

SCIENCE AND TECHNOLOGY EDUCATION POLICIES, PRACTICES AND STRATEGIES FOR ACHIEVING 21ST CENTURY REFORMS AND REMEDIATION IN NIGERIA

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Abstract

The paper discussed science and technology education policies, practices and strategies for achieving 21st century reforms and remediation in Nigeria. Science and technology education was described as an inter-disciplinary knowledge base concept that entails the process of critical thinking, analysis and collaboration. It is aimed at inculcating observable changes in the way and life of learners through real world problem solving skills. Nigeria's under-development and mass unemployment rate were traced to the absence of functional road-map to direct and propel the delivery of quality science and technology education. The need for Nigerian youths to be rightly skilled for global competitiveness, self-reliance, and entrepreneurship and job creations through science and technology education was highlighted. Efforts made to salvage the situation have not being significantly impactful to the society. Challenges were pointed out and solutions proffered. Objectives of the new national policy on science and technology education were discussed. Practices and strategies to bring about 21st century reforms and remediation to the problem were also highlighted.

Keywords: Science Technology and Mathematics Education, Policy, Practice, Strategy, and Reform

Introduction

Any nation in the world that desires to be accorded a recognizable status at the global platform of comity of nations in the 21st century regarding its industrial and economic status must develop and maintain citizenry that are vastly skilled. An empowered citizenry will result in workforce that is self-reliant and creative.

Science and Technology education plays key role in actualizing this noble ambition. Great nations of the world have used processes and products of science and technology to cause industrial revolutions that have led to rapid national development (Odia & Omofonmwan, 2018). Nigeria is not left out in the efforts of trying to use science and technology education to realize the goal of national development. Even though Nigeria is blessed with rich natural resources and human resources that are thriving in different fields of endeavour, it is still grappling with the problem of under-development.

The absence of a roadmap and poor synergy among stakeholders in science and technology education sub-sector can be part of the probable reasons for the perceived setback and lack of viability in the nation's workforce. Graduates of science and technology education as stipulated in the National Policy on Education (Federal Republic of Nigeria, 2014) are supposed to have acquired sufficient skills capable of transiting the nation from a dependent economy to a self-reliant nation. The situation on ground is that of poor implementation of the national policy on science and technology education in Nigeria. The needed vast skills and positive attitude are lacking among the youths thereby causing massive unemployment rate and increasing socio-economic tension. The process, method and attitude of transmitting science and technology concepts, knowledge and skills need to be modified for a valid, reliable and usable end-product.

Meaning of Science and Technology Education

Science and Technology Education (S & TE) is an inter-disciplinary knowledge-based concept that tends to integrate distinct disciplines in teaching-learning with a view to making an integrated view of the natural world (Matazu, 2012). It is meant to bring about observable changes in the way of life and actions of learners. This is achievable by inculcating real-world problem-solving skills and needed resilience capable of stimulating growth and development in the nation and the world at large (Agu & Isei, 2018). Students are expected to be adequately prepared to solve real-life problems through career opportunities offered by S & T education. This interconnectivity of science and technology, if wisely utilized, is an advantage in the development of skills for self-reliance and job creation.

Science studies natural phenomenon through the process of observation and experimentation. Technology applies the products of science such as scientific laws, principles and hypotheses for the improvement of standard of living with the help of tools and machine. Inventions and discoveries of science and technology have been applied in different fields of human endeavour and national development.

In recognition of the relevance of Science and technology at all levels of Nigerian education sector, the National Policy on Education of Federal Republic of Nigeria prescribed the inculcation of the spirit of inquiry and creativity through the exploration of the environment (FRN, 2014). The philosophy of Science and Technology Education (S & TE) offered the guidelines, objectives, structures, standards, strategies and management for actualizing the national goals of S & TE in Nigeria (Federal Ministry of Education/ FME, 2018).

It is meant to be operated within the framework of the National Policy on Education (NPE) and other bilateral agreements and international treaties that affect S &TE to which Nigeria is a signatory.

