

## Teaching Fundamentals Towards A Result-Oriented Science Learning

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### Abstract

*This paper identifies that most science teachers are faced with a number problems, and that the rapid development of science and technology coupled with substantial socio-economic growth poses unprecedented challenges to Nigeria's science education programme. Such development it is argued ordains that science education define its contents more sharply with regard to environment, information and teaching strategies. Discovery approach, the use laboratory, interactive demonstrations and classroom control were examined as validated instructional design features that benefit diverse learners and in turn accommodate the full range of students' diversity that teachers are likely to routinely encounter. The central idea is that by adopting a framework based on the different approaches including those not even mentioned in this paper, science teachers would definitely transform to become very effective with focus on a result oriented science teaching and learning*

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**Keywords:** result-oriented, teaching innovations, scientific enterprise, scientific attitude, diverse learners, learning context, process skills

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### INTRODUCTION

An issue not in doubt, is that most science teachers are faced with a number problems, ranging from organizing and putting into action a well balanced programme in science; providing good facilities for teaching science; knowing what content and experiences to use in developing science learning; providing continuity in the development of science experiences; evaluating children growth in science understandings, abilities and attitude; and above all, knowing how to direct the teaching of science toward the goals of science and general education.

Incidentally, the world we live is ever changing with startling rapidity. A phenomenon that is not new, but natural and has been occurring since the beginning of time. Therefore it is more important today than ever before for students to receive the kind of education which will equip them to: a) anticipate this acceleration; b) obtain the know-how necessary to adjust to it and c) to solve the problems which constant change creates. Furthermore, the scientific nature of our society and individual needs of its members, demands that every person must be scientifically literate to be able to function effectively. Accordingly, all citizens must therefore be taught to understand the nature of the scientific enterprise and change in tandem with the broad aims of science education which among others, is to stimulate and excite students' curiosity about phenomena and events in the world around them. As science teachers, our basic task is to foster interest at any level of ability to enable science learners with whom we are concerned, benefit by using their hands

in support of minds and learn best through practical experience and personal involvement.

### How can these be achieved?

The rapid development of science and technology coupled with substantial socio-economic growth poses unprecedented challenges to Nigeria's science education programme. Such development ordains that science education define its contents more sharply with regard to environment, information and general education.

Historically, its teaching innovations have been dominated by two instructional perspectives; traditional and process approaches. However, traditional bound approaches seem to be inadequate to communicate vital science contents to the students because it focuses only on the learning of scientific knowledge (facts, concepts, laws and theories) as a major classroom focus. In comparison, the process approach stresses the use of hands-on activities and/or laboratory experiment to develop understanding of the mechanics of how scientists gain knowledge that in turn serve as a framework for students learning about science through experience. (Michael et al 2007). In recent years, many science educators have advanced both approaches through the use of discovery/inquiry strategies that focus on the interaction between teacher and students. And in addition, there is an evolution moving away from the process of science as a set of specific skills to a broader issue about the nature of science as representing the means through which scientific knowledge evolves. In this regard, meaningful learning requires rich instructional environment

within which students can actively construct knowledge by integrating prior learning with present learning in a fashion that is conceptually coherent. Fortunately, in science teaching the choices in terms of strategies are plenty and we cannot afford to stick to only traditional mode of teaching, but must involve a variety of approaches to abstract information and content based on what is needed for the progress of science, society and the overall development of students. What this means therefore, is to involve a system that will integrate and translate previously established and newly evolving instructional perspectives into a form that can enrich teaching in a regular classroom setting. Consequently, some of those validated instructional design features that benefit diverse learners and in turn accommodate the full range of students' diversity that teachers are likely to routinely encounter is the focus here. These among others are: discovery approach; effective use of laboratory; interactive demonstration and effective science classroom control.

#### **Applying a Discovery Approach in Science Teaching**

One of the approaches to teaching science since the mid – 1970s is the discovery approach, which still hold a strong place even in early childhood pedagogy. In this approach, a number of contexts can be found. The first is guided discovery. In this particular context the investigation of problems is the teacher's responsibility. The teacher suggests or provides virtually all the equipment needed by the students to work through the problems. He equally recommends the steps that the students need to take in order to solve the problem (Fleer, 2007)

According to Fleer, In science methodology, teachers who use guided discovery approach are able to guide students observation by asking questions (either orally or on card) such as what happens when.....? What can you say?... What do you think? Why did....? And so on. In the process, the teacher also guides the children to engage in further investigation. The second type involves placing materials in the students' environment and allowing them to use them as they wish. In this type of discovery learning popularly referred to as unguided discovery, the teacher provides the learning context such as science table which often features natural objects like nest, shells leaves, magnets, nails, bottle tops, plastic straws magnifying glasses to name but a few. In turn the students decide which problem they wish to investigate, play with the materials and develop what Fleer et al (2007) referred to as a strong experiential base to provide answers to teachers question about what they are discovering as they manipulate the materials.

