

RESOURCEFUL SCIENCE TEACHING AND LEARNING FOR SUSTAINABLE DEVELOPMENT IN NIGERIA

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Abstract

The study discussed creative science teaching and learning for sustainable development in Nigeria. The role of science teachers in actualizing development through functional education system was explored. Goal 4 of the United Nations' Sustainable Development Goals cannot be achieved without a creative workforce in science and technology teaching- learning process. Objectives of teacher education on one hand and science teaching on the other hand were outlined based on provisions contained in the National Policy on Education. The creative teaching of science involves the teacher being sensitive to learners and learning needs; being diagnostic; being proficient (expert) in the choice of strategy and method; and being flexible in varying plans and requirements with changing situation. Some practical approaches and examples for the making of a creative teacher were mentioned. The use of improvisation and the adoption of teaching strategies derived from constructivism were particularly discussed and with examples. Some noticeable challenges confronting science teaching and the need for creativity among science teachers were highlighted. Recommendations were made accordingly.

Key words: Creative teacher, science teaching and learning, educational system, sustainable development

Introduction

Nigeria is blessed with abundant human and material resources. If the resources are optimally utilized, the country's fortune can be re-positioned to compete favourably with other developed nations of the world. Science and technology education is a veritable tool to achieve the noble objective of transforming Nigeria. The first step towards building a strong economic base is to make the nation's educational system locally sustainable and internationally competitive. A viable educational system will metamorphose into skilled workforce that is functionally and relevantly productive. The resultant positive effect will translate into wealth creation, employment opportunities, sprouting of innovative enterprises, entrepreneurship and stable socio-economic base. The teacher has a pivotal role to play in ensuring high quality education capable of triggering national development. Future of any organized education system depends on teachers' quality, effectiveness and efficiency (Adejoh, M. and Adejoh G., 2014). The teacher converts principles, policies, theories and ideals into action and practical reality in the learners. It is believed that no system of education can rise above the quality of its teachers, thereby making a nation's educational system a direct reflection of the teachers' quality (Federal Ministry of Nigeria, 2014).

Development of a nation is associated with socio- economic growth, industrial stability and increase in per capita income and improvement in standard of living of greater majority of the people equivalent to that of industrialized nations. As affirmed by Ukama and Deke (2010), it is the means of empowering the citizenry to overcome poverty, limit the incidence of social vices, reduce

unemployment rate and promote peace, freedom and economic independence to meet global expectations. National development is valuable and positive changes that improve the standard of living of the people through job creation, equal opportunities, reduction of poverty, provision of infrastructural facilities, development of economic resources, attitudinal changes and advancement in science and technology among others. The major means to achieve the man-power need of the society and national development is the education of the citizenry for functionality and relevance. The prominent one among other factors that affect the training and re-training of the citizenry is the teacher factor (Anyaeibunam, Nwodo & Enibe, 2015). The science teachers play crucial role in the educational process that will result in proper development of the nation.

Teaching is a noble profession and ordained by the Creator of the universe as one of the channels of perfecting the creation process which begun millions of years ago. Teachers are heavily loaded with the onerous tasks of translating and transmitting a nation's broad-based national goal and curriculum to the citizenry through education. This involves the education of the mind, the soul and the body aimed towards functionality and practical relevance. Balance must be maintained in terms of developing the cognitive, the affective and the psychomotor domains of education, often represented by 3H's of individual learners. The head symbolizes intellectual development (cognitive domain). The heart is symbolic of character or moral development (affective domain). The hand represents the development of the physical and manipulative skills (psycho-motor domain). Some objectives of teacher education as contained in the National policy on Education (Federal Ministry of Education, 2014) and which form the cardinal goals to be pursued by educational administrators at various levels include the following:

- (a) Providing highly motivated conscientious and efficient classroom teachers to serve the educational system at every level.
- (b) Encouraging further spirit of enquiry and creativity in teachers.
- (c) Helping teachers to fit into the social life of the community and the society at large with a commitment to the broad-based national objectives.
- (d) Equipping teachers with intellectual and professional background and back-up essential for their assignment, also making them adaptable to any changing situation within the country and the outside world at large.
- (e) Enhancing teachers' commitment to the teaching profession.

