Introduction:

The world in which we live today is steeped in science and technology and governed by ever increasing discoveries, inventions and innovations. It is a world characterized by tremendous scientific and technological explorations. It is the world of the Internet and e-mails, supersonic jets, CAD/CAM, the robotics and biotechnologies. It is distant from the world of yesterday characterized by dogma, witch-craft, taboos and subjugation of man and natural phenomena.

Human development is the focus of all our activities in our modern world. Development means: *improvement of our quality of life* and this can be measured along the following:

- Our ability to know and understand ourselves spiritually, emotionally and physiologically and in recognition of our individual capabilities and limitations, live within that context,
- Our capacity to produce the goods and services we need to satisfy our needs and wants,
- Our peaceful co-existence with our neighbours and environment,
- Our ability to secure and maintain good health in our lives
- Our ability to enhance the quality of life - go beyond the basics.

There is an urgent need, thus, for us to become scientifically and technologically literate if we must be a part of the emerging global village of the 21st Century. Unfortunately, for the majority of Africa Scientific and Technological literacy is still a distant drum beat.

The Role of Science in Society:

*Science*-the systematic study of natural phenomena helps us to understand and relate better to nature and the universe at large. The study of science allows students to experience the richness of and excitement of the natural world. As adults, they will face complex questions requiring scientific thinking, reasoning and the ability to make informed decisions. For purposes of clarity and in order to give due emphasis, science is divided into Physical and Information Sciences, and Biological and Health Sciences.

Overall, Science helps us to understand our world by interpreting the laws and principles that govern it (Naughton, 1994 p.12). Science blends logic and imagination to explain and predict events through scientific inquiry. It demands evidence.
The Scientific enterprise is one of the major activities of the modern world. It is a Complex Social Activity that has generally accepted ethical principles. It is not authoritarian and cannot provide complete answers to all questions. Scientific knowledge is durable and yet ideas are subject to change (AAAS, 1989a).

The Role of Technology in Society:

Throughout the history of civilizations, the social fabric of humans and their enterprises has been involved with technology. Today, every human activity is dependent upon various tools, machines and systems from growing food and providing shelter to communication healthcare and entertainment. Some machines like tractors speed up work and do much more than has been ever done before while aero-planes and Internet perform functions that were never possible or ever imagined. This collection of devices, capabilities and the knowledge that accompanies them is called technology (AAAS, 1989b).

Unlike science, which aims at "understanding", technology aims at "solving problems". This is sometimes done without the hind-sight of science.

Broadly speaking technology is how people modify the natural world to fit their own purposes. From the Greek word “techne” meaning art or artifice or craft, technology literally means the act of making or crafting. More generally it refers to the diverse collection of processes, knowledge and skills that people use to extend human abilities and to satisfy human needs and wants (ITEA, 2000 p.2).

The contribution of technology to development and empowerment at individual level is tremendous when considered in both historical and modern development perspectives. This is evident in agriculture, manufacturing, energy, communications, transportation, construction and bio-technology.

Science, Technology and Development: an interface:

The understanding of the close relationships between science and technology and how they impinge upon development is critical. While science helps us to know what exists and why it is or behaves that way, technology gives us the know-how and capability to achieve our human needs and wants. Both science and technology have basic knowledge, skills, attitudes and values that are necessary for development (Thiam, 1996, p.71)

Scientific and technological activities would serve no useful purpose if the ultimate goal was not to improve the human condition. In Africa, development must begin first and foremost with the meeting of basic needs and a marked decline or reduction in poverty, ignorance and disease. It is unfortunate that, endowed so abundantly with natural resources, Africa is still up for a scramble by those nations with scientific and technological capabilities (Kerre, 1987).
The modern world is by and large a man made world where technology reigns. Technological advancement has tremendously enhanced human capability. It has extended the senses and created possibilities never before imagined. Our modern day political clout, economic might and socio-cultural transformations are subject to and functions of our technological capability.

**Africa’s Initiatives in the Promotion of Scientific and Technological Literacy**

Africa’s response to the development of scientific and technological capacities has traditionally been through the introduction of science curriculum and technical and vocational education curriculum in the national education system. While primary and secondary education levels of education have often been responsible for laying the foundations in science and technology and providing opportunities for awareness creation and exploration (Kerre, 1999), higher education institutions including technical and vocational education and training (TVET) institutions and universities have been responsible for training and producing middle and higher level scientific and technological manpower for national development.

Other avenues of capacity building have included the establishment of specialised higher level institutions for research and development (R&D) often coordinated by Ministries of Science and Technology or other relevant Ministries. Nigeria and Kenya have Ministries of Science and Technology with the mandate promote scientific and technological growth as shown in Table 1.

