CHAPTER SEVEN

INTRODUCTION TO THE VARIOUS AREAS OF SCIENCE AND TECHNOLOGY

Bright ATALOR

Department of Environmental Management and Toxicology

Faculty of Science

University of Delta, Agbor

7.0 INTRODUCTION

The advancement of science has been beneficial to humanity since it has allowed them to get a greater understanding of their environment and the activities they engage in. Additionally, technological improvement and scientific progress have sparked revolutions in a number of industries, including medicine, agriculture, education, information technology, and many others. When considering any kind of advancement in the modern world, science and technology must be taken into consideration.

Science fundamentally is the systematic study of the structure and behaviour of the natural and physical world through observations and experiments.

Technology (which is basically derived from the Greek work '*technologia'*) is an art, skill, or ability, which is used to create and develop products and acquire knowledge.

Scientists used their knowledge to develop technology and then used technology to develop science; so, because of this reason science and technology are an integrated term in today's world.

7.1 Various Areas of Science

According to The National Academy of Sciences (2016), Science is the use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process.

Bauer (2009) defined Science as the pursuit of knowledge and understanding of the natural and social world following a systematic methodology based on evidence.

The various areas of science are mainly constituted of three main branches; natural sciences, formal sciences and social sciences.

7.2 Natural Science

This is one of the branches of science concerned with the description, understanding and prediction of natural phenomena, based on empirical evidence from observation and experimentation. Natural science can be divided into three major disciplines, namely Physical Sciences and Life Sciences.

7.2.1 Physical Sciences

Brossard and Scheufele (2013) viewed physical science as a branch of natural science concerned with non-living matter, energy and the physical properties of the universe, such as physics, chemistry, astronomy and geology.

Physical sciences encompass fields of physics, chemistry, astronomy, geology, oceanography, meteorology, planetary science, astrophysics and polymer science.

The following are branches of physical sciences:

- **Physics:** This branch of physical science involves the study of matter and its motion through space and time, along with related concepts such as energy and force. It is the analysis of nature, conducted in order to understand how the universe behaves.

  The branches of physics include astronomy, atmospheric physics, biophysics, chemical physics, geophysics, mechanics, nuclear physics, relativity, quantum physics, thermodynamics, atomic, molecular, and optical physics.
- **Chemistry:** This branch of physical science studies the composition, structure, properties and change of matter. Chemistry is the science of atomic matter (matter that is composed of chemical elements), especially its chemical reactions, but also including its properties, structure, composition, behavior, and changes as they relate to the chemical reactions.

  Branches of chemistry are physical chemistry, organic chemistry, inorganic chemistry, nuclear chemistry and analytical chemistry.

- **Astronomy:** Astronomy is the study of celestial objects (such as stars, galaxies, planets, moons, asteroids, comets and nebulae), the physics, chemistry, and evolution of such objects, and phenomena that originate outside the atmosphere of Earth, including supernovae explosions, gamma-ray bursts, and cosmic microwave background radiation.

  The branches of astronomy include astrobiology, astrophysics, planetary science and astrochemistry.

- **Earth Science:** This is the study of how the natural environment (ecosphere or Earth system) works and how it evolved to its current state. It includes the study of the atmosphere, hydrosphere, lithosphere and biosphere.

  It also includes numerous concepts such as dating of rocks and minerals, the types of rocks, analysis of landforms, fossils, amongst others.

  The branches of Earth science are atmospheric science, geology, geochemistry, geochronology, geophysics, volcanology, petrology and mineralogy.

7.2.2 Life Sciences

Life sciences are concerned with the study of all life forms, namely aquatic, land and air at the microscopic level. The life sciences comprise fields of science involving the study of living organisms such as plants, animals and humans. It not only covers branches of biology but also touches cross-disciplinary topics such as biophysics and biochemistry amongst others (Biggs, 2005).

The branches of basic life sciences include biology, anatomy, astrobiology, zoology, genetics, biochemistry, toxicology, microbiology, biotechnology, ecology, neuroscience, mycology, pathology, pharmacology, physiology, virology, immunology, enzymology, botany and histology.

- **Biology**: The scientific study of life.
- **Anatomy**: The study of form and function, in plants and animals, and other organisms, or specifically in humans.
- **Astrobiology**: The study of the formation and presence of life in the universe.
- **Zoology**: The study of animals.

