

REFOCUSING CHEMISTRY EDUCATION FOR SUSTAINABLE NATIONAL DEVELOPMENT: CASE FOR CREATIVITY IN CHEMISTRY EDUCATION IN SENIOR SECONDARY SCHOOLS IN NIGERIA

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ABSTRACT

This paper titled “Refocusing Chemistry Education for Sustainable National Development: Case for Creativity in Chemistry Education in Senior Secondary Schools in Nigeria”, focused on creativity in chemistry education as a means of attaining sustainable development in Nigeria. The aims included to raise consciousness and direction on how chemistry education should be refocused to make it more responsive to the needs of sustainable development through creative teaching and learning. The paper noted the close relationships between the nature and purpose of science education and the broad objectives of the Millennium Development Goals (MDGs) and the National Economic Empowerment and Development Strategies (NEEDS). It was noted that chemistry education by nature develops rational mind, service technology for development and provide the knowledge and understanding necessary for conduct of personal and national life if taught with conscious efforts to produce creative chemistry graduates. This requires that chemistry should be taught with the intent to make it practical oriented and make the products able to contribute to national development. It was however, noted that most current approaches to chemistry education in Nigeria do not encourage creativity. The paper identified overloaded curricula, lack of incentive to teachers, poor professional preparation, among others as constraints to creative chemistry education and suggested among others, that it should be refocused for innovation and creativity through curriculum content review, teacher development programmes and provision of incentives to both teachers and students.

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KEYWORDS: Science, Chemistry, Chemistry Education, Creativity, Sustainable Development, Refocusing

INTRODUCTION

Education is the bedrock for the sustenance of every civilization. Most nations of the world give priority attention to education as a primary source of manpower for national development. Accordingly, the Federal Republic of Nigeria (FRN) (2004:2) stated that “Education in Nigeria is an instrument *par excellence* for effecting national development”. The emphasis and direction of educational development of a nation derive from her immediate and projected needs. The world is fast changing as a result of developments in science and technology. In consequence, development in science and technology enjoys wide acceptability as key to participation in the socio-cultural and economic activities by individuals and groups. Advancement in science and technology is a global index of development. Extent of advancement in science and technology is a measure of national development. These facts have made emphasis on educational development tilt towards science and technology education.

Science and Science Education

Science is the knowledge obtained through the study of the operations of general laws of nature especially that knowledge which is obtained, tested, proved and accepted through scientific methods (Igwe, 2003).

According to Ndirika and Agommuoh (2014) science involves investigation of the living, physical and material components of the environment and making sense of them in logical and creative manner. The relevance of science in individual life and national development cannot be overemphasised. Science is everywhere in today’s world; advances in science and technology are transforming our world at an incredible pace, and the future will surely be filled with leaps in technology (Atkinson, 2011). Mbajiorgu in Okoli, Obiajulu and Ella (2013) viewed science as an act of doing and is more concerned with various investigative processes and activities with regards to developing, acquiring and controlling knowledge, skills, capacity and attitude about the natural factors of the environment

There is no one aspect of daily living that science has not made easier, faster or safer. Science results in technology that people rely on for health, communication and transportation. Scientific knowledge helps people understand the world from a cellular to a universal level and apply the understanding in solving socio-cultural and economic problems. Science, with technology, has been in vast use in medicine, agriculture, industries, transportation and communication, to mention but a few.

It is a known fact that no nation can develop without vast scientific knowledge and growth (Balagot, 2013). Nigerian government, like many other countries the world over, has placed emphasis on science in her policies and programmes in order to reap the benefits for national development. Accordingly, FRN (2004) stated that government shall popularise the study of science and the production of adequate number of scientists to inspire and support national development. The implication is that Nigeria recognises the place of science education in national development. Nigeria has a vision of science education that is capable of acting as effective catalyst for national development.

Science education is the instrument through which science content, attitude and process skills are shared among individuals not traditionally considered part of the science community or who have inadequate knowledge of particular aspects of science (Odo & Nwele, 2013). To achieve national development, Nigeria defined set goals for science education (chemistry inclusive). FRN (2004:29) stated the goals of science education in the National Policy on Education as to:

- (i) cultivate inquiring, knowing and rational minds for the conduct of a good life and democracy;
- (ii) produce scientists for national development;
- (iii) service studies in technology and the course of technological development and
- (iv) provide knowledge and understanding of the complexity of the physical world, the forms and conduct of life.