Challenges of Science and Technology Education in Nigeria

Some of the challenges of Science and technology education in Nigeria as identified by Sofowora and Adekomi (2012) are the following: inadequate exposure of students to practical and basic experiments, poor library facilities, poor method of teaching and continued use of traditional methods that have not provided competency based training capable of embracing the new speedily revolving economies. Another problem is that of learning challenges in early school years; and poor performance/ poor quality of prospective entrants into tertiary institutions which in turn have affected students' enrolment into Science and technology (S & T) education. Odia and Omofonmwan (2018) corroborated the problem enumerated and added other limitations to include: poor funding, poor teaching- learning infrastructures, inadequacy of classrooms and teaching aids (such as projectors, computers, laboratories, technology workshops, libraries etc), paucity of quality teachers, polluted/ un-conducive learning environment and problem of insecurities and banditry. Others include lack of political will to do the needful, inadequacy of content, paucity of facilities, equipment and materials in science laboratories and technology workshops, overcrowded/ over-populated classrooms, scarcity of researched- based reference materials, textbooks, and lack of motivation. These lapses have to be tackled before S & T education can begin to produce individuals that are capable of being self-reliant life and creative. Students learning science and technology in Nigeria as postulated by Badmus and Omosewo (2018) are faced with the problem of obsolete laboratories, use of outdated textbooks, unrealistic methods of teaching, lack of requisite mathematical background for effective calculations and manipulations, poor attitude due to lack of real representation of science concepts and subject- matter.

The present state of mass unemployment rate and socio- economic upheaval in Nigeria shows that science and technology education is yet to achieve the desirable impact. It was observed by Matazu (2012) that graduates of S&T education appear not to have acquired the relevant and functional hands-on skills and minds-on experience needed to transform the man-power need of the nation. The consequence translates into scarcity of enterprise, lack of opportunity for self-employment and self- reliance, and a corresponding shortage of technological discoveries and invention in different fields. Unrealized and unfulfilled human and national broad-based goals at both individual and institutional levels are part of the consequences. Inability of S&T graduates to transform theoretical classroom- based work into practical relevance is common experience in work places. There must be a decisive turn-around in the teaching- learning approach of science and technology.

One of the greatest problems of education in Nigeria which affects science and technology education is the gap between policy formulation and the implementation of policy prescriptions (Siyanbola, Adeyeye, Olaopa & Hassan, 2016).

For instance, the three types of tertiary institutions (Universities, Polytechnics and Colleges of Education) have dissimilar features that make co-equality and parity difficult in the competitive eyes of Nigerians. The practice in some private primary and secondary schools regarding policy implementation is another source of hiccups. Many private schools operate as business ventures and solely established for monetary gains and without priority to education policies related to rendering of social services.

Policies and Practices in Science and Technology Education

Policies are guides and standing orders that are usually based on the ideological convictions and presumptions of the policy makers and meant to specify at some generality what should be done, when and by whom (Anikweze, 2014). They are values, practices and ways of acting that shape the consciousness of people and produce social identities. Policies act as reference points at the institutional level and assist the institutional authority to maintain disciplined leadership and promote the core values of the system (Haines, 2000). Education policy is a system of administrative guidelines and regulations put in place to direct stakeholders in the education sector towards the actualization of the national goals of the nation's education system. Educational policies are in evolution and may often be backed up with legislation thereby providing it with teeth to bite. Science and technology education policy is a functional guideline specifically meant to direct and propel the actualization of quality science and technology education that are of worldwide acceptability. Federal Government of Nigeria has acknowledged the positive effect of science and technology education to national development by supporting it through adorable programmes, actions and policies (Agu & Isei, 2018).

Guidelines for Science and technology education are included in the National Policy on Education (2014). The National Policy on Science and Technology was started in 1986 and initially designed for a period of development with a philosophy that underscores Nigeria's dedication in creating an independent and self-reliant economy. Some Universities of Science and Technology, Colleges of Science and technology, Polytechnics, Research Institutes, Monotechnics and Technical Colleges were established with the aim of providing science and technology education for citizens as the way forward to the future.