- **Genetics**: The study of genes and heredity.
- **Biochemistry**: The study of the chemical reactions required for life to exist and function, usually a focus on the cellular level.
- **Toxicology**: The nature, effects, and detection of poisons.
- **Microbiology**: The study of microscopic organisms (microorganisms) and their interactions with other living organisms.
- **Biotechnology**: The study of the combination of both the living organism and technology.
- **Ecology**: The study of the interactions of living organisms with one another and with the non-living elements of their environment.
- **Neuroscience**: The study of the nervous system.
- **Mycology**: The study of fungi.
- **Pathology**: The study of the causes and effects of disease or injury.
- **Pharmacology**: The study of drug action.
- **Physiology**: The study of the functioning of living organisms and the organs and parts of living organisms.
- **Virology**: The study of viruses.
- **Immunology**: The study of the immune system.
- **Enzymology**: The study of enzymes.
- **Botany**: The study of plants.
- **Histology**: The study of tissues.

7.3 Formal Sciences

Buchi and Neresini (2008) defined formal science as an area of study that uses formal systems to generate knowledge such as in mathematics and computer science.

Formal sciences are disciplines concerned with formal systems, such as logic, mathematics, statistics, theoretical computer science, information technology, data science, game theory, systems science, decision theory and theoretical linguistics.

The branches of formals sciences include logic, mathematics, statistics, data science, information science, systems science and computer science.

- **Logic**: This is the study of correct reasoning or good arguments. It is often defined as the science of deductively valid inferences or of logical truths. Logic can be divided as formal or informal logic.
- **Mathematics**: This is an area of knowledge that includes the study such topics as numbers (arithmetic and number theory), formula and related structures (algebra), shapes and spaces in which they are contained (geometry) and quantities and their changes (calculus and analysis).
- **Statistics**: Statistics is the discipline that concerns the collection, organization, analysis, interpretation, and presentation of data.
- **Data science**: Data science is an interdisciplinary field that uses scientific methods, processes, algorithms, and systems to extract knowledge and insights from noisy, structured and unstructured data, and apply knowledge and actionable insights from data across a broad range of applicable domains.
- **Information science**: This is an academic field which is primarily concerned with analysis, collection, classification, manipulation, storage, retrieval, movement, dissemination, and protection of information.
- **Systems science**: This field is concerned with understanding system- from simple to complex-in nature, society, cognition, engineering, technology and science itself.
- **Computer science**: computer science is the study of computation, automation, and information. It spans theoretical disciplines (such as algorithms, theory of computation, and information theory) to practical disciplines (including the design and implementation of hardware and software).

7.4 Social Sciences

Durant and Thomas (1989) defined social science is the branch of science devoted to the study of societies and the relationships among individuals within those societies. It is any branch of academic study or science that deals with human behavior in its social and cultural aspects.

The major branches of social science include anthropology, psychology, sociology, economics, environmental studies, history, geography, law, political science and information science.

- **Anthropology**: This is the scientific study of humanity, concerned with human behavior, human biology, cultures, societies and linguistics, in both present and past, including past

human species. Social anthropology studies patterns of behavior, while cultural anthropology studies cultural meaning, including norms and values.

- **Psychology**: This is the scientific study of mind and behavior. Psychology includes the study of conscious and unconscious phenomena, including feelings and thoughts.
- **Sociology**: Sociology is a social science that focuses on society, human social behavior, patterns of social relationships, social interaction, and aspects of culture associated with everyday life.
- **Economics**: This is the social science that studies the production, distribution, and consumption of goods and services. Economics focuses on the behaviour and interactions of economic agents and how economies work.
- **Environmental studies**: This field systematically studies human interaction with the environment. Environmental studies connect principles from the physical sciences, commerce/economics, the humanities, and social sciences to address complex contemporary environmental issues.
- **Political science**: This is the scientific study of politics. It is a social science dealing with systems of governance and power, and the analysis of political activities, political thoughts, political behaviour, and associated constitutions and laws.
- **Library science**: This field applies the practices, perspectives, and tools of management, information, technology, education, and other areas to libraries; the collection, organization, preservation, and dissemination, of information resources; and the political economy of information.
- **Information Science**: This is an academic field which is primarily concerned with collection, classification, manipulation, storage, retrieval, movement, dissemination and protection of information. Historically, information science is associated with computer science, data science, psychology, technology, library science, healthcare, and intelligence agencies.

7.5 Technology

The term “technology” comes from the Greek word “*teckne*” (which relates to art or craft) and “logia” (which relates to study). The combination of these two words, *teknologia*, means systematic treatment. (Arthur, 2009).