According to Nuno (1998) goals of science education include inculcating in the learner, the multiple methods of science and the role of imagination and creativity in science. Kazeni (2005) stated that science education gears towards developing in the learner critical-thinking, questioning, analysis, problem-solving and decision-making skills. These attributes are necessary for the development of the individual and the society.

Development refers to increase in the capacity of the physical world and human elements of the society to improve their well-being. It is the gradual growth in the human and material resources of a society to make them better and more advanced (Onwu, 2009). The implication of this understanding is that development transverses aspects of human and societal existence to include cultural, scientific, educational, technological, infrastructural and social development. It is common to refer to development within a nation as national development. National development is the ability of a nation to improve the

lives of its citizens. Measures of improvement may be material, such as an increase in the gross domestic product, or social, such as literacy rates and availability of healthcare. The World Bank presented national development in terms of the ability to improve the quality of life of the citizens and stated that national development is assessed based on: access to education and healthcare, employment opportunities, availability of clean air and safe drinking water, absence of threat of crime, and so on (World Bank, 2004).

Developments in science and technology now receive prime attention as yardsticks in determining the level of national development. According to Onwu (2009) a nation is considered developed to the extent of its advancement, as well as contribution to global development through science and technology. Each development in science and technology however, comes with its attendant problems. There is no gainsaying the fact that scientific and technological developments have created myriads of problems ranging from desertification, pollution of land, air and water, reduced soil fertility, to the more complex and devastating issues of global warming and greenhouse effects. In addition, despite the efforts made by the global community to fight these problems, there are still some typical socio-scientific issues which, according to Onwu (2009), are in the front burner of African development. The issues include hunger and undernourishment, lack of good drinking water, poverty, unemployment, adult illiteracy, low agricultural productivity, diseases, deforestation/desertification and social crime. Nigeria has her fair share of these problems. Ironically, it is imperative on each nation to fall back on science and technology to solve the problems. The capacity to utilise science and technology for national development depends on the efficiency of science education.

Science education embodies all education processes aimed at providing unlimited opportunities for learners to understand and utilize necessary knowledge, skills and attitudes required to operate effectively in a scientific and technological society (Okeke, 2007). According to Kola (2013) science education is that discipline which deals with sharing of science content and process with individuals who are not considered traditionally to be members of the scientific community; the individuals could be students, farmers, market women or a whole community. According to Okoli, Obiajulu and Ella (2013) science education represents a catalytic process for social and educational development, training and public awareness – the values, behaviours and lifestyles required for a sustainable future. Science education is not just a discipline but an interdisciplinary concept which includes chemistry

education, biology education and physics education. This work focuses on chemistry education to illustrate the relevance of creativity in science education for sustainable national development.

Chemistry is a science that deals with the composition, structure, and properties of substances and with the transformations that they undergo (Merriam-Webster Dictionary, n.d). According to Anand (2014) chemistry is the study of composition, structure, properties and interaction of matter. Chemistry is a branch of physical science that studies the composition, structure, properties and change of matter. Chemistry as a discipline has the potentials to positively impact on the environment and socio-economic fortunes of Africa in general and Nigeria in particular. Chemistry prepares the learner to be able to relate human activities to their effects on the environment and human lives so as to counter its negative consequences thereby ensuring sustainability of development.

According to Chang (1996) chemistry has application in seeking solutions to environmental pollution, depletion of energy, radiation and problems relating to industrial production. The desire to exploit chemistry in solving the problems can be achieved if the teaching and learning of the subject is refocused through appropriate delivery techniques.

Through chemistry education the knowledge, attitudes and skills relating to chemistry are transmitted to learners. The component knowledge includes the knowledge of the composition, structure, properties, applications and changes of matter and their applications to solving personal and society problems. Chemistry education teaches skills useful to personal and national development. It makes the learner develop the ability to make informed decisions. Specifically, chemistry education should be properly aligned to effectively address relevant issues of sustainable development. One of the ways of achieving this is to ensure creativity in chemistry education.

