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Scientific and Technological Skills Acquisition at the Primary School Level as a Strategy to Mitigating the Challenges of Vision 2020 in Nigeria *(Pp. 334-349)*

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Abstract
Primary science is the foundation on which subsequent science teaching and learning at the secondary and tertiary levels of education is built. The low number of graduates in science and technology from the higher institution that are independent, or self reliant shows that there is low or no skills teaching in science and technology, which have generated a lot of concern .the world is continuously being reduced to a global village due to science and technology. There is therefore need to mobilize as many pupils as possible and the teacher as well to learn and teach science skills. This paper therefore highlights the interest and different skills which are imperative for pupils in science and technology. It discusses strategies for skills acquisition, how to demonstrate such skills, how to motivate learners to acquire science and technological skills, and how to help learners practice the new skills acquired. Recommendations are given on how the primary school teacher can get involved in the crusade that skill is imperative for pupils in science and technology.

Introduction

The study of science and technology has been accepted as very relevant to the survival and progress of the human race. This claim is strongly supported by the place of science and technology in the education process. The educational systems of all nations include elements of science and technology at all levels. As bodies of knowledge, there are acceptable methods through which skills in them can be acquired. The Nigeria Government, through its policy on education, very well supports the teaching and learning of science and technology at the primary school level of education. Specifically, the provisions in the National Policy on Education for primary education spell out the goals as including:

1. Lay a sound basis for scientific and reflective thinking
2. Give the child opportunities for developing manipulative skills that will enable him to function effectively in the society within the limits of his capacity.
3. Provide the child with basic tools for further educational advancement including preparation for trades and crafts at the locality.

In interpreting the goals that relate to scientific and technological undertaking, government has prescribed that the following subjects be included in the curriculum for primary education.

- Science usually interpreted as primary science, or integrated science , or general science, or simply as science;
- Mathematics which helps to develop reflective thinking;
- Physical and Health Education for development of a sound mind and body;
- Agriculture/Home Economics to be seen as an applied science that easily relates to the immediate society of the child;
- Cultural and Creative Arts which includes drawing and handicrafts among others, as preparing the child for trades and crafts of the locality. These two undertakings easily go by the name local crafts, which is interpreted as one of the foundations for technology at this level of education (Ivowi, 1995).

At the moment, it appears that the programme for science and technology at the primary education level is not sufficiently articulated to encourage the acquisition of the related skills. This arises from a number of factors, which include the following:

1. Absence of special programmes and projects in science and technology for primary schools that have as target the use of selected media for skills acquisition;
2. Lack of sufficient personnel with relevant expertise in the teaching and learning of science and technology at the primary education level.
3. Poor method of teaching science and technology at the primary school, where undue emphasis appears to be placed on the cognitive domain to an almost exclusion of the other domains;
4. Inadequate practice of the curriculum provisions for science and technology at the primary school, where a little science is done sparingly and almost nothing in the area of technology in Nigeria because of many reasons such as:

- Lack of trained teachers to handle the subjects;
- Lack of space for the practice of Agriculture;
- Lack of cooperation and motivation from experts in Local Craft;
- Absence of any arrangement to coordinate and/or integrate practices in craft in the locality with teaching in the primary schools;
- Absence of proper values education, where the provision for handwork and handicraft and Agriculture on Fridays has been jettisoned for flimsy reasons;
- Absence of learner - friendly environment with particular reference to science and technology in many primary schools

We need to impart to children scientific and technological skills to prepare them for future activities and contributions to national development. In the rest of this paper, we focus on:

1. Scientific and technological skills,
2. Strategies for skills acquisition

3. Demonstration
4. Motivating learners to acquire skills
5. Helping learners to practice new skills
6. Challenges to scientific and technological skills acquisition for vision 2020 in Nigeria.

1. Scientific and technological skills

There is an enormous assumption that since children in the primary school are taught primary science, there is no need for primary technology. It is assumed that science and technology are inferior variable in education especially at this level. However, there is an important distinction between technology and science, which should be made clear in the minds of curriculum planners and teachers. Science is concerned with understanding the world around us, while technology is concerned with using resources or materials, energy and natural phenomena to achieve some purpose relating to human activities. A central distinction is on the purposes. Understanding is the main purpose of scientific activity, while solving a problem that meets human need is the main purpose of technology. However, in trying to achieve the purposes, an interaction of some sort is entered into.

