

ENHANCING INDUSTRIALIZATION THROUGH BIOLOGICAL SCIENCE AND TECHNOLOGY (BST) EDUCATION

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ABSTRACT

Biological Science and Technology Education provides students the opportunity to acquire the relevant knowledge, skills and competences needed for industrialization and survival in this present scientific and technological age. Innovative methods of teaching which involve practical activities to engage students while learning are imperative for students' development to enhance industrialization. The paper considered "Enhancing Industrialization through Biological Science and Technology Education (BSTE)". It highlighted the need for education and discussed these concepts: Science, Technology, and Industrialization. It discussed BST Education and factors militating against it in Nigeria. Various sectors of the economy that rely on science and technology were discussed, scientific and technological discoveries were analyzed. The role of "BST Education for Industrialization" were also explained. Recommendations on how to improve BST Education because of its vital role in industrialization were made which include the following: the need to; modernize the methods of teaching BSTE to bring life back into science, increasing the budgetary allocation to education, streamlining and stabilizing the funding of schools, establishing research infrastructures in all tertiary institutions among others. The paper concluded that B ST Education is the driving force of industrialization and new advances in technology make mass production possible. Therefore, more attention should be given to BST Education.

Keywords: Biological Science, Technology, education, industrialization.

INTRODUCTION

Education is the process of providing information to an inexperienced person to help him develop physically, mentally, socially, politically and economically. It is a process through which individuals are made functional members of the society (Ocho, 2005). Education is a process through which the young acquires knowledge, skills and realizes his potentialities and uses them for self actualization to be useful to himself, others and the society at large. It is a veritable instrument for human capital development. Education provides the required labour force for the development of the society. A functional education promotes the progress of the society. And to provide a functional education, the school programmes must be relevant, practical and comprehensive. One of such functional education is the biological science and technology (BST) education. The programmes are comprehensive, practical and relevant to the society especially in this era of economic depression when every nation is striving for economic transformation and sustainable development. Science in its general view is the tool with which man learns about his environment, its resources and problems and how to control and utilize them both productively and sustainably (Ukpai, Gabriel, Okechukwu and Ugama 2016). Biological science is a natural science that focuses on the study of life. It is one of the core science subjects taught in senior secondary schools in Nigeria.

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Biology is a combination of both real and abstracts concepts and involves a lot of drawings and practical topics hence students often find it difficult to understand. As a science subject, biology teaching should focus on the mastery and development of scientific knowledge, skills and attitudes in students. Ukpai and Awoke (2013) asserted that biology if well taught to students, provides opportunities and activities to develop and make students better citizens capable of contributing to industrialization and national development. BST Education is the sure way or a means to a scientific and technological greatness of African nations and Nigeria in particular. Competence in and a quality science and technology education is the foundation of industrialization and economic transformation of developing countries. BST Education constitutes the bedrock for prosperity and advancement of any nation. As a result, any nation which does not give priority to the type of science taught in her schools is risking the future of the youngstars and national development. Daramola in Ajere, Evle and Langkuk (2002), pointed out that today our young graduates who are not properly equipped with the rudiments of contemporary science will grow up tomorrow only to discover that the haphazard and incomplete knowledge of science and technology given to them in school is not sufficient to understand the sophisticated operations of advanced science and technology. Considering all the efforts made to reform science curriculum since after independence in Nigeria at various levels of education to meet the needs and aspirations of the nation especially in areas like industrialization and sustainable development, one would still agree with Akpan (2008) that Nigeria has no problem with her science and technology education programmes. One of Nigeria's major problem is that of implementation of polices and strategies especially in area of education delivery. Akpan (2008) noted that science and technology education in Nigeria is mostly affected by poor implementation procedures and use of archaic teaching methods. And this has a resultant effect on students' performance in science and technology courses (Ukpai 2012). Studies have shown that there is an increasing enrolment in SSCE biology yearly, but each year candidates perform poorly in the examination (Okoye patience 2013). Okoye stressed that one of the contributing factors to this students' poor performance among others is the poor teaching methods adopted by most S&T teachers and failure of most S&T teachers to teach the practical aspects of the subjects. Studies revealed the poor state in which science and technology are taught in our schools. Ajere, Evle and Langkuk (2002), Nwagbo (2008), Akpan (2008), Hassan (2010), Yursuf (2010) and Jongar (2009), all stressed that poor methods of teaching S &T is one of the major problems in S& T education and consequently, students perform poorly in those subjects. . Practical classes constitute an integral part of biology science and technology therefore, should go hand in hand with the theory classes (Nwakonobi and Okoye 2010). Uzoechi (2009) stressed that many S&T teachers lack the competence, skills and creativity to organize practical classes hence, they simply avoid practical classes. That is why Okoli (2011) opined that S&T teachers should as a matter of urgency make a paradigm shift from being instructors, expositors, fact givers and verifiers to become facilitators, stimulators and incorporating practical activities into biological science and technology lessons. This is imperative if the students must acquire the relevant scientific knowledge, skills and competencies needed for industrialization and be able to survive in this present scientific and technological age. This study upheld the use of innovative methods that are practical, activity- based and students- oriented which will improve the quality of students and professional expertise to enhance industrialization.