Teaching plays a pivotal role in actualizing the internationally recognized 4th Sustainable Development Goal of ensuring quality education for all by 2030 (UNESCO, 2019). Achieving inclusive and quality education for all cannot be realized without a professionally sound and motivated teaching workforce. Science teaching plays a key role in national development of any nation. Good science and technology teachers breed good engineers, good doctors, good surveyors and vast good products in other fields of human endeavours. Being a science teacher goes beyond imparting knowledge, attitude and skills of science and technology. It encompasses diverse complex roles. Apart from positive personality traits expected of a science teacher (such as patience, honesty, calmness, resourcefulness, subject-matter competence, optimism, alertness and being real among others), the science teacher must be equipped with innovative strategies and creative skills needed for the actualization of the noble aims of the United Nations. Such barriers to be surmounted include: those of evolving digital divide, apathy towards teaching by up-coming school leavers and mass retirement of the good old hands (attrition), lack of job satisfaction and poor motivation of teachers particularly in developing nations, perception of teaching as a herculean task, particularly as it involves preparing young scientists and technicians to achieve the set vision, and other limiting factors (UNDP, 2020). Professionalizing teaching became imperative. It dawned on educational managers the dire need to purge the profession of novice, mediocre and half-baked teachers who constitute risk factor in the sector.

Three major means of implementing the educational goal's targets as identified by the United Nations include: the provision of effective learning environment, expansion of scholarship opportunity to developing nations and strategies to address teacher quality and quantity (UNESCO, 2021). The most veritable means of achieving the global educational goals is the teacher factor. Teachers play fundamental role in realizing the sustainable development goal 4 (SDG4) targets. SDG4 is the education goal aimed at ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all by 2030. Equity gap already created by the shortage and uneven distribution of professionally trained teachers particularly in educationally disadvantaged area and problem of brain- drain is of present global concern. To guarantee quality education being canvassed, teachers and educators need to be empowered, adequately recruited and remunerated, motivated, professionally qualified and supported within well- resourced, efficient and effectively governed systems (Quandt, 2020).

Aims and Objectives of Science Teaching and the Curriculum

Two major aims of science education are: (a) the production of a scientifically literate society and (b) the development of potential scientific and technological manpower. The starting point in the selection of themes and topics in science and technology education is the curriculum. The curriculum provides the expected learning experiences within and outside the school as learners relate with the environment. The making of a creative science teacher begins with the structuring of elements contained in the curriculum organization, such as content/ topic, the objectives, learners' activities, teachers' activities, instructional materials and method of evaluation. Sequential spiral curriculum is being implemented in Nigeria which involves the teaching- learning of science concepts gradually increasing vertically in complexity with increasing level of education (Eniayeju, 2014). Sub-themes constitute topics under them which are arranged beginning at the lower order of task and advancing to higher order. It graduates from simple to complex. Discovery teaching-learning and guided inquiry methods are recommended. Aims and objectives of science teaching as posited by NERDC (2012) at both the Basic Education and Senior Secondary Education programmes levels in Nigeria include the following:

- i. To help pupils and students imbibe the basic knowledge and skills of science and technology at an early age. The foundational rudiments of science and technology are laid at this level of education.
- ii. To help students develop interest and liking for science and technology field at an early stage. Through the inquiry making process and problem- solving skill being inculcated, students' interests are aroused in science and technology.
- iii. To enable students transfer and translate the knowledge and skills acquired from studying science and technology into solving societal problems. Basic needs and complex problems facing humanity in the locality can be tackled at this level.
- iv. To enable students appreciate the benefits and develop interest in the numerous career opportunities offered by science and technology. Numerous prestigious and lucrative adventurous job prospects abounding in science and technology have their foundational knowledge inculcated at his level. Some of the disciplines in science and technology are self-enterprising.
- v. To enable students prepare for further studies and professional advancement in higher institutions as it pertains to science and technology. To pursue a profession or career in science and technology field, prospective entrants need the basic preparation knowledge.