Over the past two centuries, the use of the term “technology” has changed significantly. By the 1940s, “technology” referred not only to the study of industrial arts but also included all machines, tools, instruments, weapons, communicating and transporting devices, as well as the skills by which humans build and use them.

More broadly, technology refers to tools, machines, and a collection of techniques that may be utilized to solve real-world problems. The tools and machines can be as simple as a nail pin or as complex as a particle accelerator or space station. Also, they need not be physical; virtual technologysuch as software and cloud services fall under this definition of technology.

In a broader way, technology is a means to fulfill a human purpose.

Since technology can be so simple or extremely complex, it can be categorized into different groups. Below, are all the different types of technology with modern examples

7.5.1 Information Technology

Information Technology refers to the development, maintenance, and use of computer software, systems, and networks. It includes their use for the processing and distribution of data. Data means information, facts and statistics gathered together for reference, storage or analysis(Arthur, 2009).Today, Information Technology (IT) refers to everything people use computers for. While this field commonly deals with computers and computer networks, it also incorporates other information distribution technologies such as telephones, television, and the Internet.

The applications of Information Technology can be seen in multimedia conferencing, e-Commerce, cloud computing, online banking, speech recognition, Intrusion Detection System and online advertisement.

7.5.2 Biotechnology

Heidegger (1977) defined biotechnology as the use of living organisms or biological processes for the purpose of developing useful agricultural, industrial, or medical products, especially by means of techniques, such as genetic engineering, that involves the modification of genes.

Biotechnology utilizes biological systems and living organisms to develop different products. It covers a wide range of disciplines, from genetics and biochemistry to molecular biology.

Based on applications, biotechnology can be categorized into seven types:

- *Red biotechnology*: involves the development of vaccines and antibodies, artificial organs, diagnostic tests, and regenerative therapies.
- *Green biotechnology*: is applied to fight pests and nourish crops and strengthen them against harsh weather conditions and microorganisms.
- *White biotechnology*: consumes fewer resources than conventional processes. It is used to create industrial goods. It involves designing organisms and enzymes to create valuable chemicals or destroy hazardous chemicals.
- *Blue biotechnology*: exploits sea resources, such as micro-algae, to develop products and industrial applications.
- *Yellow biotechnology*: focuses on food production. For instance, conducting research to decrease levels of saturated fats in cooking oils.
- *Gold biotechnology*: uses advanced computational techniques to obtain, store, analyze and separate biological information, particularly related to DNA and amino acid sequences. It plays a crucial role in numerous fields, such as structural genomics, functional genomics, and proteomics.
- *Gray biotechnology*: addresses environmental issues and focuses on the maintenance of biodiversity and the removal of pollutants.

7.5.3 Nuclear Technology

Nuclear Technology is technology that involves the nuclear reactions of atomic nuclei. When changes occur in the nucleus of atoms, massive amounts of energy are released. Nuclear technology involves all techniques that manipulate/control such changes in the nucleus of some specific elements and transform them into usable energy.

It is extensively used in nuclear power plants to produce electricity. Nuclear power is an efficient and clean way of boiling water to create steam, which turns turbines to generate electricity.

The applications of nuclear technology are production of electrical energy, radiotherapy, smoke detectors, sterilization of disposable products and radioisotope thermal generators used in space missions.

7.5.4 Communication Technology

Communication Technology refers to all the tools used to send, receive, and process information. Communication technology involves converging audiovisual and telephone networks with computer networks through a unified system of cabling or link. (Franklin,1999).

There are four main types of communication technology that have contributed to the ease of sending messages are telephone, radio, television and internet.

The applications of communication technology can be seen in Local area network (LAN), videotext, teletext, internet, wireless information transfer and Global Positioning System (GPS)

7.5.5 Electronics Technology

Electronics technology is the application of scientific theories and principles in the design, production, installation, testing, service, use, and control of electrical and electronic parts, equipment and systems.

Electronics deals with everything that involves emission, flow, and control of electrons in vacuum and matter. An electronic component can be any physical entity (such as capacitor, resistors, inductors, diodes, and transistors) in a system that affects the electrons or their associated fields in a way consistent with the intended operation of the electronic system.

Electronics mainly comprises passive and active components, solid-state devices, operational amplifiers, audio and radio-frequency amplifiers, oscillators, frequency modulators, digital circuits, digital circuits, power supplies, and optoelectronics devices such as solar cells, light-emitting diodes, and optical fiber.

