- DiPerna, P., & Shaw, M. (2018). *2018 schooling in America: Public opinion on K-12 education, parent and teacher experiences, accountability, and school choice*. EdChoice.
- Eze, S. C., Chinedu-Eze, V. C., & Bello, A. O. (2018). The utilisation of e-learning facilities in the educational delivery system of Nigeria: A study of M-University. *International Journal of Educational Technology in Higher Education*, 15(1). doi:10.1186/s41239-018-0116-z
- E-student.org (2019, December 21). The History of E-Learning. Retrieved in September 5, 2020 from <https://e-student.org/history-of-e-learning/>
- Federal Ministry of Education (2020, September 13). E-learning Resources. Retrieved in September 13, 2020 from <https://education.gov.ng/e-learning-resources/>
- Ghirardini, B. (2011). *E-learning methodologies: A guide for designing and developing e-learning courses*. Food and Agriculture Organization of the United Nations.
- Google (2019). Future of the Classroom emerging trends in K-12 Education: Global edition: Google for Education.
- Hismanoglu, M. (2011). E-learning Practices in North Cyprus Universities: Benefits, Drawbacks and Recommendations for Effective Implementation. *International Education Studies*, 4(4). doi:10.5539/ies.v4n4p149
- Huang, R., Kinshuk, & Price, J. K. (2016). *ICT in education in global context: Emerging trends report 2013-2014*. Springer.
- Hubwieser, P. (2012). Computer Science Education in Secondary Schools -- The Introduction of a New Compulsory Subject. *ACM Transactions on Computing Education*, 12(4), 1-41. doi:10.1145/2382564.2382568
- ICEF Monitor (2018, July 09). The continuing expansion of online learning in the US.

*Revamping Computer Education through Sustainable and Secure E-Learning Innovations and Compliance*. **F. I. Okeke; C. E. Mbanusi; K. C. Okonkwo and I. C. Anyagafu**  
Retrieved in September 7, 2020 from <https://monitor.icer.com/2018/05/continuing-expansion-online-learning-us/>

IGI Global (2019, April 14). What is E-Learning? Retrieved in September 1, 2020 from <https://www.igi-global.com/dictionary/innovative-approach-training-international-students/8785>

Isaac, O. A. (2018). Computer Science Education in Nigeria Secondary Schools – Gap Between Policy Pronouncement and Implementation. *International Journal of Engineering Research and*, 7(04). doi:10.17577/ijertv7is040350

Kats, Y. (2010). *Learning management system technologies and software solutions for online teaching: Tools and applications*. Information Science Reference.

Kolade, A. T. (2011). Imperatives of Information and Communication Technology (ICT) for Second Language Learners and Teachers. *English Language Teaching*, 5(1). doi:10.5539/elt.v5n1p44

Kushnir, N., Manzhula, A., & Valko, N. (2013). Bridging the Generation Gap in ICT Education. *Information and Communication Technologies in Education, Research, and Industrial Applications Communications in Computer and Information Science*, 229-251. doi:10.1007/978-3-319-03998-5\_12

Lane, C. (2019). Digitizing Learning. *Innovative Trends in Flipped Teaching and Adaptive Learning Advances in Educational Technologies and Instructional Design*, 138-161. doi:10.4018/978-1-5225-8142-0.ch007

Lujara, S. (2010). *Development of e-learning content and delivery for self-learning environment: Case of selected rural secondary schools in Tanzania*. Blekinge Institute of Technology.

Mashhadi, V. Z., & Kargozari, M. R. (2011). Influences of digital classrooms on education. *Procedia Computer Science*, 3, 1178-1183. doi:10.1016/j.procs.2010.12.190

Media Nigeria. (2018, April 27). History Of E-learning In Nigeria. Retrieved in September 7, 2020 from <https://www.medianigeria.com/history-of-e-learning-in-nigeria/>

Meier, M. (2012). E-Learning and Teaching Innovation. *Journal of Technology and The Intuition Information*, 4(3), 104-107. doi:10.5507/jtie.2012.062

Mutula, S. M. (2010). *Digital economies: SMEs and e-readiness*. IGI Global (701 E. Chocolate Avenue, Hershey, Pennsylvania, 17033, USA).

