

IMPACT OF SCIENCE AND TECHNOLOGY ON DEVELOPING NATIONS

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ABSTRACT

The paper discusses the impact of Science and Technology (S&T) on developing nations. The meaning of science and technology is surveyed from different perspectives. The Nature of science is also highlighted in the light of Science and Technology processes, skills, attitudes, methods and products and their impact on society. It is advocated that a scientifically and technologically literate society would harness these processes, attitudes, products and impact of S&T to transform any given society and ease human suffering. Some specific areas of the positive impact of S&T are discussed. The negative impact of S&T such as the problem of environmental pollution, unemployment and loss of job to machines, moral and ethical issues, accidents and increasing threats to world peace and security among others are also examined. Some areas of conflict between science, technology and society such as human cloning were also reviewed. Things to be done by developing nations to get out of the problem of infrastructural deficiency and low industrialization status bedeviling them are highlighted.

Key words: *Impact, Science and Technology and Developing Nation*

Introduction

Science and technology are closely related as both play critical and vital role in the society. Science and technology can be perceived as the bedrock of modern world and cannot be separated, though they differ in their products/ outcomes, purposes, processes and scope. In order to understand and appreciate the differences between science and technology, one has to understand the basic underlying concepts upon which they are based and are evolved.

Scientists in a Laboratory (e.g Chemists) discover useful chemical reactions that benefit the society. At this stage, Chemical Engineers are called in to put the scientific discovery into production on an industrial scale. Every technology is based on specific scientific principle arranged or organized into easy applied form. Once scientific research is completed, people and companies study the science findings and use them to make a product that they believe is marketable. For a refrigerator to be produced, for instance, the science behind refrigerants must be utilized or harnessed. Science of refrigerants has to do with the chemical compounds that are alternately compressed and condensed into liquid and then permitted to expand into a vapour or gas as they are pumped through the mechanical refrigeration system to cycle round it.

Meaning of Science

Science can be defined either from the product perspective or from the process perspective. It can be viewed as both a process and a product of knowledge in the study of natural environment. Science is described by Asim (2017) as the study of nature and the natural environment made up

of living and non-living components. Science as defined by Chattopadhyay (2015) is theoretical facts that naturally exist. Emovon in Otuka and Uzoechi (2014) viewed science as a body of knowledge that is acquired through observation and systematic experimentation. The systematic body of knowledge and concepts deal with cause and effects relationship. Science is seen by some authors as more of the nature surrounding and developing laws, principles and theories particularly on how nature world use simple or not simple mathematical equations that help in predicting the future of system. Technology is the application of these equations and laws to help human beings live their lives with greater ease. Science, according to Choubey in Chattopadhyay (2015), refers to the development of some hypotheses. The hypotheses are conducted under controlled experimentation, then observations and findings are analyzed, results are drawn leading the experiment to some conclusions.

Meaning of Technology

Technology on the other hand is the practical application of scientific knowledge or scientific findings to make and maintain devices which ease human efforts. Technology as an applied science is the practical aspect of science. Technology is related with designing and developing a solution that solves a problem and may lead to the creation of a product, process or environment that is implemented in real life. Technology, as affirmed by NISTEP (2016) is a label that is given to sets of things built by humans. For instance, products of Computer technology include laptops, mainframes, desktops, microchips in elevators et cetera. Technology uses the end products of science to develop. End products of technology include various kinds of plants and machines, tools, houses, utensils, transportation facilities (e.g. automobiles, aircraft and ships), construction work (e.g. bridges and skyscrapers), communication facilities (e.g. telephone and radio), computer systems, electricity, modern scientific and medical processes and other forms of technological innovations to ease the problems of mankind.

Nature of Science

Nature of science is a way of knowing the characteristics, values, beliefs and claims inherent in the developments of scientific knowledge. The tenets of science as identified by Otuka and Uzoechi (2014) include:

- (i) There is no single set or sequence of steps in a scientific investigation.
- (ii) All scientific knowledge (theories and laws) are tentative and subject to change.
- (iii) Scientific knowledge must somehow be supported with empirical evidence and be testable/ verifiable.
- (iv) Scientific knowledge evolves from creative imagination and creative interpretation of data by the scientist.
- (v) Scientific knowledge is a product of observation and inference.