In recent times, attention is being given to the progressive development of science and technology, both at the tertiary institutions level and the secondary school level. The State Ministries of Education in Nigeria and the Universal Basic Education Commission are expected to help supervise and inspect teaching- learning of Basic Science and technology, together with other science and technology related subjects both at Basic Education level and Senior secondary School level to ensure conformity with the approved standards. The aim is to germinate, nurture and harvest quality science and technology as basis for human and institutional development. Inspection reports of schools applying for recognition as public examinations' centres are usually forwarded to the examining bodies for consideration and further verification before recognition status are granted.

Monitoring of schools ensures usage and compliance with recommended schemes, syllabuses, text-books and instructional materials; availability of standard science and technology facilities and materials; and engagement of qualified teachers.

The National Policy on Education as postulated by FRN (2014) recommended that a greater proportion of educational expenditure be devoted to science and technology education and covering for primary, secondary and tertiary curricular. The science curriculum is spiral in nature with increasing complexity as educational level increases, and prescribes the inculcation into learners the spirit of inquiry and creativity through the exploration of the environment and adoption of thematic approach (Eniayeju, 2014). At the Basic education level, permanent literacy, numeracy and communication skill are inculcated, sound base for scientific and reflective thinking is laid, and the child is given the opportunity to develop manipulative skills for effectiveness in the society and within the child's capacity. At senior secondary school level, science and technology education provides opportunity for enquiry, discovery, problem- solving skill and co-operation for manpower training in the applied sciences and provision for technical knowledge and vocational skills necessary for agricultural, industrial, commercial and economic development.

At Polytechnic and College of Science and Technology levels, National Policy on Education stipulates S & T education that trains and imparts necessary skills for production of technicians, technologists and other skilled personnel who can apply scientific and technological knowledge to solve environmental problems for man's convenience and for self- reliance and enterprise. At the University level, science and technology education policy recommends the need for teachers in professional fields to have component and relevant exposure to industrial and professional experiences. Also, that 60% admission opportunity be allocated to science oriented courses in conventional universities and not less than 80% in the universities of science and technology.

The United Nations Educational Scientific and Cultural Organization (UNESCO) had earlier advised beneficiary nations of the need for twenty- six per cent (26%) national budget benchmark to be devoted to education (Badmus & Omosewo, 2018). Half of UNESCO benchmark is yet to be achieved in Nigeria, thereby depriving the field of education the needed funding, particularly S& T education. Policy decisions in educational system of Nigeria, particularly S & TE need to be backed by an Act. The much the National Council on Education (the highest Education policy- making body) can do hitherto is to urge concerned functionaries to implement policies and usually nothing happens to those who refuse to comply. This trend must change to right the wrong. An enforcement mechanism deserves to be put in place within the system to ensure full implementation of policies and programmes of government concerning S & T education.

The political and religious ideologies of Nigeria need to have overt influence on the science and technology education system. The philosophy of science and technology should seek to explain the procedures and processes of scientific and technological inquiry such as observation, calculations, presumptions and even patterns of reasoning.

Whether the system is conservative, progressive or revolutionary or whether the regime is totalitarian, democratic or anarchist, the policy and practice on science and technology education are affected. Other pertinent issues include: the leverage of science and technology education policy and practice to the democratization of society, equal opportunity for access to and success in school, gender sensitivity and female empowerment (Anikweze, 2014).

The Nigerian constitution accords all citizens (including learners in remote areas) equal opportunity to access same quality science and technology education. In a pandemic crises recovery era, practice and strategy demands a radical action in the context of science literacy rates, length of compulsory basic education, and equalization of science and technology education opportunities across gender and socio-cultural background. Factors perceived to be impeding the enforcement of the provisions of the Universal Basic Education in Nigeria for quality science and technology education should be identified and tackled promptly. Expanding the horizon of various supports and developing individual and group capabilities to the overall advancement of S & TE in the society should be encouraged through the creation of conducive environment.

Pressures should be reduced on and incentives provided for concerned stakeholders and volunteers opting to invest in science and technology education and research. A variety of science and technology resources should be provided and made available to schools in surplus. Proper financial, material and technical/ human resources need to be mapped out for science and technology education.