Problem of the Study

Most senior secondary schools in Nigeria offer Chemistry. Similarly, relevant university faculties offer the subject as single honour or as part of science education and often as chemistry education. The expectations are therefore high that chemistry graduates who are dished out at all levels should exert positive improvement on the relevant sectors to achieve sustainable national development. But this is not so. Nigeria like most other African countries, is still faced with myriads of the woes of underdevelopment (Onwu, 2009), which solutions ought to arise from effective application of the knowledge of chemistry. These woes include hunger, pollution, environmental degradation and diseases.

The failure to attain the goals of chemistry education can be attributed to many factors among which are inadequacy of facilities for effective teaching and learning of chemistry (Nwafor and Umoke, 2014), poor teaching methods (Kazeni, 2005) and lack of proper focus on the higher order attributes of chemistry education like creativity. The study of chemistry in Nigeria starts from the senior secondary school level of education. Effective chemistry education should therefore start from this level. Based on the foregoing this study examined the refocusing of chemistry education in senior secondary schools in Nigeria for creativity to facilitate sustainable national development.

Creativity in Chemistry Education

Creativity is the tendency to generate ideas that may be useful in solving problems (Mumford, 2003). According to Ndirika and Agommuoh (2014) creativity is the bringing into being something which did not exist before. Processes, products or thoughts can be results of creativity. Creativity relates to originality. One is said to be creative if he possesses the skills and ability to produce something new (Ndirika and Agommuoh, 2014). To be creative also implies to regularly solve problems, fashion products or define new questions in a domain in a way that is initially considered novel but that ultimately comes to be accepted in a particular cultural setting (Gardner in Uzoechi, 2014). The concept and nature of chemistry makes creativity an imperative so as to ensure that it is made relevant and effective in national development. This requires that chemistry should be taught and learnt effectively.

Effective learning of chemistry is one that involves the hands-on activities of the learner (Kazeni, 2005). According to Enebechi (2008), hands-on activities of science (also called the science process skills) include observing, measuring, inferring, classifying, predicting and communicating, formulating hypotheses, identifying variables, defining variables operationally, designing investigations, experimenting, analyzing data, indicating cause and effect relationship and formulating models. Odo (2013) summed hands-on activities as activities which the scientist engages in while carrying out scientific investigations, and which aids the advancement of scientific knowledge, practice and attitude in both disciplinary and interdisciplinary manner. The hands-on activities go on naturally with active approaches to science teaching which enhance the acquisition of science process skills..

Champagne and Klopfer in Esomonu & Onunkwo (2004) identified guided inquiry, demonstration, laboratory, process approach, project, field trip, and co-operative learning as approaches that enhance the acquisition of science process skills. Kazeni (2005)

noted that these methods have been found to be effective in enhancing meaningful teaching and learning of science, including chemistry. According to Giginna and Nweze (2014), effective science teaching enhances objective reasoning, critical thinking ability and creativity. For chemistry education to produce creative chemists in Nigeria, it should therefore, be taught and learned in a manner that adopts the hands-on approaches which make chemistry environmentally and culturally relevant and enhance the attainment of sustainable development in Nigeria.

Creative Chemistry Education and Sustainable Development

The subject of sustainable development has varied definitions. The World Commission on Environment and Development (WCED) in Onwu (2009) defined sustainable development as development that meets the needs of the present without compromising the ability of future generation to meet their own needs. To the United Nations Environment Programmes (UNEP) (1995) sustainable development means improving the quality of human life while leaving the carrying capacity of supporting ecosystems. Sustainable development involves development which incorporates equilibrium and harmony between meeting the needs of today and leaving optimal opportunity for future development and existence of the ecosystem.

The problem of sustainability of the environment in particular has been of international concern. The Millennium Development Goal's, MDGs (n.d) in goal number seven challenged the world to ensure environmental sustainability. The goal specified that nations of the world should meet the following targets:

1. Integrate the principle of sustainable development into country policies and programmes and reverse the loss of environmental resources;
2. Attain by half by 2015, the proportion of people without sustainable access to drinking water and improved sanitation facilities; and
3. By 2020, make sufficient improvement in the lives of at least 100 million slum dwellers.