Fields of science are classified along two major branches: Natural science (study of natural and applied phenomena) and social science (study of human behaviour and societies).

The end products of all scientific endeavours lead to the accumulation of scientific knowledge about the world and the environment also referred to as the content of science (Otuka & Uzoechi, 2014). The products of science include: (a) scientific laws – statements describing natural phenomena or generalizations that were inspired from experimental findings; (b) scientific principles - generalization propounded from several related concepts; (c) scientific facts - tested ideas that have been found to be true; (d) scientific theories – explanations made from hypotheses that have been confirmed or generalizations that have to do with related principles about natural phenomena which predict varieties of experimental and observational findings; (e) concepts - ideas generalized from relevant and (f) specific experiences; and hypotheses-tentative conjectural statements that are subject to verification in order to establish the state of truth.

Scientific attitude are inclinations developed by scientists to act or behave in a particular way and manner during the process of investigation. These attitudes include rationality, curiosity, honesty, suspended judgment, idea sharing, discipline, parsimony, persistence, self – criticism, open-mindedness, self-control, organizational ability, patience, skepticism and objectivity.

The scientific method is a systematic process, proven to be effective and applied in scientific research to make useful findings. The scientific method begins with problem identification and follows a logical sequence of making hypotheses and testing/ verifying the hypotheses, designing and carrying out experiments, making carefully organized observation, collecting data, looking out for pattern in form of analysis and inference; and then drawing conclusion. The scientific method is recommended for scientific and educational research because it has a logical guideline; it is objective; it is based on empirical and verifiable evidence; and the result is replicable. Societal problems can be solved adopting the scientific method.

Science makes use of process skills which scientists deploy to arrive at new knowledge or information about the environment. Science process skills are various mental and motor skills used by a scientist to gather knowledge for solving problems in the environment. These skills can be acquired through practice in a series of activities carefully designed and thought through. Such science process skills include observing, measuring, raising questions, communicating, counting, predicting, manipulating, collecting data, controlling variables, identifying, hypothesizing, experimenting, reporting, classifying, inferring, verifying, interpreting data, drawing conclusion and making generalization. Observation is the most important science process skill. All other science process skills have to do with observing some phenomena. Observation means paying careful attention to details by deriving impression from things happening in society. Many adults today cannot observe properly, therefore, they need the skill which can be gained through science and technology processes. Measurement has to do with degree, extent or quantity of exactness when describing issues. Statistics (if possible) can be used to back up arguments in measurable terms. These ones and other science process skills can be acquired by learners and society at large through the study of science and technology.

The process skills involved in technology include designing, manipulating, inspecting, identifying, selecting, drawing, measuring, testing, diagnosing, analyzing, assembling, dismantling, repairing, installing, handling tools and equipment. Others include ability to construct, ability to plan, decision making skill, problem solving skill, interpersonal skills et cetera. Technology uses concrete materials for

building the products whereas science is all about idea and principles. Science inquires “why” and technology answers “how”. Technology as posited by Grady (2012) uses advanced knowledge to solve problems; Science seeks advanced knowledge. Engineers, Technologists, Technicians, Artisans and Craftsmen help to modify the physical world based on theories propounded in science. Scientists, therefore, help to modify theories based on the physical world. In this connection, Scientists and Engineers have to collaborate for Technology to be achieved. Science represents the theory, and technology represents the practice.

The Interface between Science, Technology and Society (STS)

The way society perceives science and technology on one hand and the way science and technology impact society on the other hand, varies from nation to nation depending on cultural background. Just as science and technology cannot exist without society, so also society cannot function effectively without the touch of science and technology. Infact, it may be said that while Science and Technology draw their inspiration from society, society in turn, shapes the realities taking place in Science and Technology. Science and technology have core principles, laws and hard facts which society cannot tamper with. Culture or society cannot influence nor touch certain things in science and technology. For example, the principle of force of gravity and other laws of science remain the same in different societies. The element that is indestructible is a universal law of science. In agricultural production, for instance, the use of fertilizer to improve crop production could be beneficial and on the other hand be harmful. Fertilizer has oxidants which the plants absorb from the earth. Human beings feed on the crops (i.e produce of the harvest). The products from these farms when consumed remain in the human body and could cause one harm or the other. This confirms the first law of nature that states that Matter cannot be destroyed but only converted from one form to another.

