

Technological transformation and science education: Implication for Nigeria

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Abstract. This paper examined the importance of science education in technological transformation in Nigeria. The world today is being driven by technology. Consequently, Nigeria has over the years invested substantially to improve technological transformation but the result has not been impressive. The increasing complex nature of the society, and associated sophisticated technological products demand for a higher degree of scientific literacy. The aim of the study was to examine the role of science education in technological transformation for national development. The work adopted exploratory method. The findings show that science education is a veritable tool to enhance technological transformation and national development. In order to overcome the challenges of science and technology education, the paper recommends; national integrated strategy, increase in the budgetary allocation, enhancing creativity at school level and improved human capital development.

Keywords: science, education, technology, transformation.

INTRODUCTION

The new world order and the globalization agenda of the twenty first century are controlled by the revolution in science and technology (Omer 2011). This era of globalization has overcome geographical boundaries and expanded the horizon of man. Different countries of the world are steadily working hard to achieve a higher standard of living, to industrialize and catch-up with the developed nations in terms of growth in technology. There is therefore, the need that the citizenry possess scientific and technological skills to face the challenges of today's complex life. Nigeria as a nation is not left out in this struggle, since it is a known fact that the level of development in any human society has been directly dependent on the level of technology derived and applied in that society. Okah-Avae (2003), observed that technological applications could be in the form of shelter, devices for warfare, agriculture, communication, movement, transportation techniques and many more. Indeed, modern technology has attained such a level of efficiency and dominance that it has brought man to the state of total dependence.

Nigeria therefore has come to realize that the world as we have today is driven by technological transformation. As Uza (2013) rightly observed that science and technology bring about economic growth and sustainable social development of nations leading to industrialization. Consequently, many programs are being set up to pursue technological transformation which is generally regarded as a catalyst for national development. The transformation agenda of the present government is the major strategy planned to assist in the country's quest for development. Nevertheless, it is worthy to note that the technologically advanced countries of the world achieved their position of eminence by dint of hard work based on effective science education. There is therefore need for emphasis to be laid on the teaching and learning of science and technology in Nigeria.

Technology

UNESCO (1994) defines technology as the know-how and creative process that may utilize tools, resources and systems to solve problems, to enhance control over the natural and man-made environment in and endeavor to improve the human conditions. It is defined by Okah-Avac (2003) as the systematic study and development of techniques for making and doing. In a general term Olagunju (2014), describes technology as the process by which human beings make tools and machines to increase their control and understanding of the material environment and improve on standard of living. Technology can be said to be body of knowledge and devices by which man masters his environment. It is the scientific knowledge used in practical ways especially in the designing of new machines and equipment. In a narrow sense therefore it can be described as the practical application of science. Science is universal while technology is a human creation and therefore society centered. In other words, technology is basically indigenous. Consequently, the call for technology transfer by some developing countries has not yielded much fruits. Ali (2013) said that indigenous technology may be considered to be that technology that has local roots, serves local needs, solves local problems, easily acceptable and familiar to the local people from whom it is made. He stressed that such technology should be conceived, created, developed to be adopted by local experts and or through local skills and which comes about through the use of local raw materials and harnessing of local natural resources. This is why the level and quantity of foreign technology in Nigeria has been decried in many quarters. Evidence shows that some of the companies set up in Nigeria that are foreign technology based collapsed shortly after inception. Ajaokute steel mill is a case in point.

Historically, no nation has been known to have developed without technology. It is central to industrial development, economic viability, political stability and the resultant improved standard of living. Mastery of modern technology has been the hallmark of national transformation which Nigeria has realized in the recent times.

Technological transformation strides in Nigeria

Technological transformation entails a process of mobilizing resources and harmonious integration of modern and traditional technologies organized and fitted into feasible projects designed for specific purpose (Afolabi 2009). Osisioma (2012) viewed transformation as a fundamental shift in the deep orientation of a person, an organization or a society, such that the world is seen in new ways and new actions and results become possible that were impossible prior to the transformation. It is a mandate for a radial, structural and fundamental rearrangement and re-ordering of the building blocks of the nation. Against this background, every country of the world is striving to achieve a high level of transformation using modern technologies and Nigeria is not an exception.