Students and pupils should be accorded the opportunity of choosing from different options in the subject –matter of science and technology. The practice suggests that Nigerian science and technology education is stratified according to age, sex and socio-cultural background of the learner. There ought to be homogeneity in science and technology among the three types of tertiary education in Nigeria- University, Polytechnic and Colleges of Education. The disparities in quality between the public schools and the private schools, the geo-political differences amongst the states of the federation and that existing between the federal owned institutions and those of the states all logically account for the absence of homogeneity. Other factors that are considered emphasize the development of individual learner's aptitudes, interests, social needs and talents or the regional variations based on regional needs and peculiarities (Anikweze, 2014).

Aims of the New National Policy on Science and Technology Education in Nigeria

Long before independence, Nigeria has incorporated the science curricular in its education. But it has not had a national policy specifically meant to direct and propel the delivery of quality science and technology education for global recognition (Echono, 2020). Adopting the policy leads to the enactment of guiding principles and pertinent strategic opportunities for effective implementation mechanisms for S & T interventions towards the reduction of the unemployment problems in Nigeria. The first National Science and Technology Policy in the country were produced in 1986 with a philosophy that emphasized Nigeria's dedication in creating an independent and self-reliant economy (Jemide, 2020).

The policy was designed to create harmony and bring about transformation in the pursuit of knowledge about the environment through Research and Development. The aim was to use S & T knowledge to ensure better quality of life of the people. However, this noble desire has been hampered by the absence of functional road- map and scarcity of critical technical and vocational skills to drive it (Erunke, 2021). This has resulted in noticeable gaps and poor synergy among stakeholders in the science, technology and vocational education sub- sector, and also the dampening of optimal development in the sub-sector. The Federal Government of Nigeria, according to the Minister of Education, Adamu, Adamu in 2020 during the presentation and launch of the new guideline for implementation, repositioning and delivery of quality science and technology education stated the need for Nigerian youths to be rightly skilled for global competitiveness, self- reliance, entrepreneurship and job- creations.

The new national policy on science and technology education, according to Erunke (2021) in Vanguard news has linkages between schools and communities in the area of human capacity building and institutional capacity. Also, it has the need to provide required facilities and equipment on a systematic and sustainable basis, and highlights training of science and technology teachers across the country. It becomes necessary to educate the public and spread information and knowledge of the new science and technology education national policy to stakeholders, states of the federation and other relevant agencies in order to guide actions, coordinate, monitor and evaluate the sub-sector (Jemide, 2020). The ultimate aim is to ensure sound science and technical delivery at all levels. It was launched as a consequence of the abysmal performance of science and technology students in public examinations in Nigeria and West African region; also the lack of functional relevance of many graduates of science and technology fields in Nigeria; and the need to attract talented and bright minds into the workforce of S & T. Recall that the mission of the Federal Ministry of Education (FME) in Nigeria as contained in the National Policy on Education, (2004) and revised FRN (2014), as re-affirmed by FME (2018) is geared towards the use of education as a tool or channel to foster the development of Nigerian citizens to their full potentials, in the promotion of a strong, democratic, egalitarian, prosperous, indivisible and indissoluble sovereign nation under GOD.

The policy re-direction was a fall out of a recent meeting by the National Council on Education (NCE) which recommended the review of Science and Technology Education curricular. The draft National policy document was initially presented to a Reference committee on Technology and Science Education at the Joint Consultative Committee on Education (JCCE) held at Awka, Anambra state, from February, 27th to March, 3rd, 2017. After its adoption by the JCCE, it was recommended for approval to the National Council on Education under the supervisory role of Director, Technology & Science Education Department, Federal Ministry of Education, Abuja. The new policy document, as affirmed by the Federal Ministry of Education (2018) is multi- sectoral in nature, considering its holistic approach to leadership and life skills training for pupils, students, teachers and youths in and out of school.

The implementation guidelines for the new national policy on science and technology focuses on the following: crisis – sensitive planning, gender equality, governance and accountability, science and technology learning outcome. The policy also highlights pre- service and in-service training of teachers of science and technology, teacher demand and supply, provision of science infrastructures, workshops, equipment, textbooks and other resources in educational institutions. Key stakeholders to be involved in the implementation of the policy include: sectoral Ministries, Departments and Agencies (MDAs), Institutions of Higher Learning, the Private Sector, Non-governmental Organizations (NGOs), Media, Professional associations and International Partners (Adamu, 2018).

