

CONTEMPORARY ISSUES IN SCIENCE, TECHNOLOGY, ENGINEERING, ARTS AND MATHEMATICS TEACHER EDUCATION IN NIGERIA

**A Festschrift in Honour of
PROFESSOR ISAAC OLAKANMI
ABIMBOLA**



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PROFILE OF PROFESSOR ISAAC OLAKANMI ABIMBOLA

Isaac Olakanmi Abimbola is a Professor of Science Education at the Department of Science Education, Faculty of Education, University of Ilorin (Unilorin), Ilorin, Nigeria. He was born on 2nd August 1948 at Òdò-ìjèṣà, in Àtākùnmòsà East Local Government Area of the State of Osun, Nigeria.

He is a professionally trained and certified teacher of over fifty years teaching experience. He has taught at all levels of education. In addition, he is a certified Applied Scholastics International Master Instructor.

He was educated at St. Bartholomews Anglican Primary School, Òdò-ìjèṣà; L. A. Secondary Modern School, Òké-Oòyè, Ilesà; Wesley College, Ibadan; The University of Ife, Ile-Ife, Nigeria; The University of Wisconsin-Madison, Madison, Wisconsin, USA.

His research is in the area of student misconceptions and alternative conceptions in biology. It focuses on how students can learn with perfect understanding. This is to enable them apply their knowledge in problem solving. He has published several scholarly articles in reputable home-based, national, and international journals. In addition, he has published many books on Curriculum and Instruction, Integrated Science, Biology, History and Philosophy of Science, Research Methods, and Study Technology.

Professor Abimbola has supervised several theses and research projects of many science teachers and educators holding important positions in Nigeria.

He has been External Examiner to several Colleges of Education and Universities in Nigeria. He has been External Assessor of Ph.D. candidates theses in many Nigerian Universities. He has been External Assessor for promotion of senior academics in Colleges of Education, higher education regulatory agency and Universities within and outside Nigeria. He is a regular participant in NUC and NCCE Accreditation exercises. He is a regular presenter of research papers in local, national, international conferences and capacity building programmes. He has served as Member of Editorial Boards of several national and international Journals. He has delivered awareness-training programmes on Study Technology to many secondary school and university students and teachers. He is a member of many professional associations in science education.

Professor Abimbola has been Visiting Professor to Michigan Technological University, Houghton, Michigan, USA, and Tai Solarin University of Education, Ijagun, Ijebu-Ode, Ogun State, Nigeria.

He was previously a primary school teacher and later a Headmaster, Methodist School, Pápá, in Olójuoró Area, Ibadan Less-City (Jan-April, 1969); Classroom teacher, Wesley College Practising School, Elékùró, Ibadan (April 1969-September 1971); NYSC teacher, Teachers College, Bama, Borno State (August 1975-June 1976); Education Officer II, Ministry of Education, Ibadan, Oyo State July-12 September 1976); Professor Abimbola has been in the service of the University of Ilorin for the past 42 years; Assistant Lecturer - Professor, University of Ilorin, Ilorin (13 September 1976 — 1 August 2018); He was the first democratically elected Head of Department of Curriculum Studies and Educational Technology, University of Ilorin, Ilorin, Nigeria (1 August 1999 — 28 February 2002); Provost, Osun State College of Education, Ilesa, Osun State, Nigeria (1 March 2002 — 28 February 2006); Foundation Director, Centre for Research, Development and In-House Training (CREDIT), Unilorin; First Dean, Postgraduate School from the Faculty of Education, Unilorin; Foundation Research Manager, Faculty of Education, Unilorin.

Professor Abimbola is leaving rich legacies for us, and in us, in his positive personal attributes of integrity, scholarship, hard work, thoroughness, professionalism, and his useful books. He is leaving behind important research legacies in the area of study technology as represented in misunderstood words, situations, and symbols, and perfect understanding. We shall continue to remember his advocacy for multiple-choice testing as a panacea for students learning difficulties that may prevent perfect understanding.

