

Sustainable Development in Developing Societies

The Place of ICT-Driven Computer Education

<https://doi.org/10.3991/ijet.v15i12.14007>

Wilson Nwankwo (✉)

Edo University Iyamho, Iyamho, Nigeria
nwankwo.wilson@edouniversity.edu.ng

Christian C. Njoku

Aminu Saleh College of Education, Azare, Bauchi State

Abstract—Computer Science Education (CSE) is a field of study in the 21st century that cannot be ignored by any nation in search of rapid integrated development. When driven by Information and Communications Technology (ICT) tools, the field could become a live wire for national socio-economic development with the capacity to transform and sustain same. This paper follows a qualitative approach in examining the relevance of an ICT-driven CSE in sustainable development and advocates for a proper entrenchment of ICT-based pedagogy in the existing curriculum in tertiary institutions for better learning experience and quality education delivery for development. The various areas in which CSE and ICT are applied for sustainable development are appropriately discussed. Also discussed are the challenges and barriers to the deployment of ICT solutions towards the realization of sustainable development goals (SDG) in higher education and technology development. It concludes by reiterating a paradigm shift towards an integrated education model that explores use of ICT at all academic processes across all the three tiers of education in Nigeria to contribute its quota in the realization of the SDGs.

Keywords—Computer Science Education, Sustainable development, ICT, Computer education, Quality education

1 Introduction

Humankind now lives in the information or computer age. This is an age different from the Stone Age and the Neolithic age. Computers and allied devices have become an intricate part of daily living as it keeps reshaping the world we live in. It has enveloped our world more than any other technology in the last 100 years. The role of computers today has gone beyond the execution of complex, repetitive and laborious tasks, it now handles and processes all sorts of data and information in business, education, government, research etc. [1]. The technology has advanced a new age where information drives the economy and socio-political structures. Sectors affected

include agriculture, architecture, art, commerce and global trade, communication, education, governance, law, music, politics, science, transportation, and writing [2].

1.1 Computers and computer education

In modern times, computers are embedded in various electronic and electrical devices all of which are intended for problem solving in one human endeavor or the other. Applications of computers in education have been on the rise in the last decade. The entire realm of educational technology and modernization programs are all connected to computers and ICT devices. Today, conventional classroom-based education is quickly given way for blended, online, and open distance learning respectively [3][4][5]

Computer education is defined in Nigeria's National Policy on Education (NPE)[5] as the "acquisition of knowledge, skills and abilities to manipulate and interpret the languages of the computer". In other words, computer education is primarily developed to enable learners acquire skills and knowledge that are hinged on the various aspects of computing such as programming, graphics, modeling, etc. and to apply same for solving basic life problems. CSE is a hybrid of Computing and General Education respectively and often called Computer Education. Thus, Computer education as a field shares a lot with Computer science, a scientific and more of a technical discipline that is concerned with the theory of computation, design, and engineering of software and hardware[6].

At present, ICT is used in three perspectives: as a technology, field of study, and, lastly, as a process. As a technology, it supports capturing, processing, storing and communicating information. ICT may include computer hardware, software, networks, and other allied devices [7]. As a process, ICT reflects those techniques and procedures that create value and opportunities in a socio-economic system such as education [8][9][10]. In this paper, the technology and process perspectives of ICT are emphasized. Computer education is greatly shaped by ICTs and the union of the duo and application towards the attainment of SDGs is the theme of this paper.

1.2 State of computer education in Nigeria

This relevance of computer education is contained in the provisions of NPE [11] in Section 5, item 20 and option C which states "secondary education shall provide trained manpower in applied science, technological and commerce at sub professional grades". Option H of the section stresses an all important goal of secondary education i.e. "to provide technical knowledge and vocational skills needed for agricultural, commercial, industrial, and economic development". This vision as enshrined in the policy is far from becoming a reality. The government at various levels, have designed various means towards remedying the decades of dearth in policy failures. One of the persistent problem is the availability of competent human capacity to support teaching and learning.

To provide such capacity and manpower for teaching and research at all levels of education, specialized Universities of Education and Colleges of Education were

created and duly accredited to run programs including Computer Education. Though a step in the right direction, the number of such facilities do not in any way match the growing population. With Government reforms in education in the late 90s, private universities and tertiary institutions were allowed to operate thus increasing the number of tertiary institutions that provide mid and expert level manpower training in computer education.

Presently, Nigeria is serviced by 766 institutions classified into Universities, Polytechnics, Colleges of Education, Health, and Agriculture, Innovative and Vocational Educational Institutes respectively [3]. With a population of 200 million, the number of research-based institutions in Nigeria is considered inadequate when compared to countries like United States and India among others. It is interesting to note that while these institutions produce thousands of graduates year in year out, the economy of the country is yet to feel the impact of such programs owing to the fact that 95% of graduates lack the requisite skills to spur development of the economy hence are job seekers and not job creators hence the rising spate of unemployment [12][13][14][15][16] [17].