The 3 – folds objectives of science teaching which are derived from the nature of science itself, as posited by NOUN (2021) include the following:

1. To develop the cognitive or intellectual ability of the students by the product content of science.
2. To develop the psychomotor abilities of the student with particular reference to problem-solving skills gained and the mastery of science processes.
3. To develop in the students scientific mindedness and favourable outlook towards science and its benefit to mankind.

The aspects of the nature of science upon which the above mentioned objectives are derived and which deals with the attitude and behaviours of scientist include the following: rationality, objectivity, suspending judgment, critical mindedness, open- mindedness, honesty, humility and intense curiosity (Uzoechi & Otuka, 2014).

Creative Teaching of Science in Schools

Creativity involves the use of imaginative skill to produce or work out something new out of a subject- matter (Hornby, 2015). It is the capacity to step out of the existing boundary of knowledge in a dynamic way with a view to getting better (Adaji, 2020). In order to achieve effectiveness in science teaching, the teacher must be creative. Being creative might involve 'trial and error' geared towards steady improvement and discovery of better strategies of achieving set goals. Being a creative science teacher begins with the teacher's personal experience and enlightened conviction capable of igniting and lightning up the fire in the learners regarding their thought process. Adaji further opined that in every child, either of the following mindset might be found: a sleeping lion, a dead lion or an awoken lion. The creative teacher wakes the lion sleeping in a child. The creative teacher resurrects the lion dead in a child. The creative teacher keeps awake and active the awoken lion in a child. Learners should be able to assess and access their teacher. In summary and as posited by Lovark in Sambo and Adejoh (2014), a creative teacher must be sensitive to the needs of learners and the learning tasks. A creative teacher must be diagnostic by being able to determine what students require and what to be done to achieve mastery of the task. A creative teacher should be an expert in the choice of suitable teaching method and strategy to be combined to produce desired result. A creative teacher exhibits flexibility in varying plans and requirements as situation demands.

Among several useful personality traits that make for teacher effectiveness and creativity in science teaching as pointed out by Adejoh, Egbe-Okpenge and Goshwe (2019), high quality teacher preparation and resourcefulness appear striking. To be creative and effective in science teaching, deep knowledge and understanding of the subject- matter and skill on how to impart it must not be compromised. The ability to think out and utilize diverse strategies and methods in teaching with the aim of sustaining the interest of learners is one of the hallmarks of creative teachers. The other personality attributes expected of a creative teacher includes: strong personal standards, patience and self-control, being trustworthy and a model of respect, confidence and persistence, and then a conscientious capacity to plan and articulate lesson noting desired learning outcomes.

The strategic and social roles of science teachers in national development as affirmed by Adejoh M and Adejoh G (2014) can be summarized as follows: inculcating good virtues and positive attitudes, useful skills, desirable scientific and technological literacy, personal discovery and potential for productive development into learners, also fostering unity and democratic values among learners of diverse ethnic extractions. To have a quality science education, pupils and students must be handled using methods, strategies and treatments that are flexible enough to give room for innovation and creativity.