Professor Abimbola is happily married with children and grandchildren.

He loves photography and many varieties of music.

Biology Education Group (2018)

FORWARD

Research in science teacher education are on-going world-wide as a result of advances in knowledge, changing policies, evolving teacher education standards and professionalism, and the challenges of globalization and internationalization of education. Many challenging issues have arisen that need to be better understood and addressed in the pre-service science, technology, engineering, art and mathematics (STEAM) teacher education in Nigeria. The understanding and new insight will help to enhance and to continually improve the quality of STEAM teacher education. Professor I.O. Abimbola has devoted greater part of his academic career through research and teaching to the development and improvement of science teacher education. It is based on Professor Abimbola's immense contribution to development of science teacher education that the theme: Contemporary Issues in Science, Technology, Engineering, Art and Mathematics (STEAM) was chosen. The theme is for STEAM educators to reflect on contemporary development, evolving issues and challenges in the STEAM teacher education that could lead to evolving quality and innovative ways to enhancing pre-service STEAM teacher education for the 21st century.

This festschrift is in context of the foregoing. It is published under the Editorial Consultant of the Biology Education Goup, Department of Science Education, University of Ilorin, Nigeria, in honor of Professor I.O. Abimbola, a renowned Science Teacher Educator who retires 1st August, 2018 after 43 years of meritorious academic service; teaching, research and community engagements nationally and internationally.

Sixty-eight articles on the theme and the sub-themes were received from authors and subjected to thorough peer review process. Thirty-six (36) of the articles received scaled the peer review standard. What is therefore published in this festschrift are those articles that meet the required standard and addressed those contemporary but significant issues on STEAM teacher education in Nigeria. The articles therein are focused on and accordingly classified under sub-themes that address issues on Quality of STEAM Teacher Education, Teacher Education Curriculum, Teacher Education and Professional Development, Teaching and Learning, Instruction in Teacher Education, Policy and Teacher Education, Gender and STEAM Education, etc. A special section on compendium of Professor Abimbola supervised Master Dissertation and Doctor of Philosophy Thesis in Science Education revealing his significant contribution in aspect of research mentorship is presented as important component of this book.

The ideas, new narratives, research findings, suggestions and recommendations expressed and advanced by the authors have addressed critical issues for practice and have open up new enquiries into STEAM teacher education that should be focus of further inquiries by STEAM teacher educators.

Considering this book as significant resource book for STEAM teacher education, we recommend it to all teacher education institutions, National Universities Commission, National Commission for Colleges of Education, and other agencies involve in STEAM

teacher education curriculum development, STEAM teacher educators and STEAM pre-service students and all knowledge seeking individuals interested in STEAM teacher education.

The Editorial Team highly appreciates all the authors for their valuable intellectual contribution to this book and to the Academic Board of the Faculty of Education, University of Ilorin, for its quality input and support. To the Consulting Editors your diligent and thorough review process that attest to the quality of the book is immensely appreciated.

Professor M.T. Mustapha

PREFACE

In keeping with the global academic tradition whenever the retirement of an erudite scholar is celebrated by the academic community, the Biology Education Group, Department of Science Education, University of Ilorin, Ilorin, Nigeria, produced this festschrift in tribute to Professor Isaac Olakanmi Abimbola. He is a professionally trained and certified science teacher, as well as, a Certified Applied Scholastics International Master Instructor whose teaching experiences across all levels of education in Nigeria span more than half of a century. Professor Isaac Olakanmi Abimbola who has announced his retirement from the services of the University of Ilorin, Ilorin, Nigeria, after 42 years of active service, is one of the pioneer staff of the University and the Department of Curriculum Studies and Educational Technology (CSET), now known as the Department of Science Education. He is the first Professor of Biology Education in the University. His research interest is in the field of student learning, especially student misconceptions and alternative conceptions in biology, with a special focus on how students can learn with perfect understanding. His scholarly contributions have significantly enriched Biology Education.