However, Nigeria's developmental efforts have been over the years been plagued by lack of continuity, consistency and commitment to agreed policies, programs and projects as well as and absence of a long term perspective. This has resulted to poor improvement in the overall welfare of Nigerian citizens, high level of poverty and unemployment. She has realized the fact that sustained progress in reducing poverty and related problems will require strengthened institutions for science technology and innovation. The need for a holistic transformation of Nigeria has necessitated a strategy that will accord focus for development of the important sectors. Consequently, the federal government articulated a program which was tagged Transformation agenda 2011-2015 aimed at deepening the effects and to provide a sense of direction for the government. The agenda is based on a set of priority policies and programmes which when implemented will transform the Nigerian economy to meet the global standard and the future needs of the Nigeria people. The seven sectors identified as the main growth drivers during the transformation period 2011-2015 are agriculture, water resources, solid minerals, manufacturing, oil and gas, trade and commerce, culture and tourism.

Regrettably, after over four years of the policy reforms, Nigeria has remained a nation without effective industrial technological transformation. Performance in the sectors has been constrained by several factors including, low productivity, low level of private sector investment, inadequate funding, low investment in research, poor development of value chain and low value addition, poor quality of goods and services, poor state of physical infrastructure, policy instability and discontinuity, high cost of productivity, shortage of skilled manpower and low level of technological paucity which indicates that educational system in Nigeria is ill suited. Okonjo-Iweala (2012) for instance reported that productivity in Nigeria agricultural sector which contributes about 40 percent of the gross domestic product (GDP) and employs more than half of the workforce remains low. Yield per hectare is 20 to 50 percent of what is obtained in similar developing countries. There is lack of the right plant varieties, implements and storage system is not efficient. Yet global experience shows that with the right investment in science and technology education, output can rise quickly.

The fact that Nigeria has established many universities and other tertiary institutions that can form the basis for development of science and technology at different levels, to provide support for the take off and sustenance of technological transformation but much has not been achieved is indeed worrisome. Technological transformation is expected to solve unemployment among other things, but this is doubtful with unabated rise in unemployment in Nigeria. Modern society demands a workforce that can use technological information as a tool to increase knowledge, productivity and creativity. This can only be achieved in Nigeria through effective science and technological education.

The role of science education in technological transformation of Nigeria

Science education refers to the systematic study of everything that can be examined, tested and verified (Olagunju 2014). It is a process of teaching or training especially in school to improve one's knowledge about the environment and to develop one's skill of systematic inquiry. Science education gives people the knowledge as well as skills that help them to solve economic, political, and social and the numerous emerging issues in the environment. Some of these basic skills which science education inculcates in people include; observation, communication, measurement, experimentation, recording, controlling variables, prediction, questioning, relationships, understanding space and time, inference, analysis of data, formulating models and many more (Cirfat, Zumyil and Metshak 2007), (Ofonime 2007). In addition it accords important attitudes to the learner some of which includes; respect for opinions, critical thinking, skepticism, open-mindedness, love for truth and accuracy, team spirit, diligence. The overall goal of science education therefore is to get these necessary facts, processes, skills and attitudes into the students head in order to effectively prepare them for the industrialized economy of the present century. Specifically in Nigeria, National Policy on Education states the goals of science education to be;

- i. Cultivate inquiry, knowing and rational mind for the conduct of a good life and democracy.
- ii. Produce scientists for national development, technological development and
- iii. Provide knowledge and understanding of the complexity of the physical world, the forms and the conduct of life.

The policy indicates that the training of a citizenry capable of competing in an increasingly global society driven by science and technology has been a prominent goal of science education in Nigeria. The basis for achieving the set goals is effective science education. The role of science education in technological transformation has been long established. Hence the transformation agenda of the federal government on education is geared towards enhancing the efficacy, resourcefulness and competence of teachers and other educational personal through training capacity building and motivation.

Nevertheless, the level of achievement in education is still low in Nigeria. Ali (2013) observed that many African countries like Nigeria turn out science graduates that yet are scientifically illiterate. This indicates that more need to be done by stakeholders in education to harness the usefulness of science education in technological transformation. The level of technological transformation of any human society is directly depended on the level of science and technology education learned, derived and applied in that society (Mogbo 2002). The increasing complex nature of the society and associated sophisticated technological products demands for a higher degree of scientific literacy, if the society is to function effectively. Garuba, Agwede and Abumere (2012) observed that no nation could make meaningful progress in this information technology age, particularly in economic transformation without technology whose foundation is science. Scientific knowledge and skills can only be acquired through effective science education. Investing in human capital development therefore is critical to achieving national transformation. Human resource is the most important factor that constitutes to the success of any form of transformation, since it is the people that will put other resources to work, (Florida 2002 and Sawyer 2006).