In the primary school, the teaching of only science to the exclusion of technology is an over-compromise of the primary school curriculum, because that gives neither the satisfaction of real problem solving nor the intellectual excitement of investigation for the purpose of understanding or satisfying curiosity. The compromise takes a form of science-oriented activities in which applications of science principles in everyday life are studied from the point of view of the illustration of the usefulness of science rather than the problem that was solved. Furthermore, activities in primary classrooms take the form of series rather than disconnected problems to be solved. While each may be interesting, such activities do not enable children to build up ideas, which may help their understanding and solution of further problems. For young children, technology is best understood through participation that is rooted in understanding. This understanding is enriched through application of the nature of knowledge in technology.

In the cause of learning science and technology, it is expected that both process and products be acquired to enable the individual to apply them to solving problems for the improvement of society. It is instructive to refer to processes and skills since the skills arise from the various processes. Gega (2006) present science skills as process- based. An examination of science

curricula, especially the primary science curriculum, shows that the under listed actions and behaviours define the skills expected from learners of science. He defined what each pupil should be able to do at the end of learning primary science. The skills through a series of activities are carefully designed and implemented. The Scientific Skills include the following:

observing	classifying
measuring	recording
hypothesizing	designing experiments
controlling variables	manipulating
using models	interpreting data
inferring	concluding
generalizing	predicting

The behaviour changes expected from learners of science are so specified in terms of what learners can do as to provide a clear focus for teachers who may be in doubt as to what to teach or teachers who may be tempted to produce themselves in the pupils they teach. The skills listed can be acquired and demonstrated by a primary school child if appropriate activities are designed and presented to the school pupils.

While science skills can be referred to as process based, technology skill can be referred to as manipulative based. This is because technologists are mostly engaged in overt actions, which involve a lot of manipulation of materials and machines to create an effect. The skills acquired from technology are however not exclusive of the skills from science. Some scientific skills are seen in the area of technology and the reasons are obvious. Science and technology are different sides of the same coin. Technological skills listed by Nneji (2000) and Juna (2004) include:

Inspecting	Identifying
Selecting	Handling
Drawing	Measuring
Testing	Diagnosing
Analyzing	Designing
Assembling	Dismantling
Servicing	Repairing
Installing	

Most of the skills listed are observable behaviours which comes about as a result of some form of manipulation of tools, equipments and machines. A

lot of activities abound in the environments from which appropriate experiences for the acquisition of the skills can be drawn. It is left for the technology teacher to ensure that the activities being presented to the pupils are those that are characterized by the skills pupils are expected to acquire.

As should be noted, the skills are in hierarchy and even for a particular skill; it has different levels of sophistication or difficulty Ivowi (2001), stated that a skill is usually accepted to have been acquired if it can be demonstrated correctly at least every two out of three occasions when demand is made. This two-thirds rule is required in terms of quality and at least for a start. Far more demand is made in later stages as skill demonstration improves with time and practice. A learner centered approach is highly recommended for the teaching and learning of science and technology since the envisaged content mastery and attitudinal changes are geared towards the learner. So, the focus is the learner, and consequently, we need to encourage children to:

- Locate sources of relevant information and be able to obtain them for their use;
- Interact with materials provided with a view to extracting valuable information from them;
- Work cooperatively with peers to explore the environment;
- Take part in field trips and industrial visit;
- Be actively involved in the processes of science and technology to acquire the related skills;
- Demonstrate scientific and technological attitudes through accurate reporting of events in and outside science and technology classes;
- Take active part in problem-solving activities.

2. Strategies for skills acquisition

There are many approaches to science and technology teaching, which could lead to acquisition of related skills. We have already indicated the need for learner-centered approach in this regard. Problem-solving is another strategy for acquiring skills. In recent times, the science-technology-society (STS) approach has become common in practice. STS in defined by the National Science Teachers Association (NSTA) of USA as the teaching and learning of science in the context of human experience. In this connection, the importance of science and technology is emphasized, and technology

concepts are to be included in science courses. STS, according to STAN (2001) provides a direction for:

- Achieving scientific and technological literacy by placing emphasis on responsible direction taken by individuals in the real world of science and technology.
- Creating a techno-scientific awareness in individuals in the society in which they live;
- Developing the ability to think or analyze situations in the society critically and resolve them effectively by techno-scientific methods.