Although he was born during the analog era, Professor Isaac Olakanmi Abimbola successfully bridged the digital generation gap to become a leading proponent and prolific user of modern digital technology in teaching and learning in the Faculty of Education, University of Ilorin, Ilorin, Nigeria. He has been Visiting Professor to many universities, such as Michigan Technological University, Houghton, Michigan, USA, and Tai Solarin University of Education, Ijagun, Ijebu-Ode, Ogun State, Nigeria.

He is keenly interested in his students' research works, provides prompt feedbacks and technical assistance. However, working with Professor Isaac Olakanmi Abimbola can sometimes be very stressful, especially if you compromised standards, paraded poorly structured ideas, outdated information, and if you are always reporting efforts, rather than products. He is, however; ever ready to purge you of your misconceptions and alternative conceptions to enable you gain meaningful understanding of issues and problems under focus. For him, everything is knowable and can be done perfectly well; hence, he continuously sets high standards and exhibits zero tolerance for laziness and carelessness. The success of his students is the cornerstone of his engagement with the students. His invaluable guidance and leadership by example, in high quality service delivery, has significantly shaped the professional development of his students and other professors often seek his creative advice.

The theme of this festschrift is Contemporary Issues in STEAM Teacher Education in Nigeria. STEAM is a new acronym for Science, Technology, Engineering, Arts, and Mathematics. It is in recognition of Professor Isaac Olakanmi Abimbola's invaluable contributions to the field of Biology Education, that his professional colleagues, students and acquaintances contributed their original academic works to this festschrift. These contributors spread across every level of the nation's education ladder, across the

nation and even outside the nation. There are thirty-eight chapters organized under seven sections in the festschrift.

The focus of the seven chapters under Section A is on contemporary curricular issues in teacher education in Nigeria. There are also seven chapters in Section B focusing on issues concerned with teacher education and teacher professional development programmes in the nation. Ten chapters that focus on learning were under Section C, while there were only two chapters in Section D, the chapters highlighted issues related to instruction in teacher education. The next eight chapters constitute Section E. Policy issues in teacher education were discussed in the eight chapters. There were only two chapters in Section F, which addresses the need to promote guidance and counseling services in teacher education in Nigeria. A compendium of Master Dissertation and Doctor of Philosophy Theses in Science Education Supervised by Professor Isaac Olakanmi Abimbola was organized under Section G.

We, the Biology Education Group, Department of Science Education, University of Ilorin, Ilorin, Nigeria believe that the academic works contributed in this festschrift would extend knowledge significantly in the field of teacher education, especially biology education, to which our esteemed and beloved Professor Isaac Olakanmi Abimbola has made remarkable contributions. Teacher educators would remain deeply indebted to him for long.

Ganiyu Bello Ph.D.

ACKNOWLEDGEMENTS

The Biology Education Group, Department of Science Education, University of Ilorin, Ilorin, Nigeria, gives all praises and adoration to the almighty God, for the successful disengagement from active service of our beloved Professor Isaac Olakanmi Abimbola after 42 years of meritorious service. We, pray God to make his retirement a pleasant experience.

We are deeply indebted to his professional colleagues across the nation for their unflinching academic, moral and financially support toward the production of this festschrift. Special thanks go to the outgoing Dean of the Faculty of Education, Professor N.B. Oyedeji, incoming Dean, Professor M.F. Salman, the Director of the Institute of Education, Professor L.A. Yahaya. We appreciate the contributions of Professor A. M. Olagunju, and Dr. M. M. Osokoya from the University of Ibadan. In addition, we are grateful to Professor Isaac Olakanmi Abimbola's students and acquaintances for their financial and academic contributions toward the production of this festschrift. We equally, appreciate the invaluable contributions of all the Staff and students of the Department of Science Education, Faculty of Education, University of Ilorin, Ilorin, Nigeria.