METHODOLOGY

Analysis of biological science and technology, the various sectors of the economy that rely on science and technology, scientific discovers and industrialization.

SCIENCE AND TECHNOLOGY

Technology is all about using science to do work. UNESCO in (Ekpa 2002) rightly defined 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 an endeavour to improve the human condition. Technology according to Robert 1975 in Olarinoye (2009) is “the totality of the means employed by people to provide material objects for human sustenance and comfort. Thus, it is the act of doing something with our physical and material environment. In science, man endeavour to understand his physical environment but in technology, he is concerned with controlling this environment (Olarinoye 2009). Science is knowledge and technology is doing something with one’s physical environment and to control it. Hence, science and technology are not one and the same. Science and technology compliment or reinforce each other by way of complex, two –way interactions, Olarinoye (2009) affirms that each one, science and technology can build upon itself or upon a cross linkage from either one to the other. Olarinoye further stressed that technology is dependent upon science for knowledge of the properties of materials and of sources and properties of energy, for predicting the behaviour of natural forces and for opening up new field of technology. While Science on the other hand is dependent upon technology for its tools and instruments, for the preparation of materials, for the storage and dissemination of information and for the stimulation of further research. Technology is simply applied science. Technology is much more older than science. Right from the ancient days, Technology has been production oriented, men have been involved in different productions like pottery-making, weaving and casting metals, these early technology are not based on scientific knowledge. It was about the period between 1500 and 1700 A.D that the first effort to apply science to technology started and since then, men have become active in applying science to technology. Technology would have or suppose to have become almost completely science based but it is not so especially in developing countries of the world. For instance in Nigeria, technology is still partly in the hands of local people who have no idea of science or its application. Most of them are rather illiterates and they do their productions basically on natural talents and/or inheritance. Although there is an improvement today but much is yet to be done. The need for industrial, technological and economic transformation in the West African sub-region is so essential if we are to be counted among the member countries that made – up the sub-region. This is why Ogwo (2006) pointed out that globally there is evidence of strong relationship between the technological right of a country and its economic potentials such that most economically advanced countries are those that possess high technological capabilities Akpan (2008) citing economic commission for Africa (ECA) stated that there is a strong link between science and technology and economic development. The strength of a country’s science and technology (S &T) is a function of the quality of her education. Science and Technology have therefore become crucial factors for sustainable development worldwide. S&T education has divided countries of the world into three Viz –“Underdeveloped”, “developing” and “developed” economies. The various sectors of the economy characterized by their strong reliance on science and technology are:

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|------------------------------|--------------------------------|-------------------------|
| ● Agriculture | ● Health | ● Industry and Commerce |
| ● Energy | ● Information Technology | ● Environment |
| ● Defence and Security | ● Minerals and Mining | ● Water Resources |
| ● Transportation Development | ● Population and Demography | ● Urban & Regional |
| ● Land | ● Housing | |
| ● Communications | ● Space Science and Technology | |

Enhancing Industrialization through Biological Science and Technology (BST) Education

Biological Science Technology Education (BSTE)

Biological Science and Technology (BST) Education is a means to facilitate the production of goods and services for human sustenance and comfort. This involves the learning and teaching of the knowledge and skills needed in these productions. The teacher here is to impact in the learners the knowledge and skills involved in these productions through teaching, disseminating information through public lectures, publications and research among others. Formal S&T education is provided in schools, colleges, polytechnics and universities. A lot of reforms have been going on in Nigeria curriculum especially as it concerns S&T education since after independence when Nigeria began to recognize science and technology as a means of national development. Much emphasis are laid on science and technology teachings in schools in order to develop the students so that they can fit in industries and labour market when they graduate from school and as such be able to contribute their quota in the development of the country. This led to the introduction of 6-3-3-4 system of education with the aim of producing needed manpower in different sectors of the economy.