The Nigerian government is aware of the role of science education in technological transformation and consequently has stipulated a ration of 60:40 in favour of science and technology related courses in the conventional universities, 80:20 in universities of technology and 70:30 in the polytechnics, (Ogunlaye1999). However, available statistics on students enrolment seems to show that these ratios are not obtained, rather more students enroll in the non-science courses in the different tertiary institutions in Nigeria. The nature of science and the resulting technological applications will become more meaningful in Nigeria when the required skilled scientists are turned out from schools.

Using science education to achieve technological transformation in some key areas in Nigeria

Technological transformation can only be achieved by scientifically skilled workforce which is a product of effective science education. The transformation agenda of achieving development in key areas of Nigeria cannot be attained without the relevant scientific and technical capacity to handle the challenges. Adikwu (2012) opined that for any nation to experience economic growth there must be a strong stimulation of science. This can only be achieved through effective science education. Science education equips the learner with knowledge and skills to perform noble tasks useful for improving socio-economic standard. It enables nations to explore opportunities for scientific and technological breakthrough. Appreciable progress therefore can only be achieved in the transformation agenda when the efforts of the government and individuals are marched with effective and relevant schooling. When that is done, science education can be used to achieve technological transformation in the following key areas which include;

Workforce

The science courses are designed to produce capable scientists who contribute meaningfully to academic excellence of the society to raise the economic level of the country. Knowledge and skills science gives, can promote responsible citizenry, a strong economy, healthier environment and a brighter future for Nigeria. Sawyer (2006) observed that many countries have witnessed a rapid transformation from an industrial to a knowledge economy. Knowledge economy is based on the production and distribution of knowledge and information, rather than the production and distribution of things, Human resource has been established to be the most important factor that brings about success of any form of transformation (Florida 2002). The skills that science provides can produce a generation of individuals who are better prepared for any career and can make greater contributions to technological transformation of the nation. For instance, students who have learned to think critically and have a good dose of skepticism can make better informed decisions, which can lead to effective workforce and on the long run bring about transformation of the country.

Research and industrialization

Studies have proved that science and technology is an important condition for advancement which engenders industrialization and civilization (Olagunju 2014). Industrialization which is the result of technological transformation is the direct application of scientific knowledge and skills. Innovative teaching strategies such as inquiry, discovery, project and many more if well articulated and enabled by the teacher would expose the students to the world of research and discoveries. In addition the scientific skills and attitudes of ingenuity, love for accuracy and truth, open mindedness, curiosity, reporting, experimentation, empirical studies, collaboration and many more that science provides can promote creativity in the learner and produce a generation of young and skilled scientists who would form a good formulation for industrial take off and national transformation. Partnership between the public and schools in areas of research, resource persons and utilization of resources would go a long way in boosting technological transformation in Nigeria.

Agriculture

Teaching agricultural science in schools is not enough to bring about the desired change. The school and in particular the teachers should provide conducive environment, proper human and material resources for practical lessons, practical lessons on animal and plant lives, soil and farm implements is a good way of preparing the foundation to boost food production in the country. The present programme of retraining and motivating young graduates to embrace farming shows

that there is a gap between school experiences and everyday life in Nigeria. Interest after all is not built over night but something that grows over a period and better if it is nurtured early in life. Scientific skills and knowledge gained in the school and applied afterwards in real life can lead to technological change and modernization in agriculture in the following

aspects; crop production, storage and preservation, food processing, crop yield and resistance to pests and diseases, maturity time and tolerance to adverse climate. In Nigeria today, the yield of crops have increased to some extent by the use of improved hybrid varieties in such crops as maize, rice, groundnut, cotton, cassava, guinea corn and millet. The progress achieved through the efforts of the ministry of agriculture is as a result of scientific research and applications.

Water resources/solid minerals/oil and gas

Teaching science as inquiry brings the students to the world of exploration and discovery while in school. Linking science learning in schools to everyday life is a good approach to nurture science literacy and a powerful technological transformation of the country. Teaching science subjects such as geography, biology, physics, chemistry, using innovative methods would enable the students to internalize concepts and skills, then application in real life would be much easier. The emphasis is on the need for a shift from the age longed traditional rote learning to inquiry and discovery methods. A strong foundation in science subjects at the primary and secondary levels of education will motivate many more candidates to enroll for science-based courses in the tertiary institutions. The teacher therefore has an indispensable role to play in the attainment of the goals of education in Nigeria. The demand therefore is on science education that will produce reliant scientists and engineers that will harness the natural resources to generate the much needed energy for technological transformation.