Dr. Mulkah A. Ahmed
Ag. H.O.D Science Education

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ROLE OF STEAM TEACHER EDUCATION IN ACHIEVING SUSTAINABLE DEVELOPMENT GOALS

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Abstract

Attainment of sustainable development goals would be most referred when teacher education is effective, specifically science teacher education, by making use of innovative approach such as STEAM and the role of STEAM education in promoting human sustainability. STEAM is an educational policy required in achieving effective outcome in teaching and learning of science education. Hence, for sustainable development goals to take place STEAM teacher education has a major role to play. Due to the utmost importance attach to the achievements of SDGs through STEAM teacher education, this paper discussed the need for STEAM teacher education. The paper also gives insight into how the fourth goal which is quality education can be used to achieve other sustainable development goals. Finally, the role of STEAM knowledge in solving the three categories of SDGs targets which are environmental, economic and societal problems are discussed. It is recommended among others that for effective training of science teachers through STEAM education for achievements of SDGs, emphasis must be laid on STEAM teacher education that focused on application of STEAM knowledge in solving environmental, economic and societal problems.

Keywords: STEAM, STEAM teacher education, Sustainable development goals, Role,

Introduction

The achievement of sustainable development goals has much to do with effective teacher education especially Science teacher education. Science is defined as organized set of knowledge which exists in form of concepts, laws, principles etc (Omorogbe & Ewansiha, 2013). It is an inevitable tool used in proffering solutions to human problems for human being to live peacefully. Hence, effective teaching and learning of science are of utmost importance to human survival. In order to achieve these, researchers like (Hazelkorn, 2015; Keswet, Agbowuro, Jimwani, & Gesilano, 2016) have submitted that the knowledge of science alone may not be adequate in catering for knowledge required in taking care of problems encountered in the society. Therefore, there is need for collaborative approach to teaching and learning of science in which science is taught in combination with other disciplines such as Technology, Engineering, and Mathematics. This approach is known as Science, Technology, Engineering and Mathematics STEM education.

The STEM approach to science teaching and learning later became STEAM as a result of inclusion of Arts. STEAM is described as an educational approach to learning which employs Science, Technology, Engineering, Arts and Mathematics in promoting

students' effective learning (Byun & Baek, 2016). STEAM education can therefore be regarded as a type of education which makes use of Science, Technology, Engineering, Arts and Mathematics principles in teaching and learning of science.

For effective building of the nation, the knowledge of STEAM is very necessary. Thus, for the teaching and learning of STEAM to be sustained, the education of science teachers required the knowledge of STEAM. This is because teachers have been recognized as key agents of education policy implementation (Byun & Baek, 2016). It has been observed that in order to promote critical and creative thinking, problem solving effectiveness required in forward driving and project completion in children, there is the need to embark on science teaching such as STEAM (Berg, 2017). It was reported further that STEAM education will encourage both present and future students' critical thinking that will meet up the advances in technology. Hence, to achieve this, the science teachers also need to be trained using STEAM education approach.

It can be observed that achievement of the STEAM teacher education amounts to achievement of sustainable development goals such as Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs). Goals are long term specifications expected to be achieved by making effort. Higuera (2018) defines it as future achievement which requires planning and stating of specific targets which can enhance achievement of the goals. In the act of processing achievable common goals for United Nations of 193 members, the member countries came together to put forward what is known as Sustainable Development Goals (SDGs). They are set of goals relating to future international development which are expected to replace the Millennium Development Goals (MDGs) (JCI, 2018).

The SDGs are set of goals which emanated from MDGs. MDGs and SDGs are part of national goals which require the use of innovational method of teaching science such as STEAM. In a like manner, Umoh (2015) ascertained that there is no better knowledge required in achieving sustainable development goals than science and technology. Therefore, with incorporation of Engineering, Arts and Mathematics principle to teaching of science and technology, there is no doubt that the SDGs will be effectively achieved when STEAM teacher education is put in place.

Need for STEAM Teacher Education

The acquisition of STEAM education by students in all levels of education in Nigeria cannot be over-emphasized due to the importance of the subjects being integrated together to form STEAM. They are the required knowledge in solving human problems and also providing their needs. The subjects that are being integrated together to form STEAM are Science, Technology, Engineering, Arts and Mathematics. Science can be described as knowledge that encompasses the existence of natural phenomena. It is being required in providing solution to series of problems that ensue in the world. Apart from scientific knowledge required in the provision of human needs, it has also been

identified as a necessity in realization of accelerated development in Nigeria (Omorogbe & Ewansiha, 2013).