To promote the knowledge of computer applications and usage more efforts need be expended by the government to help boost its rapid and sustainable development. It has been reported that computer software development now accounts for 13.8% of Nigeria's gross domestic product [18]. It is believed that the integration and use of ICT in CSE is vital to sustained increase in the nation's gross domestic product. According to the NCC, ICT is likely to outweigh the revenue derived from oil and gas in the next two years.

1.3 Sustainable development (SD)

Sustainable development is a concept that has many perspectives hence many opinions conveying different understanding. Brundtland [19] had stated that it is "development that satisfy the present needs of the people and does not compromise the prospects of future generations as to meeting their very needs". Bryant [20] had opined that SD ensures members of the society enjoy better quality of life at all times. However, SD requires the right tools and infrastructure that would assure consistency and progressive attainment of individual and national economic development. In driving development through the deployment and utilization of tools and technologies, ICT, policies, and political will, are three non-negotiable elements.

The main objectives of SD are social inclusion, economic growth, and environmental sustainability. It is believed that SD is a collective responsibility of everyone. It is instructive to note that it is such commitment and collaborations among countries that would entrench a lasting development that would meet the various contemplated needs of the present and future society [21]

Wu et al [22] state that SD goals have five fundamentals. They are: People, Prosperity, Peace, Partnership and Planet. These five elements are directed towards ending poverty, enjoyment of prosperous and fulfilling lives, economic, social and technological progress, peaceful, non-violent and inclusive societies, and maintaining careful consumption, production, natural resource management and actions on

climatic change. All the above factors are attainable through collaboration and mutual commitment to same goals hence the need for partnership which focuses on revitalizing global partnership, global participation, stakeholders and people [23].

2 Computer Education and Sustainable Development

One of the aims of teaching computing is to help learners acquire skills of practical utility, develop the capacity to think further and apply those skills in social lives, industry, agriculture, national defence, national and international affairs[24]. CSE is a channel through which skills and craft-oriented services may be provided to drive vital economic recovery processes. An ICT-driven CSE enhances students' thinking and analytic skills, reasoning, etc. with which they would create knowledge and share expertise.

2.1 Small and medium scale businesses

Persons skilled in computing can embark on small scale businesses such as data processing/publishing (which can handle design of assorted cards -wedding, birthday, and other special occasions), web site designs, computer maintenance, computer training centers, etc. Young computer programmers can do freelancing thereby creating jobs for themselves. This keeps the young ones busy thereby reducing violence and crime in the society. The result is a peaceful society devoid of hunger [25].

2.2 Social computing and cyber awareness

Computer technology connects people through legitimate social platforms through which societies could contain societal ills and challenges e.g. smoking, diabetes management, environmental protection campaigns, etc. Such avenues would encourage discussions in area of culture, educational challenges etc. Social connectivity yields peaceful coexistence, a major objective of SD [26]. SD connotes a society devoid of crime and social vices. CSE equips youths with knowledge and skill to protect the society against cybercrimes [27].

2.3 Economic sustainability

Computers and ICTs have impacted the business world by improving business environment and opportunities especially in rural areas. New methods and ways for market and business information sharing and promotion are made possible through computer educators who extend awareness campaigns to the rural areas. As ICT devices become ubiquitous rural dwellers now benefit through government-sponsored programs undertaken by skilled computer educators [28]. With these programs, farmers and others in those locations are now able to go beyond their traditional

boundaries thus, they have more opportunities to discover more buyers of their products and network with other stakeholders.

2.4 Handling climate change

Climate change applies to changes in average weather conditions, or variation of weather around long-term average conditions [29]. Climate change is phenomenon that has many contributing elements such as: biotic processes, solar radiations, plate tectonics, volcanic eruptions, global warming, etc. CSE provides necessary skills to enable scientists collect and analyze environmental information across different horizon, from the ocean to the atmosphere. Scientists and other researchers have tried resolving issues arising from climate change through the deployment of computer models to better understand the earth's climate system. Accordingly, computer education could complement the ongoing research on climate change to design and explore mechanisms to creating data streams, analysis, storage of results, etc. Scientists could build complex models to simulate and predict future developments using existing climate histories. Computer-based solutions find applications as control elements in natural and built environments (bridges, power grid, smart buildings, traffic control, oil spills, earthquake, oceans, lakes, etc).

2.5 Sustainable production

Sustainable production (SP) is associated with producers and suppliers in the supply chain. SP is directed towards efficient deployment of resources, factors of production, waste minimization, and reduction of pollution, SP is associated to Sustainable consumption (SC). SC is aimed at more efficient consumption of consumable products. SC starts with purchasing behaviour and other activities that affect lifestyles and livelihood.