**Table 1: Vision and Mission of Ministries of Science and Technology (Nigeria & Kenya)**

<table>
<thead>
<tr>
<th>Country</th>
<th>Vision</th>
<th>Mission</th>
</tr>
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<tbody>
<tr>
<td>Nigeria</td>
<td>To make Nigeria, in the nearest future an acknowledged member of the fast developing scientific and technologically progressive nations of the world and to be the Africa’s leader scientific and technological development.</td>
<td>Chart the course of scientific and technological development of the nation through: planned and guided R&amp;D, coordination of S&amp;T efforts, advising government on S&amp;T policy etc.</td>
</tr>
<tr>
<td>Kenya</td>
<td>A national culture that prides in and actively promotes the development, acquisition, dissemination and application of science and technology for prosperity and global competition.</td>
<td>To spearhead sustainable development through integration of science. Technology and innovation into the national production systems.</td>
</tr>
</tbody>
</table>

Source: Ministry of Science and Technology: policy documents, Nigeria & Kenya.
The Science Teacher Education Curriculum:

One of the most important challenges in Science Education today is the derivation of content and appropriate methodologies that we can use to impart scientific literacy. What should be taught from amongst the phenomenal growth in knowledge in: the physical and information sciences, the biological and health sciences, and the environmental sciences and human ecology?

The traditional biology, physics, and chemistry subjects are no longer sufficient to achieve what Prof. Sam Bajah has observed: “Scientific literacy for all is therefore a sine quo non for living in the twenty-first century” (Bajah, 1995, p.5-6). Scientific literacy in Africa will have to confront and influence traditional culture in people’s life styles (Cobern, 1996).

There is greater need to develop in students, the knowledge, reasoning capacity and problem solving skills required for a rapidly changing technological world.

Training of Science Education Teachers:

What curriculum then would be required for the training of science teachers?

Primary or elementary school teachers have two major problems when it comes to their preparation for teaching science and mathematics at the foundational level.

First, they have a very weak background in science. They are often secondary school graduates who could not make it to higher level training. In most cases they would have been poor students in mathematic and science. Less time is allocated to science than any other primary school subjects. Secondly, they often pursue a general curriculum where they will be expected to teach all subjects in the primary level curriculum. These often are over ten courses in two academic years. They therefore have much less time again to focus on science and mathematics.

At secondary level, they take undergraduate training- a four year degree program combining content in two teaching subjects and professional training (pedagogy). The curriculum pursued is often at variance with what is expected to be taught in secondary schools. For example those who take botany and zoology are posted to teach biology at secondary school level.

There is need to review the science teacher training curriculum to reflect the demand for up-dated thinking and performance of a modern teacher. At primary level the curriculum should lay more emphasis on foundation building: creating awareness and interest in science. This will entail helping pupils to answer basic questions and explanations about what nature/matter is, what happens in everyday life experiences etc.

At secondary school level the curriculum should focus on further clarifications and explorations of natural phenomena. Learning by inquiry, observation and experimentation should be encouraged to help students explore the natural and manmade
worlds. The students should be guided in the identification and application of laws and principles of the scientific world.

**The TVET Teacher Education Curriculum**

A major challenge in the preparation of TVET teachers is of a curricular nature. What curriculum shall they impart? And consequently what curriculum should they pursue? This, however, need not be a major issue if an appropriate delineation of the concepts of TVET and technology education is carried out and agreed before curriculum development and implementation stages.

A TVET teacher at both primary and secondary level has the challenge to prepare learners for two important pursuits: *further education* and *entry into the world of work*. It will be a dual approach in order to achieve the goals of orientation for lifelong learning, to cope with changes in technology and new lifestyles in the fast paced 21st century.

In the context of the above curricula considerations, the TVET teacher curriculum will not only prepare an individual who will have a good grasp of the TVE philosophical, sociological and psychological foundations but will also have acquired the necessary technological knowledge and practical skills in specific technology disciplines to prepare learners for the world of work. What curriculum should we consider for such an individual?

A successful training programme for TVET teachers should be multi-faceted and offer the opportunity for upgrading both subject area and pedagogical knowledge and skills. The aim of TVET teacher education is to equip the teacher with the necessary knowledge and skills to guide the learning process. This will entail pedagogy and discipline content. At present, there is no universal formula for preparing an all round TVET teacher for both elementary and secondary level of learning.

However, we can take a two-pronged approach. One is the curriculum for preparing the TVET teachers who will teach in the specialist subjects such as: building and construction technology, electrical and electronics technology, mechanical technology, information and communications technology, power mechanics and aviation technology
The other option is one of preparing teachers of technology education, those that will teach *technology* as a subject in the school curriculum. Examples of those already in practice include the United Kingdom model of *Design and Technology* for elementary through high school levels and the American version of *Technology Education* for all from Kindergarten to Grade 12.

**Training of TVET Teachers:**

**Aim**

The introduction of technical and vocational subjects in the school curriculum is aimed at providing an opportunity to all learners to acquire relevant knowledge and skills in technical and vocational occupations and to impart in learners positive attitudes toward the world of work. A TVET teacher must have both technical skills and pedagogical/teaching methodology to effectively prepare students in TVET.