Technology has been described as additional knowledge required in the simplification of human lives. Hence, to make lives comfortable for human beings, both scientific and technological knowledge need to be identified as priority. In the same vein, Science and Technology have been stipulated as pre-requisite knowledge for the development of a nation both socially and economically (Azuka, 2015).

Mathematics is being defined as the knowledge required to lay the foundation of the two subject areas- science and technology, in order to achieve the social and economic breakthrough especially in Nigeria which has been recognized as a country with high rate of poor performance of students in the three subjects areas: Science, Technology and Mathematics (Alaba & Adekomi, 2012). Hence, for Nigeria to be included in the list of developed country like China, Japan, United State of American, there is the need for the country to provide her students with effective knowledge of Science, Technology and Mathematics.

In addition to these three fields of knowledge, Engineering has also been observed as a necessity in solving series of problems encountered in a country. It is a field that makes use of scientific and technological knowledge to provide solution to human problems. Therefore, to find lasting solution to human problems, the application of scientific, technological and mathematical knowledge may not be complete without the field that will utilize the knowledge in providing concrete solutions such as engineering. In a like manner, Study international (2018) observed that due to importance of engineering in the world of technological advancement, there is need for engineer to change ideas into reality through application of mathematics and scientific principles in order to solve serious technical problems. Hence, to solve human problems effectively, the four field of study need to be integrated together, that is, Science, Technology, Engineering and Mathematics; this is how STEM education was formed..

STEAM education originated from STEM education in 1990s by John Maeda who was president of Rhode Island school of Design and it was later accepted by different institutions and education stake holders in North America (Get- to-know, 2014; Gun, 2017). It was explained further that the philosophy of STEAM was to incorporate the Arts in to STEM and the major objective of STEAM has to do with transformation research policy which lays emphasis on inclusion of Arts principles in to STEM. According to Leftbraincraftbrain (2017), Arts was incorporated into STEM in order to produce STEAM due to the following importance of Arts:

7. It helps in preventing inhibition of ideas since there is no wrong answer in Art;
8. it makes use of processes that support innovation drive;
9. it promotes people and environmental observations; and
10. it helps in creating spatial awareness in Mathematical concepts.

With the submission of Leftbraincraftbrain (2017), there is no doubt that incorporation of Arts in to STEM is very necessary for effective teaching and learning of science in order to solve human problems. The roles of teachers in the achievement of benefits of STEAM education cannot be over emphasized. Hence, they equally need to acquire STEAM education for a progressive transfer of knowledge from teachers to students. In a like manner, Keswat et al. (2016) defined teacher education as policies and procedures required by prospective teachers as well as the knowledge and skills needed for effective performance of their job in the classroom. They also observed that in the facilitation of hands-on activities in science lesson, there is need for upgrading of teachers in many countries in respect to content and pedagogy. Hazelkorn (2015) was also of the opinion that science or STEM should be linked with other subjects at all levels of education.

The training required by those who will teach the younger ones science using STEAM approach can be regarded as education of STEAM teachers. This supposed to take place in both Colleges of Education and Universities, since these are the recognized institutions for training of teachers generally. Based on the submission of Hazelkorn (2015) and Keswat et al. (2016), the training of teachers in STEAM education is of utmost importance to acquisition of STEAM education by the younger ones for them to be problem solvers and apply the knowledge to the development of the nation.

Sustainable Development Goals

For people of the world to live in peace, there is the need for them to share common goals that will promote their coexistence as human beings and these goals are expected to do with all spheres of life what will make the world comfortable for all. According to Holbrook (2009) citing Brundtland (1987) Sustainable development is the development that meets the needs of the present people without compromising the ability of future generations to meet their own needs for their survival. Sustainable development is therefore the ability to make provision for present human needs without jeopardizing the needs of future generation. In the act of providing immediate needs of people, the needs of the incoming generations should also be put into consideration so that one will not negatively affect the other in terms of satisfying their necessities.