According to van Eijck and Roth (2007), effective science education is required to develop, sustain and improve products as well as invent and maintain techniques and technologies for production. The authors noted further that humans produce and reproduce their environment through their actions and therefore are capable of acting responsibly for a sustainable future. These responsibilities fall within the task domain of science, and to a large extent chemistry specifically.

Scientific and technological development of a country is predicated on the level of efficiency of her science education (chemistry inclusive). The importance of chemistry education in the development of any society cannot be over-emphasised. Of greater interest is the link between sustainability of development and chemistry/chemistry education. Chemistry as science and by its nature aims at solving human problems and improving on the well being of the population. One of the effective ways of achieving this is to ensure creativity in the teaching and learning of chemistry.

According to Wu in Giginna & Nweze (2014), creative teaching is an open and inspiring approach for encouraging students to explore and innovate in order to develop their ability to innovate and create things. In chemistry, students are prepared to acquire skills which will equip them for creativity and productivity for self enhancement and national development (FME, 2007). Nigeria is, no doubt, in need of chemists that are trained and equipped to provide solutions to local problems such as water supply, environmental sanitation and degradation, pollution, diseases and hunger. Creativity in chemistry education would enable the learners to innovate, invent and develop home-made chemicals and technologies that would provide solutions to these problems and still sustain the environment.

Nigeria has responded to this need through curriculum reform. The Federal Government of Nigeria was also moved to undertake the reform of chemistry curriculum with the aim of attaining the goals of MDGs and NEEDS (FME, 2007). The two programmes targeted self-reliance and sustainable national development. The present senior secondary education curriculum for chemistry was therefore designed to realign chemistry education to contribute to sustainable development. The objectives of the curriculum which, according to FME (2007: iv), was designed to contribute to national development include

1. Acquiring basic STM knowledge and skills;
2. Apply skills to meet societal needs of creating employment and wealth;
3. Show chemistry and its links with industry, everyday life activities and hazards;
4. Develop reasonable ICT applications that will engender entrepreneurial skills and
5. Be positioned to take advantage of the numerous career opportunities offered by chemistry.

The curriculum also proposed that chemistry contents should be enriched with relevant materials and information from the learners' immediate environment in order to adapt learning to their needs and aspirations. Chemistry contents like chemical

industries, petroleum or crude oil, ethical and legal issues in chemical industries and environmentally related topics (FME, 2007) were therefore emphasised in the curriculum. Achievement of these objectives depends much on availability of teachers who have the competence and motivation to integrate and implement the novel concepts in the reformed curriculum.

It is obvious that science as taught and practised in schools and outside schools by most Nigerian scientists and science educators lack originality and practical approach (West African Examinations Council (WEAC), 2013). Most of the science (chemistry inclusive) topics are presented with teaching and learning approaches which are alien to the socio-cultural and environmental elements of the teacher and learner (Kazeni, 2005). A grave consequence of this is that most African (including Nigerian) scientists, cannot clearly differentiate or see the link between the science they study in school and the socio-cultural practices in their everyday life (Onwu, 2009). Part of the ways to change this situation is to make chemistry teaching and learning in schools effective and relevant by refocusing chemistry education for creativity.

Refocusing refers to putting more efforts into particular activity, in the belief to make it more successful. In this context chemistry education can be said to be refocused if specific issues that retard its efficiency are addressed to make it more effective and more relevant to attainment of sustainable national development. One of such retarding factors is lack of creativity in chemistry education. The task of refocusing an established system is usually not a simple one. Chemistry education in senior secondary schools can however, be refocused for creativity if the challenges to creative chemistry education are identified and addressed with the commitment and collaboration of stakeholders in curriculum development and implementation.

Challenges to Creativity in Chemistry Education

Many factors hinder creativity in the teaching and learning of chemistry in secondary schools in Nigeria. They include:

Overloaded Science Curricula and Syllabus

The curriculum of chemistry education is overloaded with content. Onyegegbu (2007) observed that the curricula of science education are overloaded with content. Abdulrab and Sridhar (2012) affirmed that overloading of curricula content hinders creativity in the classroom. Overloading of chemistry curriculum of senior secondary schools in Nigeria makes the teachers to pay more attention to content coverage to meet up the requirement for external examinations. Consequently, teaching and learning of chemistry hardly focus on creativity.