2.6 Environmental and Green Computing (EGC)

EGC is an interdisciplinary approach driven by computing and aimed at environment data collection and subsequent analysis to drive decisions. This is achieved via modeling, simulation, and/or prototyping on environment issues, spatial data, etc. EGC contributes to SD by monitoring the environmental changes, understanding complex systems, sharing data and building consensus among stakeholders. Green ICT deals with usage and disposal of computer-related products in such manner that it does not exert harmful effects on the society and environment. It encourages change in lifestyles and behavior to support SD through deployment of online tools, portals, etc. [30]. GC keeps the environment safe through use of eco-friendly technology. High energy systems are redesigned to eliminate greenhouse gases. Strategies adopted include: deployment of reduced emission systems, green data centers, energy efficient components, etc.

3 Conclusion

Development is a constitutional mandate of any meaningful government. SD a potential medium to ensuring the protection of the socio-economic rights of the citizenry. SD goals are achievable where computing and ICT education are encouraged and given the desired prompt attention. Though Computers and ICTs have been adjudged good remedies for poverty alleviation and veritable tools for the achievement of SD goals, appropriate utilization complemented with good reforms is what would make it yield the anticipated fruit. Therefore, Nigeria should double her efforts in provision and creation of enabling educational and research environment driven by ICTs. This would bring the long expected sustainable development. In line with the foregoing, the following recommendations are made:

1. Computer education curriculum at all levels should be fully restructured to incorporate ICT and competency-based structure. Relevant SD topics should be integrated in the curriculum.
2. The Government should incorporate public private partnership [31] in public institutions so as to build critical infrastructure needed to drive expert-level training in computer education.
3. Power supply is a major problem in Nigeria, conscious efforts should be directed towards alternative power supply.
4. Local content is important and instructional manuals should be developed in local languages to enhance knowledge and skill acquisition.
5. The cost of ICT devices should be subsidized for tertiary institutions, and where such institutions import ICT products to support their programs, such facilities should not attract custom duties.

4 Acknowledgement

We want to acknowledge the faculty at the Department of Computer Education at the Aminu Saleh College of Education, Bauchi. No funding was received for this work.

5 References

- [1] Ngwu, O.G. (2015). Refocusing Computer Education: Vehicle to Sustainable National Development in Nigeria. <http://www.globalacademicgroup.com/journals/knowledge%20review/Ngwu%20Obiageli%20Grace.pdf>
- [2] Flavin, B. (2018). 8 Surprising ways Computer Science Benefits Society. <https://www.rasmussen.edu/degrees/technology/blog/ways-computer-science-benefits-society/>
- [3] Nwankwo, W. (2018). Promoting Equitable Access to University Education through Online Learning Systems. *World Journal of Engineering Research and Technology*, 4(2),517-543

