Sustainable Development in Africa through Engineering Research and Innovation in Computer Science Education

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ABSTRACT
The major purpose of the study was to examine ways of meeting the needs of sustainable development in Africa through engineering research and innovation in computer science education. This study adopted a descriptive survey research design. The area of the study was Warri Education Zone Delta State. The population of the study consisted of 10 computer science educators in the College Of Education Warri in Warri education zone. The entire population was studied. The instrument for data collection was a self structured questionnaire. The data collected for the study was analyzed using mean and the hypotheses were tested using t-test statistics. The result of the study shows that engineering research and innovation in computer science education are relevant for sustainable development in Africa which can be manifested in technological, scientific, security, political and economic applications. The production of computer science educators, doctors, technicians and technologists in Africa depends on the level of engineering research in the continent. Computer Science Education is a very vital science subject which is needed for sustainable development in Africa. To produce and retain computer science educators, doctors, technicians and technologists, the paper recommends that specialist research teachers should be employed to teach both research and computer science at all tertiary institutions in Nigeria.

Keywords: Computer Science Education, Africa, Sustainable Development, Innovation and Engineering Research.

INTRODUCTION
Given the growing importance of computer science and engineering research in meeting national goals, African researcher needs to remain at world frontiers if African is to boost economic productivity and competitiveness, strengthen national security, improve human health, and achieve other national objectives in the next century. Computer science education is an education that deals with the hardware, software, networking, and all the processes that fall under the umbrella of giving life to a machine to enable it to perform complicated tasks and actions. Computer science education is a pathway to innovation, to creativity and to exciting career opportunities. Computer science is the study of the theory, experimentation, and engineering that form the basis for the design and use of computers. It is the scientific and practical approach to computation and its applications and the systematic study of the feasibility, structure, expression, and mechanization of the methodical procedures (or algorithms) that underlie the acquisition, representation, processing, storage, communication of, and access to information.

Sustainable development in Africa can be achieved through engineering research and innovation in computer science education, this is so because research is a systematic inquiry that investigates issues, suggests new interpretations of data or texts, and poses new questions for future researchers to explore. This involves systematic empirical investigation of quantitative properties and phenomena and their relationships, by asking questions and collecting numerical data to analyze it utilizing statistical methods. The quantitative research designs are experimental, correlational, and survey (or descriptive).
Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Learning to live sustainably on Africa is going to require enormous advances in our understanding of the natural world and our relationship with it via engineering research. To acquire that understanding, progress in engineering research and innovation in computer science education is essential. The human population is swelling toward ten billion. All of these people need food, clean water, housing and energy Fafunwa (1974). To stay within the planet’s carrying capacity, we are going to have to be extraordinarily clever about how we use the Earth’s resources especially those of the African continents.

Sustainable development is widely conceived as a “participatory process of social change in the society, intended to bring both social and material advancement (including greater equality, freedom and other valued qualities) for the majority of people through their gaining control over the environment”. Some of the elements of sustainable development include high standard of living, high agricultural productivity, high technological productivity, adequate exploration and exploitation of the natural and mineral resources of the society, less dependence on imported materials, presence of heavy industries, high literacy and numeracy rate of the citizens, appropriate health care delivery and low unemployment Ambali (2014). Engineering research is a vital tool needed for the achievement of sustainable development.

Engineering research seeks improvements in theory and practice in fields such as computer science, high-speed computation, bioengineering, earthquake prediction, power systems, nanotechnology and construction. Major contributors to engineering research in Africa include governments, private business operators, and academia. The results of engineering research can emerge in journal articles, at academic conferences, and in the form of new products on the market which is aimed at fostering sustainable development.