Trade/commerce and tourism

Developing countries cannot hope to prosper in an increasingly competitive global economy and open trading system if they do not build the appropriate science and technology capacity to produce more value added good and services,(Okonjo-Iweala 2012). Mathematics, statistics, computer and other allied science subjects taught in the school provide important skills such as measurement, calculation, data collection and analysis, reporting, prediction and many more. Acquisition of these skills prepares students for revolutionary changes in the areas of stock exchange, banking sector, international trade and insurance. Similarly effective training on the ecology of plants, animals and their management, climatic factors and changes will bring positive changes in the tourism sector.

Science education is a sure way to technological transformation. Consequently the key to energizing the entire production systems in Nigeria is consensus on content standard for the teaching and learning of science. The teacher therefore has

very important role to play in making science education work effectively. The job of the teacher is to transmit scientific facts, skills and procedures to the students. He should therefore emphasize the importance of creativity, innovation and ingenuity. When students learn how to use the scientific and technological knowledge transmitted in the classroom in real world social and practical settings, technological transformation will be granted in Nigeria.

Nevertheless, in Nigeria the dividends of science education are yet to be pronounced despite all efforts being made by the government and relevant agencies. The rate of unemployment of science graduates in Nigeria is worrisome. The indication is that science education has failed to produce skilled human capital and creative professionals needed for technological transformation.

Major challenges of science education in Nigeria

Nigeria is making some contributions to the development of science and technology, but is still underperforming relative to the abundant human capital. (Okonjo-Iweala 2012). Education which is the bedrock of economic, technological and scientific development of a nation is facing many challenges in Nigeria. The system has deteriorated to a point where students cannot acquire the necessary skills they need to become employable or innovative in an ever-changing world, upon graduation. The situation where most graduates are retrained to be gainful in the labor market shows that all is not well with the current system of education in Nigeria. The myriads of problems militating against science education in particular can be grouped into three areas namely; students, teacher/school and government/infrastructural factors.

Students' factors

The learner has an important part to play in teaching and learning process. In Nigeria, there is poor academic performance of secondary school students in mathematics and science especially in external examinations. Reports by the West African Examination Council Chief examiner (2012-2014) showed that students' performance have dropped from 38% in 2012 to 36% in 2013 and 32% in 2014. This alarming rate of students' failure in science and mathematics is of great concern to all stakeholders and it paints a bleak picture of the development of science and technology. The poor performance of students in examinations has been attributed to a number of factors which include: students' interest (Cletus and James 2001), socio economic factors (Olaleye 2003), lack of commitment to science (Ogunleye and Babajide 2011), teachers factor (Anchor and Eriba 2010) and poor instructional facilities (Adeboye 2003). Similarly, a major defect in Nigeria education system is the disconnectedness between classroom learning and students' real-life experiences. This problem may be attributed to a large extent to the existence of generation gap. Today there are cultural, psychological and social gaps between teachers and

students that most teachers may find it difficult to implement the current curriculum effectively.

School/teacher factors

At the classroom level, the teacher determines the fate of science curriculum. Ineffective teacher therefore can mess up a good science curriculum. Presently, most of the science teachers are not highly trained in modern scientific and technological facts, principles and equipment, the result is that many of today's schools are not teaching the deep knowledge that underlines innovative activity. Educational graduates need deep conceptual understanding of the complex concepts and the ability to work with them creatively to generate new ideas, new products, new theories and knowledge. The shortage of qualified manpower has remained a major setback to Nigeria's technological breakthrough. The cumulative effect according to Afolabi 2009 and Ali 2013) is the graduation of 'half-baked' scientists and technicians that know little or nothing as regards the practical application of knowledge. It is sad to note that today most of these young graduates find themselves in the classroom teaching under the National Youth Service Corps Scheme.

The problem of teaching and learning of science in Nigeria is also compounded as a result of teachers' lack of interest and commitment to teaching. 98% of the 200 education students interviewed by the writer said that they found themselves studying education courses against their wishes. This implies that most of these student teachers on graduation will not show enough interest and commitment in their work. In addition, some teachers lack or do not apply the necessary skills and effective methods for teaching science. The traditional instructional methods such as lecturing or rote learning reduce students as passive listeners and make learning difficult (Kumar and Altschuedl, 2000). Methodology of teaching is what makes a teacher a professional.