According to the report of Junior Chamber International (2018), the setting of the SDGs started with MDGs which began in year 2000 and ended in year 2015 with eight development goals which range from eradication of poverty to development of global partnership (WHO, 2018).

Although it was revealed by report of Bureau of statistics in 2014 that there was increased performance in attainment of MDGs compared to that of 2012 but some of the goals were not achieved such as poverty eradication. It was also reported further by UN that Nigeria performance was below average in all of the MDGs. According to Adegbolu (2015), the MDGs were replaced with the SDGs. The eight goals of the MDGs were replaced with 17 goals known as SDGs which the formal discussion started

in United Nations' conference held in Rio de Janeiro in 2012. On the 19th of July, the UN General Assembly Open Working Group (OWG) presented the proposal on the SDGs to the Assembly. The proposal consists of 17 goals and 169 targets (Junior Chamber International, 2018).

These set of goals were broken down into 169 targets altogether. It has been observed that lack of awareness and sensitization is a major setback in the attainment of the SDGs and that 50% of Nigeria population lacks adequate knowledge about SDGs and its effect on their development (Aramide, 2015). Thus, successful attainment of the SDGs calls for full participation of every citizen which needs to be preceded by adequate awareness. This can be achieved with effective teacher education such as STEAM education which the integrated disciplines have the ability to take of as the SDGs. Therefore, the relationship between SDGs and STEAM education can be made known to the students by the STEAM teacher and those who are not in school could be reached through media such as entertainment programme in television, radio etc and awareness creation agency such as National Orientation Agency NOA making use of indigenous language of Nigeria to portray the achievement of SDGs through STEAM education.

Aramide (2017) was also of the opinion that the fourth goal of SDGs, which is, quality education, is the key to effective attainment of all other SDGs. This is because the provision of quality education has in one way or the other related to all other goals. In order to achieve this, there is the need to cater for those who will be teaching the pre-basic level of education that is, science teachers in particular. The act of catering for them is by providing effective teacher education such as STEAM education. Since STEAM has been described as educational facilities required to equip teachers for them to provide the students with adequate knowledge (Berg, 2017). In the light of the above, Holbrook (2009) submitted that for achievement of sustainable development to occur, there is need for scientific and technological curricula transformation as regard the content of the curricula, methodology of teaching as well as assessment procedure. Also there is need for much emphasis to be laid on educational literate society especially science education. The utilization of science curriculum with STEAM content should be able to provide developing country such as Nigeria SDGs.

The fourth goal which is "quality education" is achievable through 10 targets with seven targets out of the 10 are the expected outcome, these range from, ensuring equitable and quality universal primary and post primary education which results in effective learning outcome to provision of education for sustainable development and global citizenship for all. Hence, for any country that want to attain sustainable development which Nigeria is one of them, need to provide quality education such as STEAM education becomes imperative. The provision of quality education is expected to be realizable with three targets, among which we have provision of scholarships to less developed countries in the field of technical engineering, communication technology and sciences as well as supply of qualified teachers.

In essence, the provision of scholarships for students in these fields of knowledge are necessary due to their importance in providing sustainable development. This means that for the achievement of SDGs to be effective, the role of STEAM education cannot be over looked since it has been established that Science, Technology and Engineering depends so much on Mathematics (Azuka, 2015) and Arts (Leftbraincraftbrain, 2017). For instance, in Nigeria quality education in the field of Agricultural science can be used to eradicate hunger. This can be achieved when farmers resort to farming system utilized by developed countries which requires modern method of farming such as mechanized farming, irrigation system, fertilizer application etc. that will lead to food production in abundant for the citizens. This will not only eradicate hunger which is one of the SDGs but it can also take care of poverty by serving as source of income when the surplus food produced is being export to other countries so as to boost the economy.