NSTA has identified eleven features of STS programmes, and which indicate the importance of instruction over curriculum content. A very relevant and important feature is the emphasis on process skills, which students can use in their own problem resolution. STS approach should not be contemplated upon without recourse to the feature of STS programme (Ivowi, 2000), and in approach, its effective use in science teaching has been advised to concentrate on five factors:

1. Learner friendly environment;
2. Resourcefulness;
3. Learner centered approach;
4. Problem solving focus;
5. Efficient management of all resources.

In order to use the STS approach effectively in science teaching, teachers need to create situations where students will need the basic concepts and process skills. In this way, there is stimulation in the students' learning ability, and this type of learning is in line with the Constructivist Learning Model (Teetito, 2000). The model explains that knowledge can never be observer independent. It requires:

- A personal commitment to question;
- A personal commitment to explain, and to test explanations for validity;
- Each learner to put together ideas and structures that have personal meaning for learning to take place.

According to Yager (1992), the effective use of the constructive model involves the use of teaching practices with the following specific procedures:

1. Planning activities, which involve seeking out and using students' questions and ideas to guide lessons and the whole instructional units, accepting and encouraging students initiation of ideas, and promoting students' leadership, collaboration, location of information and taking actions as a result of the learning process.
2. Classroom strategies, which involve using students' thinking, experience and interests to drive lessons; encouraging the use of alternative sources for information both from written materials and live experts; and using open-ended questions;
3. Students' activities, which involve encouraging students to elaborate on their questions and their responses; encouraging students to suggest causes for events and situations; encouraging students to test their own ideas. For example, answering their questions and making guesses as to the cause, and predicting of certain consequences;
4. Teaching technique, which involves seeking out answers to students' ideas before presenting teacher ideas or before studying ideas from other textbooks or other sources; encouraging students to challenge each other's conceptualizations and ideas; utilizing cooperative learning strategies which emphasizes collaboration, respect individuality, and use of division of labour tactics; encouraging adequate time for reflection and analysis; respecting and using all ideas that students generate; and encouraging self analysis of real evidence to support ideas; reformation of ideas in light of new experience and evidence.

These strategies are organized by constructivist teachers into four categories:

- Invitation, which relates to observation of one's surroundings for points of curiosity by which the following occur; ask questions, consider possible responses to questions, note unexpected phenomena, and identify situations where student perceptions vary.
- Exploration, which involves engaging in focused play to brainstorm possible alternatives, look for information, experiment with materials, observe specific phenomena, design a model,

collect and organize data employ problem-solving strategies, select appropriate resources, discuss solutions with others, evaluate choices, engage in debates, identify risks and consequences, define parameters of an investigation, and analyze data.

- Proposing explanation and solution, through such action as to communicate information and ideas, construct and explain a model, construct a new explanation, review and critique solutions, determine appropriate closure, and integrate a solution with existing knowledge and experience.
- Taking action, such as to making decisions, apply knowledge and skills, transfer knowledge and skills, share information and ideas, ask new questions, develop products and promote ideas, use models and ideas to illicit discussion and acceptance by others, and approach decision makers in society urging them to act in specific ways.

3. Demonstration

Demonstration is the basic method for introducing new skills to learners. Learning of skills takes a lot in the doing content of technology studies. Demonstration consists of showing the learner how a skill should be performed. The teacher does the show while the students observe. This sounds simple. But it can slip out of purpose unless certain precautions are taken.

a. According to Navarra (2008), demonstration gives best result when students feel a need to learn new content. To get the student feel the need, they suggested that the knowledge content related to the demonstration should be taught first.

b. Having established the need for the new skill, the teacher should refresh himself as to the exact objectives of the lesson. This makes the planning and presentation of the lesson on the new skill easy. Many demonstrations fail because the teacher had no pre-determined beginning and end of the demonstration.