Use of Improvisation by the Creative Teacher

In the teaching of science subjects, creative teachers should be grounded in the concept and use of improvisation. Be knowledgeable in the ordered steps or procedures that are followed to arrive at a solution to a problem, otherwise referred to as the scientific thought processes or scientific process skills. Process skills desirable for improvisation include: observing, measuring, manipulating, experimenting, recording and communicating (Noun, 2021). The skill of observing has to do with the use of the eyes and hands to aim at desired shape and size. Skill of measurement involves the use of appropriate standard unit of measurement. Manipulating skill deals with activities using tools in cutting, in planing edges and in fashioning out other kinds of designs and shapes. Communicating skill has to do with ability to communicate ideas and activities done to others within the spacing distance mapped out. A creative science teacher who is conversant with improvisation must be aware of the precautionary measures to be taken in the course of improvisation. For example, ensure uniformity of spacing distances among students, avoid domestic injury in handling cutting tools, be conscious of the preservation/ storage method of improvised material, indicate appropriate unit of measurement and observe other correct precautions in other aspects of the items being improvised. The creative teacher should be knowledgeable in both the human and the non-human (material) resources for utilization in teaching and learning of science. The place and role of the following human resources can be utilized by a creative science teacher during improvisation: laboratory technologists, laboratory assistants, laboratory attendants and other resource persons as artisans, medical personnel and laboratory security personnel.

Use of Teaching Strategies Derived from Constructivist Education Theory

One of the theories upon which a base is established for the creative teaching of science is the Constructivist education theory. The constructivist education theory of teaching- learning, centred on the work of great educational theorists and researchers {such as John Dewey, Jerome Bruner, Jean Piaget, George Kelly, Vygotsky and Kuhlthau's Information Search Process (ISP) model} has provided basic principle for training students (Illinois, 2015). Constructivism is a theory founded on observation and scientific study of how people learn using creative approaches. It assumes, as affirmed by Illinois that students learn by conceptualizing understanding of their own personal encounters with information and ideas, building on what they have previously known in order to form a personal perspective of the world. The constructivist approach is proven to have had sustainable value for designing instruction and fashioning out teaching- learning environment for the 21st century schools. Constructivists, as posited by UKessay (2015) used a model referred to as the constructivist- learning- cycle, an inquiry- based approach to facilitate the retention of information and transfer of thinking skills and content base, which enable students to advance from the concrete concepts to the abstract concepts. It spurs students to be active builders of their own knowledge base by helping them to identify, translate and transform pieces of information, build sensible ideas and make discreet decisions which depend on cognitive structures. The duty of the teacher is to fashion out and develop a learning format that is in tandem with the student's state of knowledge at the moment. The teacher acts as a facilitator of knowledge by asking such question as: "What do students need to learn?" instead of "What do I want to teach?" By identifying the pre-existing conceptions of students, teachers help to direct activities in order to build students' knowledge base. As each new knowledge or skill is imparted, the student uses previous knowledge to get to more complex ideas and integrate novel information.

Part of the imagery created by the Constructivist theory is the John Dewey's learning theory and notable motto, 'Learning by doing'. Reflection on the process is another essential factor. Learning as a creative process of inquiry begins with a proposition caused by fresh information that inspires a question or challenge. By reflection, a guiding idea is developed which leads to the search for understanding. It was pointed out by Wolske (2015) that Dewey's work provided the foundation

for inquiry learning which involves experience, action and thinking of the child in totality. Science teachers are encouraged to apply inquiry as a teaching strategy in areas of science found complex to understand. So doing, teaching – learning will no longer be an affair of telling and being told, but an active and constructive process. Example of such creative teaching strategy tested and proven to be significantly effective when compared with the conventional teaching methods include: sensory stimulation, inquiry (discovery) and gaming among several other innovative strategies (Kanu & Ohize, 2020).

Challenges Confronting Creative Teaching and Learning of Science

Though education is one of the fastest growing industries in Nigeria, desirable impacts are yet to be felt in aspects of job creation, self-reliance and national development. The nation's fortune is yet to be transformed in terms of economic growth and technological advancement. The revolving and dynamic world of today's teaching business demands well-informed individuals with creative ability, particularly in science and technology field. New ideas have to be injected into the system and obsolete ones ejected. There is intense pressure not only on available financial and material resources, but also on the number of competent and effective science teachers required to translate abstract concepts into concrete reality among learners.