Mynbayeva, A., Sadvakassova, Z., & Akshalova, B. (2018). Pedagogy of the Twenty-First Century: Innovative Teaching Methods. *New Pedagogical Challenges in the 21st Century - Contributions of Research in Education*. doi:10.5772/intechopen.72341

Oludotun, O. E. (2020, May 28). The Panoramic View of Online Learning in Nigeria Higher Institutions. Retrieved in September 5, 2020 from <https://www.thenigerianvoice.com/news/288420/the-panoramic-view-of-online-learning-in-nigeria-higher-inst.html>

Oni, S. (2012). *Revitalizing Nigerian education in the digital age*. Trafford Publishing.

Oye, N., Salleh, M., & Iahad, N. (2011). Challenges of E-Learning in Nigerian University Education Based on the Experience of Developed Countries. *International Journal of Managing Information Technology*, 3(2), 39-48. doi:10.5121/ijmit.2011.3204

Passey, D. (2016). Computer science (CS) in the compulsory education curriculum: Implications for future research. *Education and Information Technologies*, 22(2), 421-443. doi:10.1007/s10639-016-9475-z

Raghavan, B. (2018, December 10). Instructor-Led Training vs. Self-Paced Learning: After All the Commotion. Retrieved from <https://elearningindustry.com/instructor-led-training-vs-self-paced-learning-commotion>

Rainie, L., & Anderson, J. (2020, August 06). Experts on the Future of Work, Jobs Training and Skills. Retrieved from <https://www.pewresearch.org/internet/2017/05/03/the-future-of-jobs-and-jobs-training/>

Rankin, J. L. (2018). *A people's history of computing in the United States*. Harvard University Press.

Ruby-Spencer, C. (2017, August 03). 5 Ways to Maximize Instructor-Led Training.



*Revamping Computer Education through Sustainable and Secure E-Learning Innovations and Compliance*. Retrieved in September 3, 2020 from <https://elearningindustry.com/5-ways-maximize-instructional-training> **F. I. Okeke; C. E. Mbanusi; K. C. Okonkwo and I. C. Anyagafu**

Ruparel, A. (2014, July 3). The History of E-Learning. Retrieved September 4, 2020 from <https://learn.filtered.com/blog/the-history-of-e-learning>

Russon, M. (2020, February 20). How internet access is improving in Nigeria. Retrieved in September 2, 2020 from <https://www.bbc.com/news/business-51377955>

Salahudeen, O. R. (2020, February 23). Computer Scientist Salary in Nigeria. Retrieved in September 9, 2020 from <https://facts36.com/computer-scientist-salary-in-nigeria/#:~:text=For a Computer Science profession,other benefits of the profession.>

Salehi, H., Shojaee, M., & Sattar, S. (2014). Using E-Learning and ICT Courses in Educational Environment: A Review. *English Language Teaching*, 8(1). doi:10.5539/elt.v8n1p63

Simpson, O. (2013). E-Learning and the Future of Distance Education. *Distance and E-Learning in Transition*, 107-118. doi:10.1002/9781118557686.ch8

TalentLMS (2019, May 08). How to use Virtual Laboratories in eLearning. Retrieved in September 4, from <https://www.talentlms.com/blog/virtual-laboratories-elearning/#:~:text=A virtual laboratory san,experiments that yield authentic results>

Tamm, S. (2019, December 21). Types of E-Learning. Retrieved in September 10, 2020 from <https://e-student.org/types-of-e-learning/>

Uskov, V. L., Howlett, R. J., & Jain, L. C. (2019). *Smart education and e-learning*. Springer.

Yadav, A., Gretter, S., Hambrusch, S., & Sands, P. (2016). Expanding computer science education in schools: Understanding teacher experiences and challenges. *Computer Science Education*, 26(4), 235-254. doi:10.1080/08993408.2016.1257418