Today, engineering research plays a big role in sustainable development in all of its aspects: social, environmental, and economic. Many developmental challenges could be solved if adequate effort and time is devoted to engineering research and computer science education. Kuku (2012). This study provides a unique opportunity for in-depth technical discussions and exchange of ideas in engineering research and innovation in computer science education. Its primary aim is to give researchers and lecturers of higher education the tools to translate latest, real-world problems related to sustainable development into rigorous numerical simulations. This study offers to researchers, computer educators, scientists’ industrialists, engineers and computer science students from different part of the country to present their latest research, to interact with the experts in the field, and to foster interdisciplinary collaborations required to meet the challenges of modern science, technology, and society Eguridu (2014). This forum will address a large number of themes and issues. This study will be scheduled in plenary and keynote lectures followed by special and contributed sessions. We hope to receive a variety of papers from researchers and computer science educators, which will help in generating many interdisciplinary problems, thus strengthening engineering research and innovation in computer science education.

**Statement of the Problem**

Every society aspires to develop and achieve a better standard of living for her citizens and this is only possible with the presence of well trained researchers and computers scientists /technologists who can help to transform the society. Therefore, the under development of Africa could be readily traced to her lack of economic independence which in turn arise from her backwardness in engineering research, innovation in computer science and technology. Development is expected to be purposeful and sustainable in order to be beneficial to the society for a long time. In the words of Ambali (2014), "without sustainability, development itself is ultimately counterfeit and counterproductive". According to the United Nations World Commission on Environment and development (1987), sustainable development is “development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs”, Africa is presently lacking in this direction, hence the need for sustainable development in Africa through engineering research and innovation in computer science education.

**Purpose of the Study**

The major purpose of the study was to examine ways of meeting the needs of sustainable development in Africa through engineering research and innovation in computer science education. Specifically, the study sought to:

1. **Purpose of the Study**

   The major purpose of the study was to examine ways of meeting the needs of sustainable development in Africa through engineering research and innovation in computer science education. Specifically, the study sought to:
i. Determine the extent to which sustainable development in Africa can be achieved through engineering research and innovation in computer science education.

ii. Determine ways of enhancing engineering research and innovation in computer science education towards sustainable development in Africa.

**Research questions**

The study was guided by the following research questions:

i. To what extent can sustainable development in Africa be achieved through engineering research and innovation in computer science education?

ii. What are the various ways of enhancing engineering research and innovation in computer science education towards sustainable development in Africa?

**Hypotheses**

The following hypotheses were tested at 0.05 level of significance:

H01: There is no significant difference between the mean responses of male computer science lecturers and female computer science lecturers on the extent to which sustainable development in Africa can be achieved through engineering research and innovation in computer science education.

H02: There is no significant difference between the mean responses of senior computer science lecturers and junior computer science lecturers on the various ways of enhancing engineering research and innovation in computer science education towards sustainable development in Africa.

**METHODOLOGY**

The design adopted for the study was descriptive survey. This involved collection of data using questionnaire for the purpose of describing and interpreting existing conditions or qualities regarding a given population Adetula (2005). The design was considered suitable going by the nature of the study.

This study adopted a descriptive survey research design. The area of the study was Warri Education Zone. The population of the study consisted of 20 Science lecturers in College of Education Warri in Warri Education Zone. The entire population was studied. The instrument used for data collection was a five-point rating scale of Strongly Agree, Agree, Undecided, Disagree, Strongly Disagree, with weighted values of 5, 4, 3, 2 and 1 respectfully. It contained a total of 20 questionnaire items based on the research questions raised for the study.

The instrument was validated by 2 experts, 1 expert from the Department of computer Science and one expert in research and development, all in College of education Warri. The comments of the validators guided the modification of the instrument. The reliability of the instrument was established using Crombach alpha. The reliability index arising from this method achieved a degree of internal consistency of the instrument. The calculated reliability index was 0.68.

The researcher administered the questionnaire by the help of 2 research assistants. A return rate of 100% was recorded. Analysis was carried out using mean with standard deviation to answer the research questions. To reach a decision, the mean of the weighting scale was calculated thus: \( \frac{5+4+3+2+1}{5} = 3.00 \). Any mean score of 3.00 and above were accepted while items with mean below 3.00 were rejected. Two null hypotheses were tested at 0.05 level of significance using t-test statistics. If the calculated t-value is less than the critical table value of 1.96 at 117 degree of freedom, the null hypotheses is upheld otherwise the null hypotheses is rejected.