Interestingly, the learning of science and technology is situated in the society, and cannot be separated from the society. Some aspects of society’s practices can influence the teaching and learning of science and technology such as language and the habits of the people. Scientific and technological attitudes, process skills and products could have enormous influences on societies. That a society is scientifically literate means the society is well enlightened in her attitudes, processes and products of science. As positive aspects of science and technology on society are being appreciated more and more, the negative impact of science and technology are on the decline. The culture of any environment finds its way into the teaching of science because learners come to class with prior knowledge of the things happening in their environment which the teacher should take note of before introducing the lesson.

Contribution of Science and Technology to Developing Nations

Developing countries need to go back to the basics in order to catch up with the trends in the 'developed nations' of the world. Tradition and modern technological inventions need to be reconciled. The strategy of import substitution where half finished goods are imported and domestically coupled together and completed at the end of any production process does not encourage home-grown science and technology. In Nigeria, for instance, some products' bodies and spare parts are imported, assembled locally and presented in their finished form as though the production from the beginning to end took place in the country. This amounts to deception, a form of pseudo-technology and a kind of technological neo-colonialism. This situation has made developing nations a dumping ground for finished products of the developed nations of the world. This has affected the self-esteem of developing nations in world politics, economy and military prowess. To discourage this, Grady (2012) recommended that developing nations should consider the option of embarking on technological espionage to be able to acquire the rudiments for technological development. Many developed nations of the world are not willing to allow technological transfer. This is because they feel their hard earned science and technological know-how should not be transferred to other nations for competitive reasons. Some of the developed nations deliberately want to exercise influence over the underdeveloped nations' economy and policy.

Developing nations like Nigeria can encourage local manufacture of industrial products using locally sourced raw materials and available manpower. Raw materials can be sourced locally. Consumption of foreign products should be discouraged. The creative ability of developing nations cannot be overwhelmed by the colonialism which they experienced in the past. Proper feasibility studies need to be undertaken to ascertain which technology would suit the country. Governments should give more financial boost to science and technology, encourage and motivate individuals and organizations who are naturally endowed and technologically inclined to display the best of their talents, spur research activities and findings in institutions towards science and technology (Agu, 2017). Applied research, partnerships and projects should be embarked upon and undertaken to address policies, managements and dimensions of science and technology in developing nations (Scribd, 2017). The political will and determined conscious honest efforts should be demonstrated by the ruling class in guiding governmental and non – governmental organizations in the right implementation of the policies for science and technology development of developing nations.

Positive Impact of Science and Technology on Society

Developing societies (nations) have been greatly influenced positively by the products of science and inventions of technology. Individuals in the society cannot make informed decision without the knowledge of science and technology. Society's demands on science and technology are raising fast particularly in the areas of safety and security (NISTEP, 2016). Entrepreneurs use scientific and technological results for the development of products and improvement of

production systems in order to make profit. New industries are being created leading to the creation of new sciences and technologies. Progress in energy and materials technologies, for instance, has given rise to a variety of new transport modes such as railroad, automobiles and airplanes which are vastly improving human mobility and communication. Modes of transport, for example, electronic railway lines offer a better means of transport. The analog ways of doing things in the past has metamorphosed into digital approach today. Automobiles which were before now powered mechanically and electrically have gone autotronics

In the education sector, the ethical practice that facilitated improved learning and performance in learners and instructors alike has been entrenched. This has been achieved by creating, using and managing appropriate science and technological processes, attitudes, systems and resources developed and meant to ease human capability. Organized research and projects are better executed following processes and products of science and technology. Software and hardware development has greatly influenced education. For instance, the use of computer-assisted instruction and teaching materials such as tape recorded lessons or video-taped lessons have enhanced teaching and learning by effectively stimulating students' senses and capacity senses. Several aspects and levels of education and academic activities are aided and eased off using different computer applications, packages and programmes. The positive impacts of the development in science and technology have also been witnessed in other areas such as:

