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SCIENCE EDUCATORS' PEDAGOGICAL PRACTICES FOR SUSTAINABILITY IN TEACHER EDUCATION PROGRAMMES IN THE FACE OF COVID-19 PANDEMIC

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ABSTRACT

Since the advent of COVID-19, the educational system across the globe has been affected in various degrees from total closure to the use of online facilities for teaching and learning. This paper examined pedagogical practices before the advent of COVID-19, pedagogies appropriate for science teaching and learning in the face of COVID-19 and the need for the review of science teacher education programmes to equip trainee teachers with appropriate 21 century skills and knowledge for the needed digital teaching and learning environment in order to promote scientific knowledge for the purpose of sustainable development. The paper finally looks at science educators' pedagogical practice for sustainability in teacher education programme in the face of covid-19 pandemic. Mention is made of the essential impact of science education on sustainable development as well as challenges of science education and sustainable development in the Nigerian context. The paper concludes that the curriculum for science education should be reformed to reflect the needs of Nigerian society in terms of practical skills required for individual

development as well as national development to equip trainee teachers with appropriate 21 century skills and knowledge for the needed digital teaching and learning environment. It is therefore recommended that the Nigeria government should make provision for science and laboratory tools to attract and promote scientific skills and knowledge among students.

Keywords: Science Education, Evaluation, Pedagogical Practice, Teacher Education Programme.

INTRODUCTION

Science education cultivates students' curiosity about the world and enhances scientific thinking. Through the inquiry process, students recognise the nature of science and develop scientific knowledge and science process skills to help them evaluate the impacts of scientific and technological development. Science education is well recognised as a distinct field within education, and is concerned with the teaching and learning of science and the discrete science disciplines. It is the field concerned with sharing science content and process with individuals not traditionally considered part of the scientific community. Pember and Humbe (2009) viewed science education as a process of teaching or training especially in school to improve one's knowledge about environment and to develop one's skill of systematic inquiry. Science education is relevant to scientific and technological advancement of any nation, Nigeria inclusive. The science educator is equipped with philosophical, psychological, sociological as well as historical knowledge about how learning takes place and application of learning in teaching of science subjects for the development in the learner, various science process skills, cognitive, psychomotor and affective skills (Alamina, 2018). A science educator is trained in a given area of science. A functional science educator is urgently required in order to promote scientific knowledge for the purpose of sustainable development. In this wise, the development of Nigerians and Nigerian society could be hinged on the pragmatic efficacy of science education.

Science education involves the in-depth study of verified scientific concepts and principles. According to Lewis (2015), science education identifies natural phenomena appropriate to child's interest and skills. This implies that science education equips teachers, learners and the society with knowledge, skills, equipment and freedom to perform noble task useful for improving socio-economic standard. Thus, the goal of science education is to produce a sufficient number and diversity of skilled and motivated future scientists, engineers, and other science-based professionals. The views of Lewis (2015) buttressed an earlier assertion by Omole and Ozoji (2014) who had stated that science education courses are designed to produce capable scientists who contribute meaningfully to academic excellence of the society and raise the economic level of nations internalizing science process skills are essential to economic development of an individual and Nigerian society at Large. The approach is characterized by hands – on – activities which encourage the teaching and learning of science. Teachers are the builders of the nation. Science teachers create various opportunities for students to engage in doing activities that will enable them make sense of the world around them, make new discoveries, solve interesting problems and develop skills that are sustainably driven, endeavours and how it relates to science teaching if they are to help their students completely understand the content and underlying

principles of science. Science teachers are increasingly realizing the necessity to become agent of change in order to better meet the needs of students, families and communities they serve and thus fulfil society's expectations about science educators' civil responsibility. Science learning includes many factors that are the determinants of science learning quality and process. These can be classified as cognitive factors and affective factors. The cognitive factors include information processing, reasoning ability and academic achievement (Lawson, Banks, & Logvin, 2006; Schunk, 2000; Yumasak, Sungur, & Cakiroglu, 2007). While for the affective factors that are emphasized in the science education literature are attitude, self-efficacy, anxiety and motivation. In science learning, motivation is the affective factor that is given more concern than the others (Osborne, Simon & Collins, 2003). Science educators play crucial role in shaping the students' mind towards sustainability as they impart the knowledge of science. Science teachers help to develop sustainability skills for students such as: Mastery of subject matter in science, motivating students to learn science. Alamina (2008) emphasized that science teachers therefore, need to recognize the nature of motivation, in teachers' pedagogical activities as no practicing teacher at any level doubts the importance of motivation in learning. In this, motivating students plays a crucial role in science learning, which targeting in promoting student's construction of his/her conceptual understanding of science.