Role of STEAM Teacher Education in Attaining Sustainable Development Goals

There is no doubt that effective preparation of science teachers using STEAM education will go a long way in achieving majority of the sustainable development goals if not all by 2030 as stipulated by UN. As a result of the importance attached to education in achieving the SDGs in 2030 Nwaebuni (2016), in a seminar organized for journalists by Denmark based Copenhagen consensus center through AmutaOkwute who is the Nigerian representative on 15th May, 2015 in Abuja. The seminar was to sensitize participants on how to identify the great SDGs based on capability of each country. Education is one of the main theme discussed during the seminar, George Psacharopoulos who was one of the resource persons with the paper titled “Post-2015 Education in Nigeria: what are the priorities? He observed that Nigeria is one of the countries not doing well in her education and since education is paramount to economic and social development, Nigeria may not be able to solve its education problem through SDGs that instead, Nigeria should focus more on education especially the pre-basic level education which should be a continuous process.

In order to overcome the problem identified by George Psacharopoulos, the pre-basic level of education of Nigeria children needs to emphasize much on effective STEAM education. Hence, the acquisition of STEAM education by pupils in the pre-basic level of education can only be possible when their teachers also acquire adequate knowledge of STEAM through their institution of training. Researchers have classified the 169 targets of SDGs in to three major groups which are environment, economy and society (Nwaebuni, 2016; Aramide, 2017).

Going by this classification, it can be observed that STEAM teacher education has a major role to play in the achievement of SDGs, this can be possible only when the teachers are trained scientifically by making use of STEAM education approach. In the effort to lay emphasis on STEAM education as solution to achievement of SDGs,

Hazelkorn (2015) was of the opinion that there is the need for the incorporation of language and Artistic literacy into teaching and learning of science and Mathematics in

order to be a responsible citizenship and to contribute to the social and economic development of the nation. Get to Know (2014) also observed that many people believe that innovative educational strategy such as STEAM is the major key required in fostering economic growth and national developments stipulated by UN such as SDGs. For instance, the three categories of SDGs problems can be solved using STEAM education as follows:

- (1) Environmental problems – provision of sustainable cities and communities is the 11th SDG that falls under environmental problem. This problem can be solved with the application of twelve principles of green chemistry. Green chemistry is the act of using a set of principle to control or eradicate hazardous substances generated during production and use of chemical products. In doing this, scientific knowledge that deals with composition of matter known as chemistry is being employed to solve environmental problem which is a class of targets of SDGs.
- (2) Economic problem – generation of decent work and economic growth is the 8th SDG which can be categorized under economic problem. This can be taken care of when there is productive technology and engineering education that will make Nigeria students to be self-employed and prevent too much dependence on white collar jobs. It is in the same vein that Abassah (2011) attributed economic development and provision of needs of mankind to knowledge in the field of science, engineering and technology.
- (3) Societal problem – creation of gender equality is the 5th SDG which falls under the category of social problem, in order to eradicate this menace, there is need to provide the Nigerian citizen adequate knowledge of STEAM education irrespective of their gender. Acquiring adequate knowledge of technology as one of field of STEAM education can be used to cater for societal problems in SDGs.

Conclusion

STEAM education has been observed to be innovational approach to scientific teaching which comprises of subjects such as Science, Technology, Engineering, Arts and Mathematics. These subjects have been recognized as fields of knowledge that cater for achievement of SDGs in Nigeria. Due to importance of STEAM education in attainment of SDGs, this has necessitated for provision of STEAM teacher education that will provide the younger ones knowledge of STEAM education through which SDGs can be attained. Hence, the role of STEAM education in the achievement of SDGs goals which have been categorized into three, that is, environmental, economic and societal problems cannot be over-emphasized.