The philosophy and goals of S & T education in Nigeria remains a reference point for standard practice at various levels of science and technology education. The S & T education policy is government way of achieving the part of the National Policy of Education first published in 1977 and reviewed in 2004 and on regular basis (FRN, 2014). The philosophy of Science and Technology Education (S & TE), according to the Federal Ministry of Education (2018) offers the guidelines, objectives, structures, standards, strategies and management for actualizing the national goals of S & TE in Nigeria. It is meant to be operated within the framework of the National Policy on Education (NPE) and other bilateral agreements and international treaties that affect S & TE to which Nigeria is a signatory. The mission statement is the evolving of a nation that harnesses and utilizes S& TE for sustainable development. The vision is to become a key player in S & TE among developed nations for global competitiveness. The goal is primarily meant to produce the critical S & T workforce that can transform the nation's economic landscape to a world class economy (FME, 2018). Nigeria's philosophy of education is predicated on some national goals and has been articulated to guide:

- The development and equipping of individual into a sound and effective citizen, through the acquisition of appropriate skills and the development of mental, physical and social abilities and competencies;
- The full integration of the individual into the community, through the inculcation of the right values and attitude geared towards national consciousness and national unity; and
- The provision of equal access to educational opportunities for all citizens of the country at the primary, secondary and tertiary levels both inside and outside the formal school system, with a view to understanding the world around.

Based on the above provisions, it is expected that the quality of instruction at all levels of education should be oriented towards: promotion of physical, emotional and psychological development of all children; and acquisition of competencies necessary for self-reliance among other values.

Strategies and Reforms

Science and technology education is a veritable tool for most of the strategies and reforms needed for Nigeria's socio-economic and industrial stability. Lately, government has come up with different kinds of strategies and reform agenda aimed at national advancement at all levels of the S & T education system. Teachers need to be carried along with the new initiatives of government on science and technology. Recall that the mission of teacher education in Nigeria is to produce highly motivated, skilled, professionally- competent and development- oriented teachers who would be effective agents of national development (FRN, 2014).

Science and technology based subjects- teachers need to have full insight into the various strategies and reform programmes in science and technology to enable them imbibe and impart current and appropriate scientific and technological knowledge, skills, methods, products and development – oriented attitudes to students.

The National Economic Empowerment and Development Strategy (NEEDS) is a compendium of strategies for reform in all sectors of the Nigerian society. The education sector of the NEEDS reform agenda addresses issue of advancing the quality of science, technology and vocational education, early child care and education (ECCE), gender sensitivity issue, multi- grade teaching, employment generation via entrepreneurial education, women and youths empowerment and the culture of peace among others (National Planning Commission, 2004). Under NEEDS, Basic education is considered the key bridge to the future. The strategy is aimed at empowering the citizenry to acquire skills and knowledge that would prepare them for the world of work. The Federal Ministry of Education has a reform “manual” tagged Strategic National Education Plan (SNEP). The aim of SNEP is to nurture a system that guarantees the total development of the Nigerian child and citizen by offering the best of physical, intellectual, moral and physical development (FME, 2004). It is accommodated within the NEEDS of the Federal Government.

In order to address the poor level of science and technology education in Nigeria, some programmes and action plans have been initiated by the government, often done in collaboration with international organizations and sometimes in conjunction with other non- governmental organizations whose agenda tally with the actualization of national goals. Some of these programmes as identified by (Agu & Isei, 2018) and others are:

- (a) Education Trust fund (ETF)/ Tertiary Education Trust Fund (TETFund): TETFund was founded as an intervention agency backed up with an ACT and saddled with the duty of managing, disbursing and monitoring of the education tax to public (state and Federal) tertiary institutions in Nigeria; and supervises the projects being executed with the fund. TETFund ensures that funds generated from educational tax are utilized to improve the quality of education in Nigeria without direct contract award process.