The types of Electronics Technology are digital electronics, analogue electronics, microelectronics, circuit design, integrated circuits, power electronics, optoelectronics and semiconductor devices.

The application of electronics technology can be seen in the making of computers, digital camera, smartphones,Radio Detection And Ranging (RADAR), power suppliers, multimeters and interactive sensors.

7.5.6 Medical Technology

Medical Technology can be defined as the application of science to develop solutions to health problems or issues such as the prevention or delay of onset of diseases or the promotion or monitoring of good health. Medical technology is also defined as the application of science to build solutions to prevent disease, injury, or other health problems. This may include detecting diseases through advanced machines, methods to treat patients, and monitoring of good health.

In a broader sense, medical technology focuses on equipment, systems, facilities, and procedures (but not drugs). A medical device can be an apparatus, instrument, device, implant, reagent, or software.

From syringes and sphygmomanometers (a device for measuring blood pressure) to medical imaging technologies (like X-ray and MRI machines), medical machines can play a range of roles in diagnosis, prevention, monitoring, treatment, and alleviation of disease.

One of the major technological developments in healthcare is 3D printing. It is used to create specialized prostheses, splints, parts for inert implants, as well as customized replaceable body parts.

The applications of medical technology can be seen in the making of stethoscope, pacemakers, ventilators, computed tomography (CT) scanners, and surgical robots.

7.5.7 Mechanical Technology

Mechanical technology deals with the techniques of putting together mechanical parts and materials to build functional structures and control or transmit motion. For example, brakes on a bicycle, latch on a door, gear systems in a car transmission.

Mechanical engineering technologists apply principles from product design, material sciences, and manufacturing processes to create useful products and production machinery. They primarily work as troubleshooters in the ongoing maintenance of machinery and automated equipment.

The applications of mechanical technology can be seen in cars manufactured by using mechanical robots, 3D printersorpower plants.

7.5.8 Materials Technology

Materials technology is a comprehensive discipline that involves choosing materials with properties that best meet the requirements of a target application. It may also include maintaining the performance of materials during the life of a machine by resisting fatigue, corrosion, and other damages.

Since different materials have different properties, blending multiple materials yields interesting characteristics, which lead to new applications.

The phrase "smart materials," which is defined by their responsiveness to some environmental stimuli such as light, humidity, and temperatures, has recently emerged as a result of recent advancements in materials technology that enable added functionality. Over the past ten years, numerous novel materials, including carbon nanotubes, graphene, and piezoelectric materials, have been created and successfully tested.

Materials technology and science are strongly tied to one another. While the former focuses more on methodologies and testing to ascertain how to improve the product, the latter encompasses the design and development of new materials (especially solids).Example of the applications of material technology are piezoelectric materials used in micro-thrusters for satellites and self-healing coatings used to protect metal products.

REFERENCES

Arthur, W. B. (2009). The Nature of Technology. New York: Free Press. p.28-35.

Bauer, M.W. (2009). The evolution of public understanding of science—Discourse and comparative evidence. Science, Technology, & Society. 14(2), 221-240.

Biggs, R D. (2005). Medicine, Surgery, and Public Health in Ancient Mesopotamia. *Journal of Assyrian Academic Studies.* **19** (1): 7-18.

Brossard, D., and Scheufele, D.A. (2013). Science, new media, and the public.33(6115), 40-41.

Bucchi, M., and Neresini, F. (2008). The Handbook of Science and Technology Studies (3rd ed., pp. 449-473). Cambridge, MA: MIT Press.

Cacciatore, M.A., Scheufele, D.A., and Corley, E.A. (2011). From enabling technology to applications: The evolution of risk perceptions about nanotechnology. Public Understanding of Science. 20(3), 385-404.

Durant, J.R., Evans, G.A., and Thomas, G.P. (1989). The public understanding of science. 340(6228), 11-14.

Franklin, U. (1999). *The Real World of Technology* (revised ed.). Scarborough: House of Anansi. ISBN 978-0-88784-891-9.

Heidegger, Martin (1977). The Question Concerning Technology. New York: HarperCollins. pp 25-26.

National Academies of Sciences, Engineering, and Medicine. 2016. Science Literacy: Concepts, Contexts, and Consequences. Washington, DC: The National Academies Press. https://doi.org/10.17226/23595.

Wilson, E.O. (1999). The natural sciences. *Consilience: The Unity of Knowledge* (Reprint ed.). New York, New York: Vintage. pp. 49-71.

Wise, G. (1985). Science and Technology. Osiris. 2nd Series. **1**: 22-46.