Recommendations

It is therefore recommended that STEAM education should be a major focus in the training of science teachers so as to be able to achieve the SDGs goals through the effective knowledge of science. Green chemistry principles which aim to control or eradicate environmental hazards should be employed by industries so as to cater for

environmental problems in Nigeria. Also productive technology and engineering education should be prioritised in order to make the citizens self-reliance instead of depending on white collar jobs. Effective technology such as information and communication technology should be employed to take care of societal problems such as gender inequality, irresponsible consumption and production etc. Entrepreneurial education which is also achievable through effective STEAM education should be emphasized on, in various institutions of learning by the education stakeholders. Lastly, awareness should be created both in schools and outside the school on the need for STEAM education in providing solutions to environmental, economic and societal problems.

References

- Abassah, M. (2011). Analysis of the problems and prospects of the technical college teachers in Nigeria. *Proceedings of 2011 International Conference on Teaching, Learning and Change. International Association for Teaching and Learning (AITELE)*.
- Adegbolu, A. (2015). *The 17 sustainable development goals*. Retrieved February 10, 2018 from <http://adesojiadegbolu.com>
- Alaba, S. O., & Adekomi, B. (2012). Improving science technology and mathematics education in Nigeria: A case study of Obafemi Awolowo University, Ile-Ife. *World Journal of Education* 2 (6) 13-19
- Aramide, O. (2017). *Sustainable development goals in Nigeria two years and counting*. Retrieved February 10, 2018 from <http://wwwnngo.org/2017/09/26/sustainable-development-goals-in-nigeria-two-years>
- Azuka, B. F. (2015). Mathematics education for sustainable development: Implications to the production and retention of mathematics teachers in Nigeria schools. *British Journal of Education* 3 (1) 44-51.
- Barboza, N. (2000). *Educating for sustainable future: Africa in action prospects xxx*
- Berg, B. (2017). *The Critical Importance of Steam education. Why use Steam*. Retrieved March 3, 2018 from <http://liberalty.ucalgary.com>
- Brundtland Report (1987). *Easy to read version of our common future*: Retrieved from <http://www.worldinbalance.net/>
- Byun, S., & Baek, Y. S. (2016). Teachers' perceptions and practices of STEAM education in South Korea. *Eurasia Journal of Mathematics, Science and Technology Education* 12 (7) 1739-1753
- Get to know (2014). *STEM to STEAM: Integrating the Arts into Science Education*. Retrieved March 3, 2018 from <http://www.gettoknow.org>
- Gun, J. L. M. (2017). *The Evolution of Stem and Steam in the US*. Retrieved March 3, 2018 from <http://www.education.cu..portland.edu>
- Hazekorn, E. (2015). *Science education for responsible citizens. Report to the European Commission of the Expert Group on Science Education*, Luxembourg: Author
- Higuera, V. (2018). *Target goals versus planned goals*. Retrieved February 10, 2018 from www.chron

- Holbrook, J. (2009). Meeting challenges to sustainable development through science and technology education. *Science Education International* 20 (12) 44-59
- Junior Chamber International (201). Sustainable development goals. Retrieved February 10, 2018 from www.jci.ng.poll
- Keswat, L. A., Agbowuro, C., Jimwani, C. S., & Gesilano, N. A. (2016). Development of Science Education in a globally depressed economy. *International Journal of Innovation and Research in Educational Sciences* 4 (1) 2349-5219
- Leftbraincraftbrain (2017). What is Steam and why is Steam important. Retrieved March 3, 2018 from <http://www.leftbraincraftbrain.com>
- Nwaebuni, R. (2018). Goodbye MDGs, welcome sustainable development goals. Retrieved February 10, 2018, from www.thepointernews.com
- Omorogbe, E., & Ewansiha, J. (2013). The challenge of effective science teaching in Nigeria secondary schools. *Academic Journal of Interdisciplinary Studies* 2 (7) 181-188.
- Studyinternational (2018). Importance of Engineering in the Modern World. Retrieved May 19, 2018, from <http://www.studyinternational.com>
- Umoh, S. W. (2015). Science, Technology, Engineering and Mathematics. Retrieved March 3, 2018, from <http://www.globalacademicgroup.com>
- WHO (2018). Millennium development goals. Retrieved February 10, 2018 from www.who.int