Government/infrastructural factors

The success of any education depends largely on funding; in Nigeria there is inadequate funding of education and this militate against the provision of quality science teaching and learning (Obi and Obi 2014). UNESCO has recognized science education as the key to achieving millennium goals (MDGS) and therefore declared that the percentage of a nation's annual budget for education should be 26%, but Nigeria budgets only about 3% compared to other developing countries like Ghana that has 16% annual budget for education (Ikokwu-Ibe 2012). The variation in budget for science in different states of the federation and between private and government owned schools creates unequal opportunity for Nigerian children to science and technology education. It is a fact that government at all levels in Nigeria have not given science and technology education the necessary attention it deserves in terms of investment in providing adequate finance, infrastructure, training and

retraining of personnel. Inadequate infrastructure in the Nigeria schools is another area that poses hindrance to learning and research work. A good number of Nigeria secondary and tertiary institutions offer technological based programmes without some basic resources and in some cases, the teachers fail to improvise (Adelemo 2001). Nnorom and Obi (2013) reported that ill equipped workshops and laboratories exist in most secondary schools due to shortfall in funding education. Even when they are present in the schools, some may not be functional. Moreover, many school facilities often suffer from maintenance neglect leading to deterioration, increased production costs and reduction in product quality and quantity. Some schools lack enough classrooms and adequate libraries. The case of Anambra state in the South East of Nigeria should serve as a pointer. The state Government within the last three years embarked on upgrading and equipping the laboratories in all the secondary schools in the state and two years after the exercise, the state came top in both WASSE (West African Senior Secondary Examination) and in the National Examination Council (NECO).

One factor that has kept science and technology education at a low level in Nigeria and other developing countries is lack of advanced research laboratories and centers. Despite the importance of research in the world economy based on the relevance of knowledge and constant technological change, budgetary constraints and cost of research, have resulted in few research centres and low research work in Nigeria. Okonjo-Iweala (2012) reported that the productivity growth of Nigeria's scientific research is the second lowest (12%) of the 19 African countries surveyed in 2010 by The Partnership for African's Development. There is also lack of synergy and harmonization among the research centers and between tertiary institutions and the public for utilization of research findings.

Security and political issues in Nigeria have been worrisome for more than four years now (Kola 2013). The recent attack on a university in the Northern part where students and lecturers were murdered in cold blood including a professor of chemistry still remains fresh and terrifying among Nigerians. Scientific infrastructures built with huge amount of money for schools in the North Eastern zone have been destroyed and oil installations vandalized through series of bombing. Schools were closed down in many parts of the area. Learning environment is no longer safe. Some students in the affected zone could not complete their education. Some of these school dropouts might be brilliant children who would have become successful scientists Nigeria needs for technological transformations.

Conclusion

The development of any nation depends on its level of scientific literacy. Developing countries like Nigeria therefore cannot hope to prosper in an increasingly competitive global economy and open trading system if they do not build the required science and technology capacity to produce more value added goods and services. It has been established that science and technology education is a veritable tool to technological transformation, improving the quality of science and

technology education therefore should not be compromised. Implementation of Transformation agenda cannot be possible without scientific knowledge. There is need for the stakeholders in education to strengthen the teaching and learning of science at all levels in schools. All is not yet lost in Nigeria's quest of using science and technology for national transformation. When students learn how to use the scientific and technological knowledge transmitted in the classroom in real world, social and practical settings technological transformation will be granted in Nigeria.

Recommendation

- i. The most compelling way to move science and technology forward in Nigeria is to ensure availability of the required resources such as manpower, tools, equipment, specimens, chemical etc and judicious management. The government should not only provide the necessary fund but carry out thorough supervision on the procurement and distribution of these instructional resources. The school should in addition imbibe maintenance culture.
- ii. The government should strengthen primary and secondary education to check the alarming rate of students' failure in science and mathematics by establishing National science and technology foundation to coordinate the teaching and learning of science in schools.
- iii. Stakeholders in education should provide adequate training to teachers to enable them deliver meaningful science and technology instructions. Tertiary education trust fund (TETFUND) programme is achieving a lot already but the focus should be on giving specialized training for teachers geared towards their special needs. At the school level, the proprietors and administrators should organize regular retraining programmes to help teachers meet up with the current knowledge and teaching strategies.
- iv. There should be synergy and harmonization among research institutes. Establishing effective partnership among the private and public sectors, research institutes and tertiary institutions in research and utilization of resources and findings would help to boost production and economic growth in Nigeria. In addition, scientific research should be focused on the areas where there is comparative advantage like petrochemical and agriculture.
- v. Reviewing university curricula to align with industry job requirement is imperative in Nigeria. This will help to reduce unemployment and the huge amount of money used in retraining programmes of young graduates.

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