In the primary school level, the learners are taught basic science and technology. In JSS they are taught basic science and basic technology which serve as the foundation upon which further science and technology education are based. In addition to basic technology which touches on aspects of woodwork, metalwork, Elementary technology of common appliances, Applied electricity, Basic electronics, Technical drawing, Plastics, Ceramics and building; Agriculture, Home economics and Business studies are available to complete the range of pre-vocational subjects. At the senior secondary school level, Home Economics is spited into Home management, Food and nutrition, Clothing and textiles. Business studies is equally spited into its component parts of Book keeping, Office practice, Commerce, Typewriting and shorthand. Ivowi (1999) stressed that in all cases, the main objectives are to:

- a. Provide pre-vocational orientation for further training in technology
- b. Provide basic technological literacy for everyday living and
- c. Stimulate creativity.

It is for these reasons that the technological courses at the secondary school level are to be practically oriented and comprehensive. Technology education is also available at the technical colleges and commercial secondary schools, and craft skills development is the main objective.

At the tertiary level, the colleges of technology, polytechnics, universities of technology and the conventional universities offer a variety of training in the field of technology. While the conventional universities offer courses in science and technology, the universities of technology place emphasis on technological development. The colleges of technology on the other hand have a specific purpose of training technological manpower for construction, production and maintenance services of our economy.

Provision for S&T Education

The inclusion of science and technology at both primary and secondary education in the national policy on Education (FRN, 2014) is intended to provide quality education in youths. This age of science and technology demands appropriate teaching and learning of these subjects in the school system. During the early years of formal education, children are expected to learn the processes of science and relate these to their everyday activities and to their immediate environment. Manipulative skills and logical thinking are to be developed in the learners through observations and concrete operations (Ivowi 1999). To ensure these, the policy and programmes provide that for primary education:

- ♣ Each child should be taught basic science, technology and mathematics. Science shall be taught as a process skill.
- ♣ Mathematics shall be taught as functional subject.
- ♣ Both science, technology and mathematics are to be related to the child's environment. *A major policy objective of primary education is to lay a sound basis for scientific and reflective thinking (FRN 1989.8).*

In secondary level, the broad aims of S&T education are:

- ♣ Preparation for useful living within the society and
 - ♣ Preparation for higher education.
- A policy objective of the NPE at this level is to equip students to live effectively in our modern age of science and technology. To this end, it is expected that:*
- ◆ Basic science, basic technology shall be taught to every child at the JSS level.
 - ◆ Mathematics and a science subject shall be studied by every child at the SSS level.
 - ◆ Students should be equipped to live effectively in our modern age of science and technology.
 - ◆ The content of S&T education at the SSS level shall be a level higher than present GCE "O" level but lower than GCE "A" level.
 - ◆ Local production of science equipment and the practice of improvisation shall be vigorously pursued.

In order to ensure success, government has indicated its desire to:

- ◆ Provide adequate materials and manpower for S&T Education.
- ◆ Introduce science and technology and provide laboratories and increase the supply of teachers of these subjects.
- ◆ Encourage teaching methods that de-emphasize memorization of facts and emphasize practical exploration and experiential approaches.
- ◆ Provide funds for libraries, equipment and suitable textbooks for use in schools.
- ◆ Work out and validate continuous assessment. (But all these are not adequately done in the country even till date). In line with these, the curricula for S&T subjects at the SSS have been organized to be activity based and functional and to encourage the development of the child in the three domains of educational objectives. The teaching methods advocated are practical and activity – based methods which will incorporate other teaching strategies. This will bring reinforcement of Sa&T subjects.(But proper supervision of these is lacking in schools).

Problems of BST Education

Looking at the curriculum contents of the S&T education for all levels in the country, it would appear to indicate some adequate provisions for our needs. Over dependence on crude oil, changes in leadership, boko haram, herdsmen and kidnapping activities, covid-19 pandemic among other problems have constituted a setback to education in the country. Other major problems of implementation of these provisions are:

- ❖ Lack of laboratory equipment and materials
- ❖ Lack of motivated and experienced/skilled teachers
- ❖ Poor enabling environment
- ❖ Laziness among the learners and their negative attitude to science
- ❖ Insufficient infrastructural provisions
- ❖ Societal problems
- ❖ Problems involving semantics
 - ❖ Examination malpractices
 - ❖ Non-compliance in information and communication Technology (ICT).

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Today, ICT has become the driver of knowledge and it is much needed in the competitive market economy therefore there is need to inculcate this skill to the learners. However, it is unfortunate that most of the teachers who should be custodians of the skills do not have them. This is a very big gap in education for industrialization.