- [4] Nwankwo, W. (2017). Assessment of Open Educational Resources in Tertiary Institutions: The Computerized Information Model. *Communications*, 5(6): 58-72. <https://doi.org/10.11648/j.com.20170506.11>
- [5] National Policy on Education (1998). Nigerian Educational Research and Development Council (NERDC), Abuja, Nigeria.
- [6] Baptiste, C. (2017). 5 Interesting Definitions of Computer Science. Retrieved from <http://gradeacomputerscience.com/5-interesting-definitions-of-computer-science>
- [7] Heeks, R. (2002). i-Development and not e-Development, Special Issues on ICTs and Development, *Journal of International Development*, 14(1), 141-151.
- [8] An, L. (2019). Application of Computer Technology in Aesthetic Education and Feature Analysis. *International Journal of Emerging Technologies in Learning*, 14(14), 46-56. <https://doi.org/10.3991/ijet.v14i14.10713>
- [9] Clementking, A., Muhammad, A., Shah, A. and Ahmad, F. (2013). Technology Based Learning Analysis of CBCS Model at KKU. *International Journal of Emerging Technologies in Learning*, 8(3), 8-12. <https://doi.org/10.3991/ijet.v8i3.2617>
- [10] Bagon, S. (2018). Information Communication Technology Use among Students in Inclusive Classrooms. *International Journal of Emerging Technologies in Learning*, 13(6), 56-72. <https://doi.org/10.3991/ijet.v13i06.8051>
- [11] FME (2004). National Policy on Education. Federal Ministry of Education, Abuja, Nigeria
- [12] Nwagbara, E.N. (2009). Job Hunting Through the Internet: The Experiences of Some Graduates of Nigerian Tertiary Institutions. *Global Journal Of Social Sciences*, 8(1), 77-83. <https://doi.org/10.4314/gjss.v8i1.48901>
- [13] Zubair, O. M. & Omotayo, O. O. (2018). Fresh Nigerian tertiary education graduates' use of Internet sources for job information search. *Journal of Information Science, Systems and Technology*, 2(1), 34-48
- [14] Ehiaghe, G. (12 February 2019). Graduates' dilemma worsens as formal jobs shrink. <https://guardian.ng/appointments/graduates-dilemma-worsens-as-formal-jobs-shrink/>
- [15] Bisuga, S. (24 October 2019). Are Nigerian graduates employable? <https://www.pmnewsnigeria.com/2019/10/24/are-nigerian-graduates-employable/>
- [16] Umoru, H. (12 December 2019). Social Calamity Looms in Nigeria if Unemployment is not addressed, Senate Warns. <https://www.vanguardngr.com/2019/12/social-calamity-looms-in-nigeria-if-unemployment-is-not-addressed-senate-warns/>
- [17] Babalobi, B. (17 December 2019). Nigeria: Why graduates are unemployed and unemployable. <https://www.vanguardngr.com/2019/12/nigeria-why-graduates-are-unemployed-and-unemployable/>
- [18] NCC (2019). Press Release: With 13.8% contribution to GDP, ICT may double Oil and Gas in 2 years, says Communications Minister. Nigeria Communications Commission, Abuja, Nigeria. <https://www.ncc.gov.ng/media-centre/news-headlines/665-press-release-with-13-8-contribution-to-gdp-ict-may-double-oil-and-gas-in-2-years-says-communications-minister> <https://doi.org/10.1787/888933225096>
- [19] Brundtland, G.H. (1987). What is Sustainable Development? World Commission on Environment and Development: Our Common Future. <https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf> <https://doi.org/10.4324/9780203383797>
- [20] Bryant, N.A. (2003). Sustainable Development: Its Application in Nigeria. A special lecture delivered at STAN Annual Conference.
- [21] UNESCO (2017). A Decade of Progress on Education for Sustainable Development. G. Michelsen and P. J. Wells (Eds.). Paris: UNESCO

- [22] Wu, J., Huang, H., & Xiang, Y. (2018). Information and Communications Technologies for Sustainable Development Goals: State-of-the-Art, Needs and Perspectives. <https://arxiv.org/pdf/1802.09345> .
- [23] Gordon, N. (2015). Education for sustainable development in Computer Science. <https://www.researchgate.net/publication/261615196>
- [24] Annaraja, P. (2015). Teaching of Computer Science. Bharathidasan University Tiruchirappalli. Center for Distance Education, India.
- [25] Saidu, A., Tukur, Y., Suleiman. A.H. (2014). Promoting Sustainable Development Through ICT in Developing Countries. *European Journal of Computer Science and Information Technology*, 2(2), 24-29
- [26] Gordon, N (2009), Sustainable Development and Social Responsibility – Making it Professional, In Proceedings of the 2009 Higher Education Academy Subject Centre for Information and Computer Sciences, University of Kent, August 2009, 21-24, ISBN 978-0-9559676-6-5.
- [27] Nwankwo,W., Ukaoha,K.C.(2019). Socio-Technical perspectives on Cybersecurity: Nigeria’s Cybercrime Legislation in Review. *International Journal of Scientific and Technology Research*, 8(9), 47-58.
- [28] Onuoha, O. & Onyebuka, C. (2016). ICT for Sustainable Economic Development and Growth in Rural Areas. *International Journal of Computer Science and Mathematical Theory*, 2(1).
- [29] Abey Siriwardana, P.C. (2015). Climate change issues and computer science. Retrieved from <https://www.researchgate.net/publication/282121177>
- [30] Majid, M. E. (2018). Role of ICT in promoting sustainable consumption and production patterns - a guideline in the context of Bangladesh. *Journal of Environmental Sustainability*,6(1), 1-14.
- [31] Nwankwo,W.and Kifordu,A.(2019) Strengthening Private Sector participation in Public Infrastructure Projects through Concession Policies and Legislations in Nigeria: A Review. *Journal of Advanced Research in Dynamical and Control Systems*, 11(8), 1360-1370. Special Issue.

6 Authors

Wilson Nwankwo is an Associate professor at the Department of Computer Science, Edo University Iyamho, Edo State Nigeria. His research interests are Software engineering, Enterprise Information Systems, Cyber physical systems, and Informatics. nwankwo.wilson@edouniversity.edu.ng

Christian Njoku is a Senior Lecturer at the Department of Computer Science Education, Aminu Saleh College of Education, Azare, Bauchi State, Nigeria. Chrisnjoku821@gmail.com

Article submitted 2020-02-29. Resubmitted 2020-03-28. Final acceptance 2020-03-30. Final version published as submitted by the authors.