c. Every item (machines, tools, equipment, chart, drawing, instructional sheet), which is necessary to ensure a smooth and uninterrupted demonstration, should be at hand and properly

arranged before the demonstration begins. The item should be arranged in such a manner that they do not draw students' attention during a demonstration. Such items should be brought into sight at the time they are needed.

d. Students must be arranged in the most effective and comfortable way that would permit each and everyone of them to observe the demonstration without any hindrance. The environment around the demonstration must be made comfortable, noiseless and distraction-free.

e. Explanation on the essence of the demonstration is very essential. The explanations should centre on the objectives of and the principles guiding the demonstration. Students should be told in clear terms what they hope to gain by taking part in the demonstration.

f. There are usually more than one way of doing things. A good demonstration should start with one step or method at a time, and each segment should be performed slowly enough so that learners do not miss the important points.

g. A good demonstration is usually complemented with explanations and questioning. Explanations help to drive home the points in the demonstration while questioning helps to check the extent to which the learner understand and follow the demonstration.

When followed, these guidelines are capable of making the teaching of new skills effective especially if demonstration is closely followed by pupils' activities.

Pittz (2009) have identified two classes of models for learning skills. These are the traditional model and the improved models. The traditional models involve learning by imitation and directed learning. This model is relevant only in the learning of simple processes. It is not easy to use the traditional model to learn complex skills, which are highly organized and sequenced; learning of a skill through imitation cannot assist learners to acquire the technical information needed before practicing the skill while the directed learning approach inhibits information on reasons why a skill is being learnt. The components of the improved model include:

- Complimentary model
- Cluster model
- Tell them model
- Task-instructional model

The complimentary model involves the use of more than one method of teaching or technique in presenting skills to beginners. Thus the methods or techniques compliment one another. Complimenting a demonstration with the use of charts, explanations and questioning is an illustration of this model.

In the Cluster model, closely related skill components of a trade are brought together in clearly understandable form. Allowing students to practice a skill immediately after the teacher's demonstration is an example of this model.

The Tell-them model is usually employed for motivating a group of individuals interested in self development of skills in useful occupations. The model is very much applicable to a student whose skills have become obsolete and who wants a new skill. The tell-them model of skill training is used when an individual expresses some level of uncertainty about the skill to learn or about a skill of interest. The teacher then has the responsibility of telling the individual all that he needs to know about the skill for the individual to make up his/her mind. In this model, the individual is told what to do.

The task instructional model makes use of the problem-solving approach in presenting skills to the beginners. In problem solving, problems and methods of solving them are identified. The identified methods are tried out and finally tested for efficacy. Teaching learners how to carry out or repair job through the systematic approach is an example of this model.

The models have highlighted the different conditions under which skills can be learnt. Understanding the reason why learners want to learn a skill will help in the proper application of each model. Applying the models appropriately results in shooting without missing the target in skill learning.

4. Motivating learners to acquire skill

The important position of skill acquisition in technology education calls for the application of every effort to create the desire to acquire skills in the learner. The best plan of the teacher may fail to result in successful learning

unless the learners are physically and mentally ready to learn. This state of readiness must develop in the learners from within and cannot be forced by the teacher. What successful teachers do is to merely take the advantage of such state when it is presented. This of course does not suggest that the teacher should wait until some whim of learner induces him to readiness for learning before learning can be presented. There are then certain things, which the teacher can do to encourage a state of readiness on the part of the learners of skills:

1. The teacher must teach a skill when the learners show readiness to learn. Skills are graded from simple to complex. Presenting complex to young learners or to adult to learners may result in frustration and loss of interest in the learners.
2. To motivate learners, a teacher must demonstrate a high level of proficiency in the performance of the skill to the level that learners see it as a way of life or as a fun.
3. Relating the theory that guides the performance to the actual practice removes the mystery that surrounds some skill performance and makes learners to accept that they can do it. When the teacher makes clear to the learner the facts, the idea and relationship of the theory to the practice, learner's understanding increases and the desire to practice increases.
4. A practice environment that resembles the actual work environment creates the desire to learn in the learners of skill. The environment in which skill is taught is not different from the ones the learner will meet in the world of work.
5. The use of production jobs and not pseudo jobs motivate learners. Learners will put in all their efforts to practice a skill that leads to the production of a piece of article they see and probably make use of in their home and other places.
6. The teacher achieves high success in teaching learners to acquire skill if the learners get adequate explanation and information on what they are to learn. It is not enough to demonstrate proficiency of a skill; learners should be told where they could use such skills.