Industrialization

Industrialization is when a country or a place develops a lot of industries. It is the process of being industrialized. It is a sustained economic development based on factory production, and division of labour (Jin 2019). It is the process by which an economy is transformed from primarily agricultural to one based on the manufacturing of goods and services. Industries are the areas of human activities where material objects and machines are produced and may or may not be marketed directly or without dealers. Industrialization has to do with the development of industries whereby technological products are produced, that is, whereby many material objects for human sustenance and comfort are produced (Olarinoye 2009). In industrialization, individual manual labour is often replaced by mechanized mass production and craftsmen are replaced by assembly lines. Industrialization brings economic growth, more efficient division of labour and the use of technological innovation to solve problems as opposed to dependency on conditions outside human control. It is usually associated with increases in total income and living standards in a society. Industrialization therefore, makes a country to be self sufficient in terms of needed materials for her peoples' sustenance and comfort. Such a country does not have to depend on other countries for her material needs. For instance, one cannot say that Nigeria is a fully industrialized nation since most of her material needs are still imported. This is because her colonial masters did not pay attention to S&T education which is the power house of industrialization and it is a big set back to the country. But one expects that since independence in 1960, Nigeria has had an ample opportunity to industrialize, yet, the country is still far behind as a result of poor priorities and poor implementation of policies and strategies as earlier said.

Scientific and Technological Discoveries and their Impact in our Lives

The knowledge, understanding and skills gained through S&T education has a lot to do in the life of an individual, the family and society at large. It helps us in our everyday work at home, work place and industries. It serves as the driving force of industrialization. A new advance in technology has made mass production in industries possible. New invention of machines and technology enable scientific discoveries to take place and their impacts upon our lives cannot be over emphasized. Some of the scientific discoveries include:

- ▶ The lightning conductor invented by Benjamin Franklin of America through experimentation. The lightning conductor is very useful in preventing the devastating effects of thunderstorm.
- ▶ The invention of X-ray machines by Roentgen in 1892 during his experiments. When he found the rays, he named it X-rays because the rays were unknown, X standing for the unknown. X-rays are found useful in medicine, art museums, history museums etc.
- ▶ The technological discovery of opera telescope used by Galileo Galileo to prove that the sun was the centre of the universe. Galileo discovered it through scientific method. The telescope today is an instrument of navigation and research.
- ▶ The discovery of electron microscope by Albert Grewe at university of Chicago's Enrico Fermi Institute in 1970. It is useful in a wide variety of further researches in pure sciences.
- ▶ The synthesis of oxygen by Joseph Priestley. The importance of oxygen in our day-to-day existence is not questionable. It is also useful in medicine. Hydrogen was also discovered and the proofs of the composition of water were made by Henry Cavendish, a chemist.
- ▶ The discovery of electronic work which has resulted in technological development of radios, electronics, satellite gadgets, all forms of electronic players are based on scientific inventions started by Fleming in 1904. Others continued from where he stopped to the manufacturing of integrated circuits in aero-industries.

- ▶ The discovery of electromagnetic waves by scientists like Oersted, Ampere, Henry, Lenz, Maxwell, Faraday etc. Electromagnetic waves are useful in communication, particularly telecommunication or long distance communication. They are carriers of messages involved in transmission and reception through radios, televisions and GSMs.
- ▶ The discovery of Biotechnology which is a body of techniques which employ organisms, or parts of organisms to generate or modify products, improve plants and animals or to develop micro-organisms for specific applications, usually with a view to enhancing production and the use of goods and services for the benefit of mankind.

Today, advanced technology and machinery have made it easier to secure productivity and performance in work place. It also helps in farming and travel. Akpan (2008) asserted that S&T education program will rescue the nation in the area of food security through the utilization of transgenic crop technology for increased agricultural productivity, better nutrition and improved crop resistance to pests and drought. That is biotechnology, if it is properly harnessed, it has the potential of increasing our food production, enhance the quality of food, guaranteeing cleaner environment and improve medicine, etc. All these science based technological developments have been listed in order to appreciate what S&T is and what it can help to achieve especially in industries. They are so many but time and space cannot be enough to mention them and their impacts on our lives.