The instrument used for data collection was structured questionnaire which was used to collect data on the various ways of meeting the needs of sustainable development in Africa through engineering research and innovation in computer science education. The instrument was validated by two academic colleagues in College of Education Warri who specialized in computer science education, and educational research. The reliability of the instrument was established using test-retest method, and application of Pearson’s product moment correlation which was established to be 0.69. The instruments were administered directly to the lecturers in their various departments by the researchers having 100% assurance of return. The entire research questions were analyzed using the means, and presented in tables for clarity purposes.
RESULTS

Research Question 1: To what extent can sustainable development in Africa be achieved through engineering research and innovation in computer science education?

Table 1: Mean (x) scores and standard deviation showing the extent to which sustainable development in Africa can be achieved through engineering research and innovation in computer science education.

<table>
<thead>
<tr>
<th>S/N</th>
<th>The extent to which sustainable development in Africa can be achieved through engineering research and innovation in computer science education.</th>
<th>X</th>
<th>SD</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Engineering research as well as innovation in computer science education plays crucial role in the creation and dissemination of knowledge which can provide a sound basis for economic prosperity and social inclusion.</td>
<td>3.52</td>
<td>1.53</td>
<td>R IN ST</td>
</tr>
<tr>
<td>2</td>
<td>Engineering research seeks improvements in theory and practice in fields such as high-speed computation, bioengineering, earthquake prediction, power systems, nanotechnology and construction.</td>
<td>3.64</td>
<td>1.70</td>
<td>R IN ST</td>
</tr>
<tr>
<td>3</td>
<td>Creating and sharing knowledge is fundamental to growing knowledge economy and society. Africa will only be successful in achieving her national goals when the relationship between research and innovation in computer science education is fully developed.</td>
<td>3.44</td>
<td>1.72</td>
<td>R IN ST</td>
</tr>
<tr>
<td>4</td>
<td>High quality engineering research will underpin knowledge creation and technology transfer that is linked to the achievement of African’s national goals.</td>
<td>3.38</td>
<td>1.92</td>
<td>R IN ST</td>
</tr>
<tr>
<td>5</td>
<td>Engineering research need to be at the forefront of African’s economic, social and environmental development.</td>
<td>3.40</td>
<td>1.86</td>
<td>R IN ST</td>
</tr>
<tr>
<td>6</td>
<td>Elevating engineering research to a position of high strategic importance within the African continents will promote sustainable development.</td>
<td>3.85</td>
<td>1.60</td>
<td>R IN ST</td>
</tr>
<tr>
<td>7</td>
<td>Engineering research as well as innovation in computer science education will help bridge the gap between businesses and the knowledge that can make a difference to the success of such businesses.</td>
<td>3.56</td>
<td>1.75</td>
<td>R IN ST</td>
</tr>
<tr>
<td>8</td>
<td>Change is universal in nature; engineering research as well as innovation in computer science education will help determine whether a given amount of change represents natural fluctuation around a steady state or a net trajectory in a desirable or undesirable direction.</td>
<td>3.77</td>
<td>1.81</td>
<td>R IN ST</td>
</tr>
<tr>
<td>9</td>
<td>It is essential that Universities in Africa should be repositioned through engineering research to influence the direction and quality of engineering research and ensure that universities become the elite institutions that they are intended to be.</td>
<td>3.55</td>
<td>1.53</td>
<td>R IN ST</td>
</tr>
<tr>
<td>10</td>
<td>Universities in Africa should be striving towards a research community, which is defined by increased global connectedness and networks with international research peers.</td>
<td>3.46</td>
<td>1.48</td>
<td>R IN ST</td>
</tr>
<tr>
<td></td>
<td>Grand Mean</td>
<td>3.47</td>
<td>1.63</td>
<td></td>
</tr>
</tbody>
</table>

KEY: R IN ST = Results in sustainable development in Africa; CR IN ST = Cannot result in sustainable development in Africa

From the data analysis, all the issues raised affects the extent to which sustainable development in Africa can be achieved through engineering research and innovation in computer science education.
The mean score are between 3.05 - 3.96. This indicates that engineering research and innovation in computer science education can result in sustainable development in Africa. 