Motivation is seen as an inner state or force that energizes, directs and sustains behavior towards achievement of a goal. Learner motivation may well be influenced by teacher motivation. Thus, when learning is satisfying and meaningful, when what is learned is perceived to be of value by the learner and when there is confidence and purpose, then motivation will be intrinsic, bringing considerable benefits (Cavas, 2011). Motivation may well allow learners to see their learning as meaningful, engaging students' interest in the language's characteristic of science. To achieve this objective we must discuss the communicative skills teachers require to develop understanding of the processes involved in building up this knowledge. For this to occur, students must have the opportunity to express their ideas in the classroom, and to make this possible, teachers must create an encouraging environment that will allow students to acquire confidence and involvement in the scientific practices. It is teacher-student interaction that makes students aware of their own ideas and gives them the opportunity in dealing with nature in a scientific manner (Carvalho 2007).

It is vital to understand the meaning of pedagogical practices when recognizing the concept; it is concerned with attempts to initiate reform within the classroom. Keeping pace with the developments within the walls of educational institutions and the process of reforming pedagogical practice (Mikis, 2014). As it has been stated above that pedagogical practice comes of interest when educators employ various kinds of resources, materials, methods, principles and explanations during the course of their teaching. In order to enhance the pedagogical practices, it is essential to understand what the teaching-learning principles are. The following points highlight the ways how and in what kind of environment, students develop their knowledge and skills to the best of their abilities. Effective teaching is the key to improving student learning throughout the school. The science educator takes a strong leadership role, encourage the use of research-based teaching practices in all classrooms to ensure that every student is engaged, challenged and learn

successfully. All teachers ought to understand the use of effective teaching methods, including explicit instruction in order to maximize student learning.

Research works on science teachers‟ classroom practices have not been able to capture science teachers own report of their classroom practices. Classroom practices refer to all that the teacher does regularly in the classroom during classroom interactions with students to bring about learning in students (Kalu-Uche, 2010). Furthermore, Khader (2012) defined classroom practices as "a set of teaching strategies and methods of instruction employed in the classroom; The interaction between the teacher and his students in order to expand their cognitive and skillful perceptions through the appropriate classroom management, determination to teach and continuous evaluation to achieve the desired teaching objectives." The foregoing definitions imply that teachers employ several pedagogical practices in the course of any given lesson. The arguments about teachers‟ classroom practices make it imperative to ascertain what classroom practices science teachers employ in their regular interactions with students. Therefore, this study sought to find out the extent to which science teachers‟ pedagogical practices are constructivist or transmissions (behaviourist) oriented, and the extent to which science teachers‟ report of their pedagogical practices relates to their actual (observed) classroom practices.

Kalu-Uche, Alamina and Adolphus (2009) reported in a study that science teachers were not using constructivist-based strategies to any appreciable extent in classroom instruction. Statistically, science teachers‟ report of their classroom practices did not closely align with their observed practices. The differences in science teachers‟ report of their classroom practices and their observed practices suggest that science teachers do not accurately report on their classroom practice. The most common pedagogies used in science classrooms in Nigeria include Lecture, Demonstration, Laboratory methods, Field trips, Discussion, Project method (Adolphus, 2016)

COVID-19 took the nations as a surprise, exposing the ineptitude of their health systems. This adversely affected the educational systems with the extreme cases of closure of schools for more than six months. The adverseness of the effects of the pandemic is expectedly more in underdeveloped and developing nations, like Nigeria, than the developed nations. However, for educators, the COVID-19 Pandemic has resulted to the development of adaptive and transformative teaching and learning approaches as positive responses to the pandemic. According to the Organisation for Economic Co-operation and Development (OECD, 2020) students with access to digital devices and internet may not be the majority in most countries, but that supporting governments in establishing effective forms of online education will free up institutional capacities and resources in order to redirect their focus on delivering alternative learning methods for those students who do not have similar opportunities. The Economic Commission for Latin America and the Caribbean (ECLAC) reported that in the sphere of education, many of the measures that the region's countries have adopted in response to the crisis are related to the suspension of face-to-face classes at all levels, which gave rise to three main areas of action: the deployment of distance learning modalities through a variety of formats and platforms (with or without the use of technology); the support and mobilization of education personnel and communities; and concern for the health and overall well-being of students (ECLAC-UNESCO, 2020). In Guyana, South America, Oyedotun (2020) reported that following directives from the government, many educators and university lecturers started exploring forms of available video-conferencing

applications and platforms for use in the delivery of their lectures. Online platforms such as GoToMeeting, Skype, WhatsApp, ezTalk, emails, BlueJeans, and Zoom were used in addition to the Moodle platform used by the university in Guyana. According to oyedotun (2020), based on the relatively positive experience of the use of the Zoom plat-form, the university purchased Zoom Enterprise versions for use by lecturers and that with the help of the University's Software Department; it was integrated into the university's learning platform.