- i.) Revenue Generation to Nations: Developing nations of the world have improved their revenue generation from processes and products of Science and Technology. Japan and Israel, for example, are known to have grown economically as a result of revenue from Science and Technology.
- ii.) Health Care Initiatives: Scientific knowledge about the causes of diseases have brought new treatments and preventive measures. Vaccines and drugs have been discovered for the prevention and treatment of ailments of different variety in man and animals. Surgical operations and caesarian sections have been performed accurately with greater precision and within a short period of time. For example, prostrate conditions that trouble aged men are better handled using Lasers and other advanced science and technology applications. Couples who have difficulties with procreation have been aided with IVF and process of external fertilization to have their own biological children. Progress in medical technology has greatly extended peoples average life span and reduced infant and child mortality rates, resulting in a dramatic rise in the world's population with its attendant benefits and demerits, though Africa is yet to catch up with the rest of the world in this aspect.
- iii.) Agriculture: Mechanized farming and improved agricultural yield have been possible through science and technology. Cross – breeding is better carried out to get high quality produce. Better agro-chemicals for improved yield are now available through the help of science and technology. Similarly better food preservation methods and strategies have been devised to increase the shelf-life of food products.

- iv.) Energy and Power Sector: Quality of electricity generation, transmission and distribution network has improved recently through science and technology. Metering has moved from analog to digital and problems associated with electricity tariff and consumers are gradually being overcome. Renewable and non-renewable energy sources have been advanced. Developed nations have devised other forms of energy to power automobiles apart from energy from petroleum products. Breakthrough has also been recorded through Bio-fuels and other energy generation sources.
- v.) Communication and Information: The world has been reduced to a global village through the products of science and technology. The innovations in telephone and radio services have broadened communication in regions of the world. Through the inventions of internet, websites, various computer applications and mobile phones, economic activities, commerce and social network have been expanded the world over. Information and communication technology (ICT) is the in thing today and applicable to mass communication, business, education, entertainment industry, defense and security surveillance, politics, medical care, road safety, manufacturing sector. Virtually every area of human endeavour has been influenced by ICT. Space science - technology and Launch of satellites have aided global development in all communities of nations.
- vi.) Construction Industry: The construction industry has witnessed great advancement from process and products of science and technology. Skyscrapers, mansions, bridges, road networks and great edifices have been constructed with sophistication and ease through the help of science and technology.
- vii.) Defense and Crime Control: Warfare is better executed in today's world due to the innovations that have been brought about by science and technology. Weapons of war and defense have been diversified. Nuclear weapon, bio-chemical weapon and fighting machines (for land, air and sea) of different forms have been directed to launch and wedge wars. Surveillance equipment (e.g CCTV) and cameras that can pick details of events and can track offenders have been developed, thereby aiding law enforcement agencies in the fight against crimes in society.

Other very important areas where science and technology have made enormous impact include: Industrial productivity. Use of manual labour to carry out economic duties /functions has been replaced by robots and other forms of motorized machines; Transportation by rail, by road, by air and in the water has experienced tremendous transformation from what it used to be; Man's comfort and happiness level have been enhanced through scientific and technological innovations; Satellite and space science and technology have been useful in so many key areas of endeavour.

Negative Impact of Science and Technology on Society

The world is witnessing increase in human activities as a result of progress in science and technology. Advancements in science and technology have brought relief and ease to man in so many areas of endeavours, but they have also brought so many variegated pains and discomfort

alongside. Science and technology have sparked off controversies in some areas such as the issue of modified foods, cloning of human being, stem cell research and others. These areas of conflicting interests have brought policy makers and scientists together in attempts to chart the way forward. Recently, advancing globalization as well as the information technology (IT) revolution and other developments in progress have adversely affected individuals regardless of their own choices. From the case of gene-recombinant crops, it is clear that those who benefit from the utilization of scientific and technological results are beginning to steer a different course from those who must bear the risks.

Science and technology have raised an environmental issue which varies widely ranging from global warming to acid rain, destruction of the ozone layer, destruction of tropical rain forests, desertification and other forms of social problems (MEXT, 2016). Revolution in IT has led to new societal problems including the appearance of digital divide (ie information gap) between regions and nations of the world and the more current issue of information safety. Incidences of Loss of moral values and ethical problems have been evident in the society. The unhindered access of everyone to social media (e.g internet and television) has resulted in the erosion of much cherished cultures and has led to high level of immoralities, bad habits, laziness and indecent dressing among the youths.