In the modified discovery learning, the teacher sets the problem but allows the students to suggest how

they might go about solving it. Sometimes the teacher provides a range of equipment but does restrict the students to use only that equipment. In the modified/guided discovery learning, students are encouraged to work in groups while the teacher acts as a resource person. In fact all the three learning situations mentioned above draw on a common principle of discovery learning. This approach according to Fleer et al (2007) grew out of the curriculum development movement in the 1960s a deliberate move away from the philosophy that students are the passive recipients of knowledge through traditional styles of teaching. In this approach, the teacher is often viewed as:

- ❖ A classroom resource
- ❖ A counselor and friend; or
- ❖ A neutral person

Therefore, managing students within the context of discovery learning relies on the teacher who should select and organize enough materials for all students to manipulate; decide the manner in terms of groupings; think about the safety and cleaning issues before the beginning of any activity and so on.

A point to note however is that in any form of teaching especially in science, it's hard to choose one approach or method. Using one approach only, deprives the students of varied study approaches and therefore would restrict their learning and decrease students' motivation. Varying teaching approaches would enhance learning and interest as each approach is as valuable as the other and no one is mutually exclusive. This idea is taken further in describing other approaches or strategies to teaching science.

#### **Science Teaching and the Laboratory**

Webster's dictionary defines the laboratory both as a place equipped for experimental study and as a period of time set aside for laboratory work. Whether one uses the word to mean a place or a period of time, the term according to Ronald and Norman (1981), is as much a part of science as the white coat is a part of the image of the scientist. The word "lab" or "laboratory" in the minds of most people is synonymous with scientific investigation. Laboratories vary, ranging from well-equipped rooms with benches, shelves, test tubes, and microscopes, to poorly equipped rooms in basements or garages. Laboratories also range from tents or grass hut to a backyard called science corners. It means that laboratory can be anywhere a person chooses to carry out an investigation.

#### **Unique Functions of the Laboratory**

According to Ronald and Norman (1981), over one hundred functions of laboratory work have been described in literature of science teaching. Most of these functions, however, can be grouped under five categories which represent the important goals in science education. These categories are:

1. Learning about the nature of science and technology
2. Learning problem solving skills
3. Learning manipulative skills
4. Learning major concepts and principles; and
5. Developing interest, attitudes and values.

For (1) above, science as a way of doing things through observing natural phenomena, quantifying what has been observed, and trying to bring meaning to these observations, are noted.

The way in which scientific knowledge is applied is what we call technology. While the fundamental nature of science and technology transfer differ. However, the two enterprises are nurtured by each other and in the minds of most people are inseparable (Ronald and Norman, (1981). Allowing students to experience a full range of activities in the laboratory will bring them closer to understanding science and technology and how the two enterprises interrelate. In (2) above, lessons are built around helping develop skills that relate to basic processes of science within the context of science a process approach (SAPA) which has units such as Observation, Classification, Using Numbers, Communicating, and Predicting. Students in this context are taught how to: become skillful observers; arrange objects into groups or classes; construct and display scientific relationship; and predict future events from past recordings. This approach can be utilized in teaching lessons on “Rocks”, “Butterflies” and “Plants” to mention just a few. Let me remind us that allowing students opportunities to develop basic thinking skills has long been recognized as a major goal of science education. Accordingly, as Ronald and Norman noted, a laboratory setting becomes an excellent place for students to learn how to observe, discriminate, arrange, classify, measure, experiment, evaluate, and engage in the processes of science.

In (3) above, these are skills often taken for granted in science teaching and learning. Students should be able to perform certain “bench skills” like measuring with a pipette, focusing on microscope, bending glass tubing, dissecting a flower or animals or even lighting a Bunsen burner. These are skills that require students to coordinate the knowledge with rather complex muscular control. The laboratory presents an excellent environment for students to master these basic manipulative skills.

The learning of major concepts and principles is another important goal of science education. The laboratory provides an opportunity for students to gain exposure to factual information and scientific phenomena such as the “big ideas” in science. These major ideas, like the conservations of mass, and energy, among others represent the corner stone’s of knowledge upon which science rest.

In terms of interest, attitudes and value development in students, Ronald and Norman indicated that the result of the most studies on teaching practice suggest that student interest in science is increased when opportunities for hands-on experience are provided.