The situation was different in Nigeria with most public schools from primary to university were closed with no form of teaching and learning alternative for between 6-9 months. Some public universities quickly responded to the situation with the use of WhatsApp, Zoom, Telegraph, Microsoft Teams, etc. Similarly, some state governments like Lagos and Rivers States resorted to the use of radio and television broadcasts for some forms of teaching and learning. The questions bothering most minds are: How effective were these responses, were teachers equipped with the requisite skills and knowledge to respond to the pandemic? If so, what percentage of lecturers keyed into the use of these facilities and how competent were they?

Teachers' professional development in areas of content, pedagogy, use of technology, assessment and feedback, lesson preparation and presentation are perceived as relevant to the quality and effectiveness of the teacher. In this section, relevant research findings in literature on the place and effect of teachers' continuing professional development has been reviewed to have a good understanding of current research findings, give focus to the study and adequate guidance to the discussion of findings on the subject for the present study.

The place and role of teachers as a valuable resource in the school as a system of educational activities cannot be overemphasized. In general, studies have shown that certain factors within the teacher's control significantly influence the academic attainment or progress of his pupils (Mcber, 2000; Harwell, D'Amico, Stein & Gatti, 2000; Rivkin, Hanushek & Kain, 2005; Cox, 2015). Some of these factors according to Cox (2015) are the teacher's teaching skills, his professional characteristics and the classroom climate which together accounted for "well over 30% of the variance in pupil progress" (p.9). Some of these skills in teaching and professional characteristics are developed in teacher training and re-training activities in organized Continuing Professional Development (CPD) programmes by relevant professional bodies and institutions. Parents and sometimes, students in certain allowable circumstances use teacher quality differences among teachers to request for class placement with specific teachers (Rivkin, Hanushek & Kain, 2005). The teacher plays several roles in the context of the school system. Some of the roles of the teacher have been summarized by Cox (2015). Exploration of 21st century learning or skills has emerged from the concern about transforming the goals and daily practice of learning to meet the new demands of the 21st century, which is characterized as knowledge- and technologically driven. The current discussion about 21st century skills lead classrooms and other learning environments to encourage the development of core subject knowledge as well as new media literacies, critical and systems thinking, interpersonal and self-directional skills. For example, the Partnership for 21st Century Skills (P21) defines the following as key: core subjects (example English, mathematics, geography, history, civics) and 21st century themes (global awareness, civic literacy, health literacy, environmental literacy, financial, business and entrepreneurial literacy); learning and innovation skills (creativity and innovation, critical thinking and problem solving,

communication and collaboration); information, media and technology skills (e.g. ICT literacy, media literacy); and life and career skills (flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, leadership and responsibility). One main learning method that supports the learning of such skills and knowledge is group learning or thematic projects, which involves an inquiry-based collaborative work that addresses real-world issues and questions to equip trainee teachers with appropriate 21 century skills and knowledge for the needed digital teaching and learning environment. From the foregoing, it is therefore important that Teacher training institutions upgrade their curriculum to include contents that would enable their products acquire necessary skills that would enable them teach effectively, not just in the face of COVID-19, but also to enable them adapt easily to any emergency that the education sector may be faced with in the future.

Sustainability of Science Teacher Education Programmes Through Sustainable Development Goal

Education for all (EFA) was a set of six internationally accepted goals for education adopted in April 2000 at the world Education Forum (UNESCO, 2000). The millennium Development goals (MDGs) was a set of eight goals with much wider significance than EFA goals adopted in September 2000 at the millennium summit of the United Nations. Due to the failure of EFA and MDGs particularly in the area of protection of the environment in the face of development, the sustainable development goals (SDGs) succeeded the MDGs and EFA goals, both of which ran until 2015. The sustainable development goals are a new, universal set of goals, targets and indicators that UN member states expect to use to frame their agendas and political policies until 2050. The SDGs are a vision of progress towards a safe, just, egalitarian and sustainable society for all human beings to effectively thrive and survive on earth.

The UN is to achieve these goals within a set period of 15 years, which terminates in the year 2050. The underlining reason for the UN to move for sustainable development is the one identified by Ndukwe (2000) in Mbara (2019), which was about the cooperative relationship between growth and protection of the environment. In September 2015 at the 70th session of the General Assembly of the United Nations, member states met and adopted a new global development agenda, which gave birth to what is today termed sustainable development goals (SDGs).

Sustainable development implies an economic development, which meets the needs of the present generation without compromising the ability of future generations to meet their own needs (Akpama, Bessong & Besong, 2017). This implies that, we must not carelessly, recklessly and exploit greedily the available resources in order not to stifle the present tempo of development as well as compromise meeting the needs of future generations.