**Research Question 2:** What are the various ways of enhancing engineering research and innovation in computer science education towards sustainable development in Africa?

Table 2: Mean (x) scores and standard deviation showing the various ways of enhancing engineering research and innovation in computer science education towards sustainable development in Africa.

<table>
<thead>
<tr>
<th>S/N</th>
<th>The various ways of enhancing engineering research and innovation in computer science education towards sustainable development in Africa</th>
<th>X</th>
<th>SD</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Engineering research requires a persistent, long-term, focus on quality, innovation, continuous improvement and entrepreneurship. As part of this, the people, the organisations, and the management and funding systems, in the tertiary sector need to stimulate, to facilitate, to demand, and to celebrate the highest standards of excellence in research.</td>
<td>3.86</td>
<td>1.48</td>
<td>IC</td>
</tr>
<tr>
<td>2</td>
<td>Linkages need to be encouraged between tertiary providers, industry, and research users in other continents other than those in African continents so as to celebrate the highest standards of excellence in research.</td>
<td>3.62</td>
<td>1.54</td>
<td>IC</td>
</tr>
<tr>
<td>3</td>
<td>The tertiary sector must take responsibility for engaging effectively with tertiary providers, industry, and research users in other continents other than those in African continents to disseminate new ideas, products and services that will be relevant to sustainable development in Africa.</td>
<td>3.86</td>
<td>1.86</td>
<td>IC</td>
</tr>
<tr>
<td>4</td>
<td>Specialist computer science teachers should be employed to teach computer science at all levels of education in Africa.</td>
<td>3.74</td>
<td>2.62</td>
<td>IC</td>
</tr>
<tr>
<td>5</td>
<td>Programme should be put in place to train and retrain computer science teachers on how to improve their competencies and proficiencies in the area of actively involving computer science students in the teaching and learning process.</td>
<td>3.65</td>
<td>1.38</td>
<td>IC</td>
</tr>
<tr>
<td>6</td>
<td>Computer science graduates should be offered special remunerations on employment.</td>
<td>3.44</td>
<td>2.53</td>
<td>IC</td>
</tr>
<tr>
<td>7</td>
<td>A policy should be put in place to have research as well as Computer science teachers given permanent and pensionable appointment in any part of the countries in Africa.</td>
<td>3.30</td>
<td>1.44</td>
<td>IC</td>
</tr>
<tr>
<td>8</td>
<td>There should be regular workshops and seminars for research as well as Computer science teachers to improve their competencies.</td>
<td>3.46</td>
<td>1.50</td>
<td>IC</td>
</tr>
<tr>
<td>9</td>
<td>There is an urgent need to recruit enough qualified personnel in the teaching of research as well as Computer science teachers.</td>
<td>3.66</td>
<td>2.48</td>
<td>IC</td>
</tr>
<tr>
<td>10</td>
<td>Research as well as Computer science must be presented in such a way that it becomes real, concrete, attractive, interesting, captivating, motivating and directly related and relevant to life by providing the necessary teaching aids.</td>
<td>3.68</td>
<td>1.54</td>
<td>IC</td>
</tr>
</tbody>
</table>

**Grand Mean** | 3.61 | 1.77 |

**KEY:**

IC = Improves competencies in engineering research and innovation in computer science education

Can not IC = Can not Improve competencies in engineering research and innovation in computer science education

From the data analysis all the issues raised are ways of improving competencies in engineering research and innovation in computer science education towards sustainable development in Africa. The mean score are between 3.33 - 3.94. This indicates that all the issues raised are ways of
improving competencies in engineering research and innovation in computer science education towards sustainable development in Africa.