- (b) Technical Teachers Training Programme (TTTP): The programme was begun in 1980 as an interim strategy to provide science and vocational teacher education to science, technical and vocational teachers in Nigeria. At inception, the programme was run in collaboration with the United States of America. It is presently implemented by the Nigerian government in country's Universities and Polytechnics.
- (c) Strengthening Mathematics and Science Education (SMASE). SMASE programme was begun in 2006 as an initiative of Japan International Cooperation Agency (JICA) in collaboration with the Federal Ministry of Education in Nigeria.
The aim is the training of in-service primary and secondary school teachers in effectiveness of teaching methodology, positive attitude, content mastery, resource mobilization and utilization of locally available instructional materials. The project has the goal of upgrading the capacity of Mathematics and Science students on one hand; and improving the teaching skills of Mathematics and Science teachers. It focuses on (i) In-service Education Training (INSET) (ii) Use of Activities, Student, Experiment and Improvisation (ASEI) in teaching. The lessons are made possible using: Plan, Do, See and Improve (PDSI) practice (iii) Use of the Cascade Approach: which consists of two levels of training the national and state trainers and the training of the classroom teachers on the other hand.
- (d) Junior Engineers Technicians and Scientists (JETS): JETS club was created in 1982 to provide children with an introduction to science and technology in Nigeria. JETS club project encourage the smart children to think like scientists. It aims at awakening logical reasoning, creative thinking, innovations, science, technology and engineering practical skills. Students' ability to analyze and solve scientific problems are inculcated and built.
- (e) The United Nations Educational Scientific and Cultural Organization (UNESCO) have had a good number of programmes in Nigeria, one of which is the Sustainable Development Goals (SDGs). The internationally recognized 4th Sustainable Development Goal is targeted at ensuring quality education for all by 2030. Member nations are mandated to ensure the realization of an inclusive and equitable quality education and lifelong learning opportunities (UNESCO, 2019). The UNESCO is promoting the pursuit of "culture of reforms" through its assistance packages and strategies at different education reforms plans. Another of the UNESCO programme in Nigeria is the Open Educational Resources, an on-line depository of large number of educational resources at no cost. Other UNESCO programmes include the training and financing of secondary school students especially the girl child on science and technology programmes.
- (f) STEP –B in Nigeria. The Science and Technology Education at Post Basic (STEP-B) project was established with the aim of improving teaching and learning of science and technology in Post- Basic Education Institutions (Sofowora & Adekomi, 2012). It is in support of the call by Society for Information Technology and Teacher Education (SITE) to integrate technology into teaching and learning in the 21st century. The STEP- B was an initiative developed by the Federal Ministry of Education with the support of World Bank in conjunction with the International Development Agency (IDA). Other programmes and strategies for reforms abound and cannot be conclusively discussed in this paper.

Conclusion

Science and technology education is discovered as vital to Nigeria's quest for economic and industrial development. Science and technology education covers the teaching- learning procedures of critical thinking, analysis and collaboration of teachers and learners to incorporate the actions and ideas in the real world. Part of the expected and ultimate aims and goals of functional science and technology education policies, practices and strategies are the achievement of self-employment, skill acquisition and wealth creation in various enterprises. Attitude of open-mindedness, rationality, objectivity, intense curiosity, honesty, suspending judgment and critical mindedness are relevant for the development of science nature necessary for self- reliance and job creation (NOUN, 2020).

Recommendation

Advocacy for the popularization of the knowledge of science and technology must be intensified all over Nigeria, particularly at the rural areas. The need to equip rural schools with science facilities for effective teaching- learning of science and technology should be paramount on government's agenda. It is also important that necessary ICT infrastructure be installed in different communities to boost science and technology literacy. Training and retraining of teachers to handle these science and technology subjects are highly recommended. Re-orientation of the mindsets of science and technology education stakeholders and the populace particularly students and parents on the need to inculcate scientific and technological skills, processes and attitude in their daily socio- cultural lifestyle are strongly advocated. Conferences, seminars, workshops, symposia and use of social media communication facilities can be adopted to achieve this scientific and technological socialization. Intensive and result- oriented research, funding of programmes, inventions and mass production of invented products must be pursued by the different tiers of government. Use of outdoor laboratory, construction and equipping of modern power laboratories in schools are recommended. Science and technology teachers must strive to be innovative and be conversant with improvisation.

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