Other serious problems posed by the activities and products of science and technology which society is battling with today are environmental problems including different forms of pollution. Pollutants and their negative effects in the air, land and water are all issues to be contended with as technological activities are expanding. Deforestation, desertification, ozone layer depletion, greenhouse effect and several other forms of environmental problems abound in the society and pose serious challenge to manage.

The problem of overpopulation and its attendant social problems and tension that go with it is equally a threat to society. Increase in accident rates in homes, roads, air and sea is attributable to advancement in science and technology. For example, modern cars come with a lot of sophistication which are poorly mastered by users and could result into abuse and accidents by drivers. Similarly, the application of other mechanical devices and accessories that are used at home can cause accidents. Unemployment rate and loss of jobs are on the increase in the society. This is partly caused by advancement in science and technological activities. Machine is speedily taking over the functions being performed by men and women. For example Automated Machine (ATM), robots, modern spinning/dryer and other forms of modern machines and gadgets have taken over and thrown people into the labour markets. Poverty and widening of socio-economic gap among the regions of the world are other negative impact of technology. Threats to the pursuit of world peace and harmonious existence have risen to alarming proportion. Nations that feel they have achieved technologically always desire to test their military might on other nations through suppression, neo-colonialism in science and technology.

Conclusion

A society that is literate in science and technology can appreciate, understand and properly interpret scientific and technological knowledge and methods as well as apply them to solve their everyday problems. For developing nations of the world especially the Saharan Africa to get out of the poor infrastructural condition they find themselves in and become scientifically and technologically independent and industrialized, science and technology must be given the attention it deserves. Other measures to encourage science and technology development include the stopping of lip service to education and research activities on the part of the government of developing nations. Education is the bedrock upon which science and technology develops. Curriculum planners, educational administrators and supervisors including teachers, students and parents must co-operate to ensure that the education industry of developing nations grows beyond what is obtained presently.

Recommendations

From the foregoing discourse, it is recommended that not only should the teaching and learning of science and technology be emphasized, but how the knowledge and skill are transmitted into learners is important. Learning of Science and technology should be made interesting and more pleasurable through introduction of innovative teaching and learning approaches so as to attract more students into Science and Technology fields. This is invariably the task of the governments of developing nations and other stakeholders. Science and technology teachers need to be equipped with the right tested and proven innovative teaching strategies and methods. The use of multi-media devices can enhance multiple stimulation of various learning senses in learners and ultimately make learning of science and technology a fun and retention enduring. This will ensure that all categories of learners benefit from the use of multisensory instruction including slow learners and those with special disabilities.

REFERENCES

- Agu, P. A. (2017). Skill Acquisition for Wealth Creation and Self-Employment. Perspectives from Developing Nations. Germany: Lap Lambert Academic Publishing.
- Asim, A. E. (2016) Harnessing the potentials of technology for quality teaching and learning in higher education. *Journal of Education, publication of Faculty of Education, Awka*; Nnamdi Azikiwe University,
- Chattopadhyay, C. (2015). *What are the main differences between science and technology?* Downloaded on 18th May, 2018 from <https://www.quora.com>
- Grady, M. (2012) *The relationship of science and technology*. Downloaded on 21st May, 2018 from mickogrady.blogspot.com.ng/2012/09.

- Mext (2016) *The deepening relationship between science and technology and society*. Downloaded on 21st May, 2018 from www.mext.go.jp/component/english/
- National Academy of Sciences (2018) *Science and Technology in Modern Society*. Washington DC. Downloaded on 23rd May, 2018 from <https://www.nap.edu/9481/chapter/3>
- NISTEP (2016) *The relationship of science and technology with society*. In National Institute of Science & Technology Policy downloaded on 21st May, 2018 from www.nistep.go.jp/en
- Otuka, J. O. E. & Uzoechi, B. C. (2014) The nature of science and its implication for science education in Nigeria. *Contemporary Issues in Education*. Publication of NSUK-EDU (p15-23)
- Scribd (2017) *Influences of science and technology in society*. Downloaded on 24th May, 2018 from <https://www.scribd.com/doc/26972101/>