Scholars have asserted that teaching of science have experienced some challenges. The knowledge being imparted cannot drive learners towards conceptual understanding of scientific principles and theories. Science students find it difficult to comprehend, synthesize and apply most concepts of science compared to other subject, due partly to ineffective approach to science teaching and partly to the abstract nature of the subject and high intellectual demand required for its teaching. In teaching approaches, science is not properly related and linked to technology. Instead of students seeing science as an applied subject, it is rather being treated as pure science subject. The essence of science to learners' day to day living and the environment is not regularly emphasized.

Teacher education is the process of nurturing prospective teachers and updating qualified teachers' knowledge and skills in form of continuous professional development (Boyinsade & Sokoto, 2019). Before deciding to venture into the teaching profession, Akpan, (2015) opined that aspiring entrants need to be acquainted with the following facts:

- It is human beings (not files/ papers or items) that will be imparted. Be aware that the knowledge, skills, attitude and character to be educated might go down from one generation to the other (trans-generational). Therefore, conscious efforts must be made to pass down to learners, only correct and useful information.
- Prospective entrants' character traits, attitude and behavioural pattern would be of influence on the learners. Utmost care and precaution must be taken by the prospective teacher to exhibit satisfactory and professional conduct all the time.
- Science teaching involves character formation, discipline, organizational ability, critical mindedness, problem-solving skill and role sharing.
- Zenith of the profession is the production of well-trained knowledgeable and God-fearing human beings who can face all odds and make the best out of the situation. Success is achieved when the needed human resources to drive a nation's socio-economic and infrastructural development are produced.
- The inculcation of sound social, mental, moral, political and acceptable norms, values and useful skills into the citizenry remain cardinal achievement for the teacher.
- At whatever level a prospective entrant to the teaching profession decides to serve, rising to the top calls for certain qualities, such as: passion (interest) for the profession, readiness and

promptness to improve self through training and retraining even on the job, honesty and reliability, readiness to co-operate with other stakeholders (supervisory authorities, fellow teachers, parents and students etc.) to achieve common set goal, being law-abiding and loyal to the authority, striving to be a worthy model and a mentor, good sense of judgment, being grounded in the principles, guidelines and dos and don'ts of the profession and others.

Conclusion

The impact of a creative science teacher to the educational system and the national development at large cannot be over-estimated. Circumstantial evidence abounds of lack of functionality and poor practical relevance of the nation's education. Useful entrepreneurial skills and positive attitudes derivable from scientific principles and facts are in scarce supply among the products of institutions of learning. Science teachers can become more creative if they use their imaginative thinking skill combined with other personality attributes to devise new strategies and methods of achieving the goals of science teaching as derived from the nature of science. Self-motivation derived from the teachers' personal conviction to be creative and external motivation derived from a promising welfare package and a conducive environment are to be wisely combined in the training of youths for wealth creation, employment and national development.

Recommendation

The following recommendations are hereby put forward:

1. To be creative, the science teacher must be able to harness and put into proper utilization and improvisation the human resources and the material resources available. Also seek out and learn innovative teaching strategies derived from constructivist education learning models varying from problem-solving to child-centred approaches such as sensory stimulation and inquiry strategies.
2. Science teachers should be given opportunities for Continuous professional development at all times to enable them expand on the scope/ horizon of their knowledge and be conversant with current development in science trade knowledge. Participating in seminars/ workshops, retraining and refresher programmes and course aimed at improved lesson delivery is highly recommended.
3. Provision of standard and functional ICT facilities, equipped laboratories, technology workshops and other provisions of a conducive working environment and good welfare package (external motivation) will aid the science teacher to be creative.
4. Conscientious efforts for self-improvement and self-actualization (internal motivation) by the teachers towards creativity, innovation and effectiveness are needed. The personality traits/ attributes of the teacher must be worked on with emphasis on personal standard, subject-matter quality/ preparation and resourcefulness.

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