Teacher Inefficiency

Many science teachers lack the in-depth knowledge of the content and the requisite skills of the subjects they teach (Ndirika & Aguomuoh, 2014). The authors also identified the problem of inadequate teaching skills. The situation was made worse by introduction of new aims and contents into the curriculum. All these affect teacher efficiency and hinder creativity in chemistry education

Lack of Incentives

Creativity is capital intensive, time consuming and risky. Science teachers are not given incentives to ginger the extra labour and risk involved in science teaching (Nwafor and Umoke, 2014). This situation is applicable to chemistry education as well as chemistry teachers. Experience has shown that science teachers are not given commensurate remuneration, paid any allowance nor are they insured for taking the risks. There are no feasible measures of compensation or encouragement for science teachers and students who achieve any feat in creative ventures. Also Nwafor and Umoke (2014) observed that the low salary paid to science teachers frustrates them. The effects are lack of interest and genuine commitment to meaningful chemistry education, including teaching chemistry for creativity,

Inadequate Teacher Preparatory and Professional Development Programmes

It has been noted that weak pre-service teachers' preparation and inadequate in-service professional development of teachers hinder creativity in science education (Abdulrab and Sridhar, 2012; Onyegegbu, 2007). Teachers are not given adequate matching professional training when a new curriculum is introduced with the result that chemistry teachers are ill-equipped professionally to operate the curricula. These constitute impediments to creativity in chemistry education.

Lack of Resources

The science laboratories, including chemistry, in most schools lack space, equipment and chemicals for teachers and learners to engage in inquiry activities. Onyegegbu (2001) as well as Nwafor and Umoke (2014) asserted that many of the science laboratories in secondary schools in Nigeria are under-funded, with outdated equipment. Such a scenario does not provide challenging classroom environment that would facilitate creativity in chemistry education.

Examination System

There is overemphasis on certificates by government and private sector employers of labour in Nigeria (Obidoa, 2013). People are judged mainly by the certificate they possess rather than what they can do. In addition, examinations conducted by the certifying bodies hardly incorporate elements of creativity in assessment instruments. There is no doubt that these facts make teachers and students to concentrate on

how to ensure success in examinations, with little or no attention to creativity in chemistry education.

CONCLUSION

Nigerian education system has been variously criticized. In particular, various aspects of science education have been faulted for lack of relevance in solving the societal problems and their failure to adequately prepare the learner for life after school. This ugly situation is most pronounced at the senior secondary school level of education. This can be attributed to the failure of science education in senior secondary schools in Nigeria to create context relevant products and thoughts. Chemistry educators have not provided enough teaching and learning atmosphere required to make the learner self sufficient or be able to solve personal and societal problems in or out of school. The solutions to these gross dissatisfactory conditions lie on ensuring that chemistry education produces people who are creative. Attainment of this goal requires that chemistry should be taught with methods that enhance creativity. The learning environment and facilities should be enhanced to facilitate creative teaching and learning. There should be conscious efforts to overcome the barriers that hinder creativity in chemistry classrooms, and which consequently prevent chemistry education from responding positively to the needs of sustainable national development. This challenges the efforts of governments, other proprietors of schools, science teachers and the learners.

Suggestions for Refocusing Chemistry Education for Sustainable Development

The following strategies will help to refocus chemistry education for creativity in Nigerian secondary schools to ensure that it contributes effectively to sustainable development of the country:

1. Curriculum Review

The curriculum of senior secondary school chemistry education should be reviewed to remove contents that lack contemporary relevance, integrate the ones that bridge the gap between the learner's immediate environment and the chemistry classroom. In addition, it should introduce more activities directed at enhancing creativity in chemistry teaching and learning. Local examples and alternatives should be given more emphasis in the curriculum.