Haney in Ronald and Norman (1981) proposed eight aspects of “scientific attitude” which are still valued. These attitudes are (1 Curiosity (2) Open mindedness (3) objectivity (4) intellectual honesty (5) rationality (6) willingness to suspend judgment (7) humility and (8) reverence for life. These attitudes or values foster the human enterprise of science and can be nurtured when students are provided and placed in a stimulating and challenging laboratory environment. Generally speaking, the skills and knowledge acquired from science courses with a strong laboratory input enables students to understand in more practical terms the workings of the natural world and other environmental issues. Therefore, it is by maintaining very serious hands-on; brains-on experience that the most promising potentials of science students can be accelerated and not turned off by mere lecture approach to science

#### **Interactive Demonstrations**

Science deals with observable and measurable phenomena. Hence, there are many things that are difficult to communicate to others without showing them. Accordingly, many topics can be effectively presented to students using interactive demonstration approach which has been judged by many science educators as a very effective approach. This approach reflects the multifaceted nature of science and emphasizes science as a human construction. (Fleer et al, 2007).

Biddulph and Osborne in Fleer et al (2007) recognized a need for phasing interactive demonstration teaching and suggested a two-stage process. In stage one; the teacher should try to be more sensitive to the student’s ideas and questions with increased confidence. While in stage two, he should provide exploratory activities, through which he assists students to raise useful questions, refine these and help them to plan to carry out their investigations.

This approach has implications for the topics the teacher might choose to teach. And as a guide to selecting appropriate topics, Osborne and Freyberg (1985) indicated that school science should have relevance to

1. Everyday events
2. Students existing idea; and
3. Human relationship

And moreover, a wide variety of objectives can be achieved using this approach.

Some of the examples are:

1.	To show methods or techniques	Focus a microscope, use universal indicator paper to find the PH of a solution
2.	To display objects or specimens	Rocks, and minerals, leaves parts of TV set etc
3.	To verify facts and principles	Freezing point of water is 0°C water expands when it freezes etc
4.	To show applications	Effects of fertilizer on plants, oxygen preparation etc.
5.	To solve problems	How can sugar be separated from white sand? Differential expansion of metals when heated.

In the final analysis a combination of interactive and demonstration poses many advantages as a teaching strategy. Chief among these is that this approach like laboratory work, allow students to observe real objects and events. But in contrast, to laboratory work are usually more economical of both teachers and students time and class control very easy.

Teaching within this framework emphasizes the importance of exploration and engagement with students' initial understandings, and hence encouraging them to assume a higher level of responsibility for their own learning.

**Classroom Control in Science Teaching**

The nature of classroom climate and the quality of interpersonal relationships are fundamental to establishing a positive learning environment. Unfortunately in educational circles, no one pays any attention to good classroom control until it is missing. But certainly, if classrooms are managed well, they run smoothly and students are actively engaged in learning. In a typical science classroom or laboratory any form of control that orients students toward passivity is not only obsolete but counterproductive and hence undermine students engagement in active learning and what Charles and Senter (2002) called social construction of knowledge.

Effective classroom control in science teaching has two main goals. One is to help students spend more time on learning and less time on non-goal directed activity. And two to prevent students from developing academic and emotional problems

In the context of the above, increased academic learning time would be made possible through the following options: maintaining activity flow; minimizing transition time and holding students accountable. In maintaining activity flow, teachers should as much as possible avoid flip-flopping, responding to distraction and over dwelling on issues they thing students already know. In minimizing

transition time and perhaps holding students accountable, teachers need to decrease the chances of disruption and misbehaviour by properly communicating assignments and requirements which is an aspect of behaviour management. As a matter of fact, no matter how fantastic a lesson plan is and material well differentiated for the class, without discipline and good standards of behavior it will all amount to nothing. Therefore to ensure that common misdemeanors do not occur, cardinal rules of classroom control must be enforced. These rules range from some level of punishment for late coming to talking while teaching is going on (Davies, 2006).

**CONCLUSION**

Some approaches to the teaching and learning of science have been examined in this paper. These approaches which are not mutually exclusive have their differences, similarities and relationship which would help science teachers to develop their own framework for teaching science. By adopting a framework based on the different approaches including those not even mentioned in this paper, science teachers would definitely transform to become very effective with focus on a result oriented science teaching and learning.

**RECOMMENDATION**

It is therefore important not to reject any one of these, but rather consolidate the understanding of each by carrying a systematic comparison of these approaches in terms of advantages and problems. However, irrespective of any particular approach in the framework, the following under listed principles are critical to science teaching. These are: taking into account student ideas in planning and teaching; developing a clear rationale and a set of learning outcomes; developing students learning within appropriate contexts; engaging students objects and materials; encouraging students to ask their own questions and encouraging students to be sensitive to their environment and so on.

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