Table 3: The t-test analysis of mean responses of male teachers and female teachers on the extent to which sustainable development in Africa can be achieved through engineering research and innovation in computer science education

<table>
<thead>
<tr>
<th>Responses</th>
<th>N</th>
<th>X</th>
<th>SD</th>
<th>DF</th>
<th>t.cal</th>
<th>t-tab.</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior teachers</td>
<td>11</td>
<td>2.02</td>
<td>0.74</td>
<td>117</td>
<td>1.62</td>
<td>1.96</td>
<td>NS</td>
</tr>
<tr>
<td>Senior teachers</td>
<td>9</td>
<td>2.30</td>
<td>0.62</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The t-test analysis of data in table 3 revealed that all the 10 items on significant difference between the mean responses of male computer science lecturers and female computer science lecturers on the extent to which sustainable development in Africa can be achieved through engineering research and innovation in computer science education. The table above indicates that t-cal (1.62) is lower than the t-table of 1.96 at 0.05 level of significance. This indicated that for the 10 questionnaires items (1-10), there was no significance difference in the mean responses of the two groups of the respondents. Therefore, the Null hypothesis 1 (H01) of no significant difference between the male and female computer science teachers were upheld for the 10 research items. This also implies that there is no significant difference between the mean responses of male computer science lecturers and female computer science lecturers on the extent to which sustainable development in Africa can be achieved through engineering research and innovation in computer science education.

Table 4: The t-test analysis of mean responses of senior computer science lecturers and junior computer science lecturers on the various ways of enhancing engineering research and innovation in computer science education towards sustainable development in Africa

<table>
<thead>
<tr>
<th>Responses</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>DF</th>
<th>t.cal</th>
<th>t-tab.</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior teachers</td>
<td>11</td>
<td>2.22</td>
<td>0.70</td>
<td>117</td>
<td>1.86</td>
<td>1.96</td>
<td>NS</td>
</tr>
<tr>
<td>Senior teachers</td>
<td>9</td>
<td>2.40</td>
<td>0.54</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The t-test analysis of data in table 4 revealed that all the 10 items on significant difference between the mean responses of senior computer science lecturers and junior computer science lecturers on the various ways of enhancing engineering research and innovation in computer science education towards sustainable development in Africa. The table above indicates that t-cal (1.86) is lower than the t-table of 1.96 at 0.05 level of significance. This indicated that for the 10 questionnaires items (1-10), there was no significance difference in the mean responses of the two groups of the respondents. Therefore, the Null hypothesis 2 (H02) of no significant difference between the male and female computer science teachers was upheld for the 10 research items. This also implies that there is no significant difference between the mean responses of senior computer science lecturers and junior computer science lecturers on the various ways of enhancing engineering research and innovation in computer science education towards sustainable development in Africa.

FINDINGS
1) The study shows that Engineering research as well as innovation in computer science education plays crucial role in the creation and dissemination of knowledge which can provide a sound basis for economic prosperity and social inclusion.
2) Engineering research seeks improvements in theory and practice in fields such as high-speed computation, bioengineering, earthquake prediction, power systems, nanotechnology and construction.
3) Creating and sharing knowledge is fundamental to growing knowledge economy and society. Africa will only be successful in achieving her national goals when the relationship between research and innovation in computer science education is fully developed.
4) High quality engineering research will underpin knowledge creation and technology transfer that is linked to the achievement of African’s national goals.
5) Engineering research need to be at the forefront of African’s economic, social and environmental development.

6) Elevating engineering research to a position of high strategic importance within the African continents will promote sustainable development.

7) Engineering research as well as innovation in computer science education will help bridge the gap between businesses and the knowledge that can make a difference to the success of such businesses.

8) Change is universal in nature; engineering research as well as innovation in computer science education will help determine whether a given amount of change represents natural fluctuation around a steady state or a net trajectory in a desirable or undesirable direction.

9) It is essential that Universities in Africa should be repositioned through engineering research to influence the direction and quality of engineering research and ensure that universities become the elite institutions that they are intended to be.

10) Universities in Africa should be striving towards a research community, which is defined by increased global connectedness and networks with international research peers.

11) The study shows that computer science education has helped to transform man's rural society to modern society.

12) The level of social and economic development is closely connected with the level of development in computer science education as well as engineering research.

13) No society can develop without the effective teaching and learning of engineering research in schools.

14) The solid foundation in engineering research prepares one for other educational and professional challenges.

15) The production of technicians and technologists in any society depends on the level of the study of engineering research and computer sciences in the society.