**Goals**

The goals of a TVE curriculum, which by UNESCO’s standards, ought to be an integral aspect of the general school curriculum, should include:

- The introduction and initiation of learners to the world of work and the world of technology,
- The acquisition of knowledge, skills and attitudes desirable for career development and productive engagement in the world of work,
- The preparation of the learner for further studies at advanced level in a chosen occupational field.

Unlike the training of a technology teacher, which focuses on the broad technological domain to impart technological literacy, the training of a TVET teacher will focus on preparation of a trainer who shall impart knowledge and at the same time provide skills for occupational entry.

**Content**

The traditional TVE subjects have been drawn out of the following broad areas: Agricultural education, Business studies education, Health education, Home science education and Technical education. Technical education has over time transformed to technology education with specific subject areas of: building and construction
technology, electrical/electronics technology, mechanical technology, power mechanics technology and information and communications technology.

These subjects can be introduced at primary and secondary levels for awareness creation and exploratory purposes. At the post secondary level, specialisation is undertaken leading to occupational entry as well as further training. The demand for more practical experience by the teacher is higher at this level because it is a job entry level for a majority of students. An equal demand will be expected of the teacher trainer.

Similarly, the TVET teacher curriculum content will include technical skills competence offered at a higher level, preferably at undergraduate level, if one was to teach at secondary and post-secondary levels and pedagogical skills. The TVET teacher curriculum at Moi University, Kenya illustrates the balance in both technical and professional education competencies imparted at undergraduate and post-graduate levels.

**Training Teachers of Technology Education:**

**Aim**

The principal aim of introducing technology education as a subject of study in the school curriculum is “to impart technological literacy and capability”. Technological literacy means: having the ability to use and manage, assess and understand technological products and systems. Technological capability means: having the know-how to produce, use and manage technological products and systems.

**Goals**

The main goals of a well-delineated technology education curriculum for all should, thus, include:

**Goal 1: To develop an understanding of the nature of technology and how it relates to modern society.**

**Content:**
- Meaning, scope and characteristics of technology
- The relationships among technologies and the connections with other fields
- The influences of technology on society
- The role of Society in the development and utilization of technology

**Goal 2: To develop an understanding of, and ability to create, a design.**

**Content:**
• The role and attributes of design
• The roles and attributes of trouble shooting, research and development, invention and innovation and experimentation in problem solving.

Goal 3: To develop an understanding of, and abilities for a technological world.

Content:
• Application of the design process
• Selection, production, use and maintenance of technological products and systems
• Assess the impacts of technological products and systems

A proper grounding in these three foundational domains of technology education will undoubtedly impart the understanding and capabilities required of a modern individual not only competent but capable to determine and influence the course of his/her life and that of others in the 21st century (See Fig. 1).

Fig. 1: A Balanced Curriculum for the 21st Century

Literate, Knowledgeable and Capable

Source: B. W. Kerre, 2006
The Gender Issue in Science and Technology Teacher Education

From the UN promoted Millennium Development Goals (MDGs) and the UNESCO/UNICEF promoted Education For All (EFA) initiatives, we have learned that any properly rounded education should include the study of Science and Technology for all students or learners. They should have equal access, equal opportunities to do well and equal opportunities for employment.

Unfortunately, girls and women are often universally underrepresented in science and technology. The situation is even more evident in Africa. Where there is representation, it is often in the biological and health sciences and not in the natural sciences and engineering.

In order to effectively address this condition, more girls and women have to be brought into science and technology. It is through the intervention of dedicated science and technology teachers that any meaningful change can be gained.

Conclusion:

From the above discussions, it is evident that a teacher with less than a college education will not have gained sufficient subject content and the necessary pedagogy to effectively impart scientific and technological literacy as well as preparing students for further higher education or entry into an occupation. Today, teachers who do not have a college education are more disadvantaged because promotions and job entry requirements have moved up the scale to college degree level.

However, there are three important issues that must be addressed if a nation has to have quality and effective science and technology education in the education sector.

First is financing. Science and technology programs are comparatively expensive. National policy must, through appropriate legislation, commit a portion of its national budget to these areas.
Secondly, the nation must agree on the nature and type of curriculum that will be required to impart scientific and technological literacy as well as preparing individuals for the world of work.

Third, the quality of the teaching force will determine the success of such an endeavour. The science and technology teachers must be both theoretical and practical. They must have sufficient experience to impart capability whether in the laboratories or workshops.

Colleges and Universities should, thus, be facilitated to ensure they have the human resources and capacities to impart knowledge, critical thinking and problem solving techniques and allow for experiential learning. Besides, there is a need for higher level researchers and scholars in science and technology education who will be able to undertake responsibility for advancing the science and technology education disciplines. This has not been adequately addressed by scientists and technologist who are not educators.
References:


Naughton, John, “What is technology?” In Frank Banks (eds.) Teaching Technology. London: The Open University, 7 – 12.