5. Helping learners to practice new skills

Nathan (2007) has presented useful hints on how learners can be helped to practice new skills correctly. It is crucial for learners to take the most appropriate steps when first they want to practice a new skill. This is because skill performance is a matter of habit information and habits are formed through practice. The teacher should provide for learners things to practice as soon as the demonstrations are over. These help the learners to imitate the teacher's steps in performing the skills since the mental picture of what the teacher did would still be vivid in their minds. Allowing a time lapse would bring some intervention by other activities that may blur the vividness of the learners' thoughts. The new skill should be practice correctly at the first attempt. This grooves in the habit of performing the skill correctly. However, it should not be assumed that new learners would show perfect performance at the first attempt. Taking the correct steps and using the correct tools in the performance of a skill are major indices of correct performance. With further practice on the first attempt, perfection would result.

Job sheet or operational sheet aid a learner to master the operation of a skill. The operational sheet contains the sequence of operations which learners can follow even in the absence of a teacher to master a skill. With it, learners can proceed with the practice of the new skill at their own rate. Production job is progressively gaining place in the teaching and learning of practical skills. A production job is an actual commercial type job, product or article upon which the learner works in order to gain proficiency in the skills he or she is attempting to perfect.

Importantly, the learners need careful supervision by the teacher when they are practicing the skill. There is the tendency for some teachers to act as though demonstration, provision of tools, materials and operation sheet are all that learners need to practice a skill. Learners practicing a skill need careful observation, correction, questioning, guidance and help. These can be done only if the teacher is present when learning and practicing the skill. Often time, teachers forget that they can be charged with negligence of duty if during a skill practicing session, learners receive bodily injuries or if any other avoidance incidence occurs.

6. Challenges to scientific and technological skills acquisition for vision 2020 in Nigeria

The primary level of education is the base on which the rest of the educational system rests. Nigeria's quest for scientific and technological

break-through can only be realized if the positive attitude of pupils in primary school science is encouraged. This can be archived through the following steps:

1) Only teachers who are NCE graduates in the basic sciences should teach science in primary schools, followed by in-service-training.
2) Science laboratory should be provided to all primary schools, where pupils could interact with scientific materials.
3) There should be curriculum reform; both the content and the methodology of the existing curriculum should be reviewed.
4) Computer room should be provided in primary schools help the pupils to develop skills in computer appreciation.
5) Need to deepen science knowledge of primary and secondary school science teachers.
6) Need to provide effective and sustained professional development of primary school science teachers.
7) Recognize that science and technology involve human progress towards a more prosperous equitable future within the context of education.
8) Need to recognize that global science and technology networks serve as a platform of bringing together relevant social and professional communities to facilitate the expansion of concerted international collaboration to move effectively to address the challenges of scientific and technological skills acquisitions.
9) Government must muster the political will of tackling educational matters in general and the issue of teachers and teachers' professional development in particular.
10) The efficient teacher is entitled to a decent salary and service conditions as his counterpart with identical or similar qualification and experiences in the civil service. This will enable him to carry out his duties effectively.

Conclusion

The study of science and technology is important at all levels of education. This is supported by the crucial role science and technology play in the

development of any nation. Primary school pupils can learn the skills of science and technology. The primary school pupil ordinarily engages in daily activities that demand the use of skill identified as scientific and technological. We have provided some rationale for the teaching and learning of science and technology at the primary education level, and indicated the skills that should be acquired in the process of proper exposure to related and correct experiences. We have discussed the strategies for skills acquisition, and in particular dealt with the use of STS approach in this connection.

For the teacher of science and technology, there are acceptable approach of teaching skill whether as a process or as a manipulation. The success in teaching skill comes from knowing the best approach to adopt, the mistakes to avoid the techniques for motivating skill learners, the skills to teach and how best to help learners practice the skills they have acquired.

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