Sustainable development has three main intertwining and interwoven components: environment, society and the economy. For example, a healthy, prosperous society relies on a healthy environment to provide funds and resources, safe drinking water and air for its citizens. The focus of sustainable development is on the twin issues of achieving environmental protection and development. In essence, the process of the present development should entail the preservation of existing resources for future generations through education. The main thrust of the sustainable development principles is the sustainable use of natural resources for a healthy environment and

for sustainable economic growth, which does not compromise the needs of future generations (UNESCO, 2014).

The Roles of Science Teachers in the Sustainable Development of Science Education

Teachers are the builders of the nation. Science teachers create various opportunities for students to engage in doing activities that will enable them make sense of the world around them, make new discoveries, solve interesting problems and develop skills that are sustainability driven. Omoifo (2012) emphasized that science teachers therefore, need to recognize the nature of scientific endeavors and how it relates to science teaching if they are to help their students completely understand the content and underlying principles of science. Effective and consistent Implementation of the science and technology curriculum will lead to poverty alleviation, increase in productivity and rapid economic growth. Science teachers are increasingly realizing the necessity to become agent of change in order to better meet the needs of students, families and communities they serve and thus fulfill society's expectations about science educators' civil responsibility. Science teachers play crucial role shaping the students' mind towards sustainability as they impart the knowledge of science. Science teachers help to develop sustainability skills for students such as mastery of subject matter in science, motivating students to learn science, psychomotor skills, facilitating team work and becoming skilled personnel.

According to Lewis (2015), science education identifies natural phenomena appropriate to child's interest and skills. This implies that science education equips teachers, learners and the society with knowledge, skills, equipment and freedom to perform noble task useful for improving socio-economic standard. Thus, the goal of science education is to produce a sufficient number and diversity of skilled and motivated future scientists, engineers, and other science-based professionals. Science educators play crucial role in shaping the students' mind towards sustainability as they impart the knowledge of science. Sustainable development is the overarching paradigm of the United Nations. The concept of sustainable development was described by the 1987 Bruntland Commission Report as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (UNESCO.2012). In this context, Sustainability of science teacher education programme could mean developing a teacher education programme with appropriate knowledge and skills that meet the need to today's teachers in a 21st century classroom and teachers of later generations. For this to be possible, it is important that teachers regularly participate in trainings and re-trainings in the form of Continuous Professional Development. There is empirical evidence in literature that supports the positive effect of teachers' participation in continuing development on both the teacher's efficiency and pupils' academic attainment. For instance, Kunz, Nugent, Pedersen, DeChenne & Houston (2013) investigated the differences between rural science teachers who received professional development in guided scientific inquiry and those who did not receive any form of professional development and reported that:

"Teachers' pedagogical content knowledge (PCK) in guided science inquiry significantly increased from 34% correct before the summer portion of the guided science professional development institute (i.e., Summer Institute) to 58% correct immediately after the Summer Institute (p=.000). Similarly, teachers' scientific inquiry knowledge (SI) significantly increased from 69% correct prior to the Summer Institute to 80% correct immediately after the Institute

(p=.002). The growth of teachers' classroom inquiry knowledge (CI) was not statistically significant (from 68% to 72% correct, p=.125)"

The results above showed that teachers' participation in professional development programmes significantly enhanced their pedagogical content knowledge (a measure of their instructional strategies) and scientific inquiry knowledge (a measure of teachers' knowledge of the nature of science and inquiry in science) with an improvement (from 68% to 72%) in the teachers' classroom inquiry knowledge which measured teachers' scientific questioning skills and abilities, priority to evidence and formulating explanations (Kunz, *et al.*, 2013)

CONCLUSION

In this paper, the teacher have discussed the effects of the COVID-19 Pandemic on the education sector with the inadequate level of readiness of the sector for most countries of the world, especially in developing countries like Nigeria. We therefore have advocated the need for the review of science teacher education programmes and curriculum to equip trainee teachers with appropriate 21 century skills and knowledge for the needed digital teaching and learning environment for effective science education in order to achieve the goals of sustainable development. This is based on the fact that development in the 21st century should be secured on the scientific knowledge and skills in which science education plays a vital role. Therefore, the philosophy of science education has to be reviewed to promote modern scientific discoveries on local and national scale.

Recommendation

From the foregoing, the following recommendations are made:

- Government and private sectors should put in more effort and resources towards the development of science education and the realization of the objectives of science education by engaging services of qualified and experienced science teachers by teachers regularly participating in trainings and re-trainings in the form of Continuous Professional Development
- Government and Non-Governmental Organizations should make available modern teaching gadgets such as computers, internet, web sites facilities, overhead projectors, internet web sites facilities, firms etc, in schools and research institutes in order to encourage scientific discoveries thereby promoting quality science education to the best practices in the world.

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