2. Review of Teacher Training Programmes

Teacher training programmes for chemistry teachers in the universities and colleges of education should be reviewed in content and in respect of other professional components to link teacher training with the content and expectations of reformed chemistry curriculum and the task in the intended work place. This will make the senior secondary school chemistry teacher-training programmes

relevant to actual practice and increase teachers' efficiency and effectiveness in the implementation of the curriculum. It will also enhance the ability of the teacher to be flexible and creative in curriculum delivery.

3. Retraining of Chemistry Teachers

There should be regular professional development programmes for serving chemistry teachers at all levels of chemistry education. The training programmes should include refresher programmes in content and delivery. This is necessary since most chemistry teachers who are currently in service were not trained with the curriculum they are implementing in view. The teacher can only teach what he knows.

4. Motivation of Chemistry Teachers

Proprietors of schools should pay chemistry teachers, with other science teachers, special scale of salary and provide insurance cover for chemistry teachers as ways of encouraging them to undertake effective and creative chemistry teaching. The need for this cannot be overemphasised given the risks, time and special knowledge the teacher invests in creative chemistry classroom.

5. Equipment and Modernization of Chemistry Laboratories

Senior secondary schools without chemistry laboratory should be provided with one while existing laboratories should be expanded, modernise and adequately provided with equipment and chemicals necessary for creative teaching and learning of chemistry.

6. Incentives for Creative Feats

Governments, private organizations and wealthy individuals should give financial rewards to learners who show signs of creativity in the content-knowledge and application of chemistry. Similarly, scholarships should be awarded to chemistry teachers and learners who attain a feat in creativity. This will enhance the interest of teachers and learners. Funds should be made available to assist chemistry educators to develop, even to patent level, any creative product which has significant local input and/or relevance to sustainable national development.

7. Test of Creativity of Chemistry Students

Test instruments for senior secondary school chemistry education programmes should be refocused to incorporate elements of creativity, creative thinking and innovation. By so doing, students and teachers will be challenged to incorporate creativity into teaching and learning.

REFERENCES

- Abdulrab, H. M. A. & Sridhar, Y. N. (2012). Barriers to creative teaching from the perspectives of science teachers in higher primary schools in India. *Malaysian Journal of Educational Technology*. 12(1). 67-76. Retrieved from www.mjjet-

meta.com/resorces/1/12N1-6-MJET-Abdulrab-Creative Science.pdf on 15th October, 2014.

Anand, S. (2014). Basic concept of chemistry. Retrieved on 4th March, 2016 from <http://www.slideshare.net/alfayard/basic-concept-of-chemistry>

Atkinson, N. (2011). Why is science important? The Universe Today. Retrieved from <http://www.universetoday.com/26939/why-is-science-important/> on 20th October, 2015.

Balagot, J. (2013). The role of science and technology in development. Retrieved from www.slideshare.net/jenettebalagot/the-role-of-science-and-tecnology-in-developmef on 20th February, 2016.

Chang, R. (1996). Essential chemistry. US: McGraw-Hill Companies Inc.

Esomonu, N. O. M & Onunkwo, G. I. N. (2004). Development and validation of an integrated science process skills U. Nzewi, (ed). Journal of the Science Teachers' Association, 39(1&2) 75-82.

Enebechi, R. I. (2008). Senior secondary students mastering of biology concepts and possession of related science process skills: a correlational study. Unpublished M.Ed thesis, Department of Science Education, University of Nigeria Nsukka.

Federal Ministry of Education (FME) (2007). Senior secondary education curriculum: chemistry, SS1-3. Abuja: NERDC.

Federal Republic of Nigeria (FRN) (2004). National policy on education (4th Ed.) Lagos: NERDC.

Giginna, L. I. & Nweze, B. N (2014). Creativity in chemistry teaching: effects of e-learning on students' achievement in acids, bases and salts. Proceeding of 55th national conference of Science Teachers Association of Nigeria, pg 253-263.

Igwe, I. O. (2003). Principles of science teaching in Nigeria: An introduction. Enugu: Jones Communications Publishers.

Kazeni, M. M. (2005). Development and validation of a test of integrated science process skills for further education and training learners. Unpublished Degree of Master of Science in Science Education Dissertation, Faculty of Natural and Agricultural Science, University of Pretoria, South Africa.