16) The gap in the level of development between the advanced countries and the developing countries is as a result of the gap in the level of the teaching and learning of engineering research and computer sciences.

17) The study also shows that there is not enough number of qualified computer sciences teachers in schools. In fact in some schools there are no single qualified mathematics teachers to teach the students.

CONCLUSION

In conclusion African leaders are creating a strong infrastructure and providing resources required to assist engineering research and innovation in computer science education to grow sustainably and participate on the international scene. A strong tertiary sector and well-developed research infrastructure is just the entry stakes. The world is living in turbulent times where economic competitiveness and sustainability are concerned. African leaders need to constantly innovate to reach our national goals.

Tertiary institutions in African must not only learn how to learn better, but it must apply what it knows in new ways. The basis of any knowledge society is constant innovation and new discoveries. African leaders need to constantly innovate to reach our national goals.

Tertiary institutions in African must not only learn how to learn better, but it must apply what it knows in new ways. The basis of any knowledge society is constant innovation and new discoveries. African leaders need to constantly innovate to reach our national goals.

Efforts must be made by the government to increase the quality of computer sciences educators and research experts by building a critical mass of research capability and knowledge around focused areas and lift the relevance of engineering research by supporting research into areas that underpin national development goals. This initiative has real potential to improve the ability of stakeholders such as industries, communities and the government to understand and tackle issues of national significance leading to sustainable development.

Computer science and research is the bedrock of the economic and technological development of any Nation. The study of computer sciences at all levels of our educational system is faced with so many problems. Of all the problems, the most important one is the problem of the quantity and quality of
Computer science and research teachers in our school system. The best way to address the problems of the teaching and learning of Computer science and research is to address the problems of teachers especially their condition of service. With attractive condition of service, many students would opt to study the subject, more qualified teachers would be available in the school system, and then the performance of Computer science students would improve.

RECOMMENDATION
It is therefore recommend that:

1. Universities must take a leadership role in the pursuit of an innovative and highly skilled economy. They are also bridges between businesses and the knowledge that can make a difference to their success.
2. It is essential that African leaders should reposition their universities as well as other institutions in the continent to influence the direction and quality of research and ensure that they become the elite institutions that they were intended to be.
3. Universities in Africa should be striving towards a research community, which is defined by increased global connectedness and networks with international research peers.
4. At the same time our tertiary system African should be made to be dominated by collaboration and the sharing of knowledge between tertiary education organisations and other research providers, and the communities that they serve.
5. Linkages need to be encouraged between other tertiary providers, industry, and other research users around the world.
6. The tertiary sector must take responsibility for engaging effectively with other tertiary institution and organization around the globe to disseminate new ideas, products and services that will be relevant to sustainable development in Africa.
7. Engineering research requires a persistent, long-term, focus on quality, innovation, continuous improvement and entrepreneurship. As part of this, the people, the organisations, and the management and funding systems, in the tertiary sector need to stimulate, to facilitate, to demand, and to celebrate the highest standards of excellence in research.
8. Action should be put in place to deliberately improve the salaries and conditions of service of teachers as done in some advanced countries.
9. There is urgent need for a special incentive package inform of generous scholarships to attract talented students to study computer science. When scholarships are provided, students are attracted to apply for such courses in tertiary institutions Hoderfield and Stinnett (1961).
10. Computer science education graduates should be offered special remunerations on employment. When many prospective students are attracted into the study of computer science education, in the long run the nation shall have enough personnel as teachers at all levels and a good number of them in science and technology for the development of the country.
11. Recruitment of the best Brains into the teaching of computer science generally, the best graduates in the entire subject areas should be identified and recruited in the teaching profession as practiced in some other African and advanced countries such as Nigeria.
12. The best brains in any subject discipline should be the teachers of such a discipline at all levels. This is the only way of ensuring quality control and development in that subject area. Best brains in a subject would be enthusiastic about the teaching, research and development in the area of study Niss (1996).
13. Students wishing to study the mathematical sciences education should be awarded bursary to attract them to the courses.
14. Specialist teachers should be employed to teach computer science at both primary and secondary School level.

REFERENCES