Role of BST Education in Industrialization

Biological Science and Technology (BST) Education is essential for industrialization and industrialization is essential for economic transformation. Jim (2019) stressed that since industrial revelation, countries which merely rely on Agriculture, crude oil etc. have remained under developed, where as nations which develop industries achieve high rates of development. The relationships among economic growth, employment and poverty reduction are complex. Early industries occurred in Europe and North America during 18th and 19th centuries and later in other parts of the world. These countries that become industrialized early are called developed countries today as a result of the impacts of the industries on them. Hence, no nation can go far in development without industrialization. For instance Nigeria, we rely so much on crude oil and neglect the establishment of industries and even agriculture. Now, crude oil is failing and the country's economy is a stake. That calls for a serious rethink and paying more attention to BST education which is the bedrock of industrialization and economic transformation. In BST education, our major needs are in the areas of food production and preservation, health and nutrition, production and maintenance of goods and services. Hence, BST if properly taught in schools, will:

- **Produce highly, qualified/skilled human resources.**
Qualified/skilled technologists, health personnel, engineers, educationists, industry workers etc will be produced. Good and quality education prepares people for employment into the various fields of endeavour.
- **Provide machineries.**
Sophisticated machines for industries will be provided, tractors, threshers, planters, spray, harvesters will be produced to improve the agric sector. Technology improves mass production and preservation of food. Through biotechnology quality food is produced to serve the ever increasing population and reduce hunger and starvation.
- **Improve quality of life of citizens** People will be employed and worker's income will increase, this will improve the living standard of people and poverty will drastically reduce.
- **Generate new employment opportunities.**
ICT and biotechnology are some of the fastest growing industries; it is directly creating millions of jobs thereby reducing the problems of unemployment across the globe.

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➤ **Emergence of new services and industries**

Numerous of public services have become available online through mobile phones. Research shows that facebook apps alone created over 182, 000 jobs in 2011 and that the aggregate value of the facebook apps economy exceeds \$ 12 billion.

➤ **Transformation of workforce**

Some companies like Amazon, Desk and Sam have developed new “micro work” platforms which help to divided tasks into small components that can then be outsourced to contract workers.

➤ **Provides business innovations.**

Presently a lot of businesses are done online. The internet provides new ways of reaching out to customers and competing for market share. Over the past few years, social media has established itself as a powerful marketing tool. ICT tools employed within companies help to streamline business processes and improve efficacy. The unprecedented explosion of connected devices throughout the world has created new ways for business men to serve their customers.

➤ **Sustain the growth of national economy.**

Export services and revenues of the government will increase through income taxes, sales and excise duties thereby increasing the national income of the country.

➤ **Increase mass production of goods.**

Due to technology, mass production and improved quality of products are made possible. Mass production makes materials readily available in the society.

➤ **Improves the health condition of citizens.**

Apart from producing qualified health workers as earlier said, there will be rapid production of drugs, vaccines and equipment/facilities for cure, prevention and disease control, educate people on nutrition and good hygiene to maintain good health. Improve family health and prevent population explosion through good education.

RECOMMENDATIONS

- Government should increase the budgetary allocation to Education, streamline and stabilize the funding of schools, and establish research infrastructures in all tertiary institutions.
- Heavy machines are required in the training workshops. Government should fund all secondary schools properly to make them comprehensive in accordance with the National Policy on Education.
- Federal government in particular should concentrate on funding and publicizing S&T education by encouraging the study of all areas of S&T education.
- Since real production workers in industries do not require too much academic work before they can do their job (those who may need more academic work are the technical/planning workers). Nigerian government should fully bring back and support technical and vocational education as was practiced in the past.
- Applied science students’ final year projects in the various areas of S&T should be developed into final products for large scale industrial usage. This can be done by Nigerian government, NGOS or wealthy individuals.
- Government should encourage and support research in basic and applied science by scientists because this is where the needed knowledge, skills and technical know how come from.
- Government, NGO’s, wealthy individuals should support young S&T graduates in form of loan or partnership to start doing something on their own since building, machines, tools and equipment needed involve huge capital.
- Teachers of the various S&T education subjects should be produced for all levels of Nigerian school system and be well catered for. Teachers should modernize the methods of teaching **S&T** to bring life back into science.

CONCLUSION

BST education would not produce industrialization per se but would facilitate it. Students would have undergone all the nitty-gritty of industrialization by the time they graduate. Though all the students so produced would not be involved in production and sales business which are components of industrialization. Some may prefer to be teachers/educators etc, those who opt for industrialization in their various fields cannot do it all alone because of heavy expenses involved. We all know that industry involves a large –scale production, heavy machines, sophisticated tools and equipment are needed. S&T education is capital intensive at secondary and higher levels of education. Our governments should come to the aid of the institutions and graduating students in order to produce materials in large scale for sales and for exports. This way, industries will grow rapidly; there will be economic transformation and sustainable development.

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