Kola, A. J. (2013). Importance of science education to national development and problems militating against its development. American Journal of Educational, 1 (7), 225-229. Retrieved <http://pubs.sciepub.com/education/1/7/2/> DOI: 10.12691/education-1-7-2 [online] on 27th February, 2016.

Merriam-Webster Dictionary (n.d) Full definition of chemistry. Retrieved on 20th February, 2016 from <http://www.merriam-webster.com/dictionary/chemistry>.

Millennium Development Goals (MDG) (n.d). Millennium development goals: Nigeria. Retrieved from www.indexmundi.com7Nigera on 18th August, 2014.

Mumford, M. D. (2003). Where have we been, where are we going? Taking stock of creativity research. Creativity Research Journal, 15(1) 107-120. Retrieved 21st February, 2016 from http://publications.jrc.ec.europa.eu/repository/bitstream/JRC48604/eur_on%20creativity_new_.pdf

Ndirika, M. C. & Agommuoh, P. C. (2014). Identification of factors influencing science teachers' creativity in Abia State secondary schools. Proceedings of the 55th annual conference of Science Teachers Association of Nigeria. 127-134.

Nuno, J. (1998) Goals for science instruction for high school. Lecture on advanced science teaching methods. USC Rossier School of Education 5th February, 1998. Retrieved from www.jdenuno.comm/resum% @web/goools.htm on 15th August, 2014

Nwafor, C. E & Umoke, J. (2004). Science, technology and mathematics education for creativity: Challenges and prospects. Proceedings of the 55th Annual National Conference of Science Teachers Association of Nigeria. 141-145

Obidoa, M. A. (2013). Examination malpractice and control in public schools in Anambra State Nigeria: Implications for Counsellors. Retrieved from www.iiste.org/journals/index.../10133 on 13th October, 2014

Odo, E. E. (2013). Levels of possession of science process skills by final year NCE students of selected science subjects in Ebonyi State College of Education, Ikwo. Unpublished M.Sc. (Ed) dissertation, Ebonyi State University, Abakaliki.

Odo, E. E. & Nwele, C. N. (2013). Levels of possession of experimentation and measurement skills by Nigeria Certificate of Education students of selected science subjects in Ebonyi State College of Education, Ikwo. *International Journal of Research and Advancement in Education Methods*, 10(2), 107-117.

Okeke, E. A. C. (2007). Making science education accessible to all. 22nd Inaugural lecture, University of Nigeria, Nsukka. Nsukka: University Press.

Okoli, S. O, Obiajulu, A. N. & Ella, F. A. (2013). Science education for sustainable development in Nigeria: challenges and prospects. *Academic Journal of Interdisciplinary Studies*, 2(6), 159-165. Doi:10.5901/ajis.2013.v2n6p159 [online] retrieved on 5th March, 2016 from <http://www.mcser.org/journal/index.php/ajis/article/download/629/651>.

Onwu, G. (2009). Increasing the socio-cultural relevance of science education for sustainable development in J. Holbrook and P. Eniayaju (eds) Meeting challenges to sustainable development in Africa through science and technology. Abuja: ICASE.

Onyegebu, N. (2007). Using new technologies in creating excitement in Biology activities. Retrieved from www.academicjournals.org/article/article1379583264 [Onyegebu.pdf](#) on 15th November, 2014.

Onyegebu, N. (2010). Provision of facilities in Biology classroom: New direction and challenges. *International Journal of Education Research* 5, 70-75
Van Eijck, M, & Roth, W. M. (2007). Improving science education for sustainable development. Retrieved from Journals.Plos.org/plosbiology/article?id=101371/journalpbio0050306 15th November, 2014 .

United Nations Environment Programmes (UNEP) (1995). Global diversity assessment. London: Cambridge University Press.

Uzoечи, B. C. (2014). Enhancing students' creativity through innovative science, technology and mathematics education. Proceedings of the 55th annual conference of Science Teachers Association. 61-74.

West African Examinations Council (WEAC) (2013). Chief Examiners' Report.

World Bank (2004). What is development? Retrieved on 20th February, 2016 from http://www.worldbank.org/depweb/english/beyond/beyondco/beg_01.pdf.