THE INQUIRY METHOD OF APPROACH IN THE EFFECTIVE TEACHING OF MODERN PHYSICS CONCEPTS IN SECONDARY SCHOOLS

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ABSTRACT

Although a primary objective of the teacher is to effectively teach concepts and despite that the National Policy on Education emphasizes the inquiry method of teaching approach for the effective teaching of science concepts, many science teachers in Nigerian institutions employ methods which promote memory and understanding rather than rational thinking and productivity. This paper has investigated into the inquiry method of teaching approach which can be used to effectively teach Modern Physics concepts for logical reasoning and subsequent productivity. The approach sees the teacher as, amongst others, a guide to effective learning. Finally, the paper illustrated how the inquiry approach can be used effectively to teach 'energy level quantisation in the atom' and 'radioactivity' as concepts in Modern Physics.

INTRODUCTION

As a process of scientific investigation, the search for a wholesome understanding of physical phenomena is pursued in every part of the world. The quest for improved method of teaching science to facilitate learning is also worldwide. If science is to be learned effectively, it must be experienced (UNESCO, 1973). According to Abdulahi (1982: vii) science teachers in Nigerian schools now have a greater responsibility towards the effective teaching of scientific principles to students as these principles provide the basis for technological growth. Students' lack of interest (Zira, 2000) and poor performance in Physics in our schools may be attributed to the teaching methods used by the teachers, which promote memorization rather than logical reasoning for productivity. A teaching method that does not adequately convey the science concepts to students will definitely lead a nation to technological deprivation. Modern Physics concepts, most of which seem abstract to students, require a teaching method that would develop interest and great understanding of the concepts in the students.

The inquiry method of approach in the teaching of science can be effectively employed to teach Modern Physics concepts bearing in mind Renner, Stafford and Ragan (1973) maintain that inquiry is a method of teaching science while lecture, questioning, discussion, demonstration and others are techniques of inquiry. In an inquiry – centred classroom the teacher is at disposal to employ some or all of the aforementioned techniques. A big problem that may however be encountered by teachers in the inquiry – centred classroom, and the most difficult to maintain is the type of assessment necessary to demonstrate that learning has effectively occurred. It does not suffice to use a method in teaching science. The method must be seen to have positive effect by achieving the intended educational objectives.

To ascertain whether a student has effectively learned a concept taught by the teacher, a form of student assessment called continuous assessment can e administered on the student. According to Vasquez (1998) continuous assessment strategies involve asking the students to generate a response rather than choose one; actively accomplish complex and significant tasks; and solve realistic and authentic problems. Students' responses in the classroom can be assessed through exhibitions, demonstrations and written or oral responses at an agreed frequency, per term. The continuous assessment (Turton, 1984) divides educational objectives into three: Cognitive objectives which deals with intellectuals and academic thought process; affective objectives which is concerned with attitudes, interests, belief and character; as well as the psychomotor objectives which is concerned with physical attributes such as muscular co - ordination and manipulative skills. As assessment is an integral part of inquiry method, the National Policy on Education (1981) emphasizes on the continuous assessment system of student assessment. Hence, there is the need to also inform science teachers of methods suitable for teaching certain concepts in the continuous assessment system of concept evaluation.

THE ROLE OF THE SCIENCE TEACHER IN THE INQUIRY METHOD OF TEACHING.

The inquiry method of teaching approach connotes seeking and discovering by investigation rather than learning from exposition (Science Teachers

Association of Nigeria, 1988). Students develop understanding of a concept by interacting with the content. These interactions are part of the students' total learning process. It is important to recognize that students also possess skills that pose the teacher as a good guide of inquiry. Students and teachers are altogether involved in investigating scientific problems during inquiry that eventually leads to guided discovery. Here the teacher guides learning rather than direct or dictate. This is to say that teachers are facilitators and resources persons for learning to take place.

According to Vasquez (1998:8) inquiry- based teachers are seen to:

1. **encourage and accept students' autonomy and initiative;**
2. **use raw data and primary sources, along with manipulative, interactive and physical material;**
3. **frame tasks, using cognitive terminology such as classify, analyze, predict and create;**
4. **allow student responses to drive lessons, shift instructional strategies and alter content;**
5. **familiarize themselves with students' understanding of contents before sharing their own understanding of those concepts;**
6. **encourage students to engage in dialogue, both with the teacher and with one another;**
7. **encourage student inquiry by posing thoughtful open – ended questions and asking students to question each other;**
8. **seek elaboration of students' initial responses;**

9. engage students in experiences that pose contradictions to their initial hypotheses and then encourage discussion;
10. allow time after posing questions;
11. provide time for students to construct relationships; and
12. nurture students' natural curiosity.

When students are carrying out an investigation, the inquiry – based teacher gives only a little hint knowing that students' progress is facilitated if the teacher withholds the solution and details concerning the investigation. Although the teacher may be tempted to provide the answer and details to students, a better result is obtained when the teacher suffers in silence by not supplying the answer or details. In the inquiry method of teaching approach, the students find pleasure in making mistakes since the body of knowledge they construct in making the mistakes is the important product of the investigation. When the students are at work on the problems, resources and responses are readily provided by the teacher as classifications may be called for the students. The teacher assesses the work when the students obtain their findings. The teacher who uses the inquiry method of approach is rewarded when he finds that his students develop as independent learners. The student themselves find pleasure and satisfaction and will assume the responsibility of being independent explores and thinkers. Olarinoye (1982) confirmed that inquiry – thinking abilities are developed only when students indulge in activities that require performance of mental tasks. The ability to think logically and sequentially is gradually developed in the student taught by the inquiry – based teacher. Learning by inquiry (Renner, Stafford and Ragan, 1973) will not only develop the rational powers of the child's mind, teach him the structure of the discipline of science and let him experience the tremendous thrill that accompany scientific investigation, but will also make him consider the knowledge he accumulates as the most significant of any of the knowledge he has.

APPLICATION OF THE INQUIRY METHOD TO THE CONCEPTS 'ENERGY LEVEL QUANTISATION IN THE ATOM' AND 'RADIOACTIVITY'

The inquiry method of teaching can be used to effectively teach various concepts in Modern Physics. In this research work, however, two concepts only: energy level quantisation in the atom and radioactivity were used to illustrate the application of the inquiry method of approach to the teaching of concepts in Modern Physics.

1. Energy Level Quantisation in the atom:

In the inquiry method of teaching approach the teacher in teaching 'Energy level quantisation in the atom' provides the following guide for the students to embark upon:

i. For the investigation you will need two discharge tubes (one with hydrogen gas and the other with carbon IV Oxide), connecting wires, a high voltage source of 1000V and a diffraction grating. Collect the apparatus from the cupboards. Now, study and set up the experiment first with the hydrogen gas discharge tube. Observe whatever physical phenomenon you can see with the diffraction grating. Repeat the procedure using the Carbon IV oxide discharge tube. Also observe any physical phenomenon. Compare the observations you have made (Nelkon and Parker, 1987).

ii. At the end of the students' investigation, the teacher may ask the students what they observed in the discharge tube each time they used the diffraction grating in the two experiments. This is to enable the teacher assess the students' achievement. After receiving responses from the students the teacher then elaborate by letting the students know that the well - defined separation lines they had observed when the hydrogen gas discharge tube was used is called a line spectrum. The well - defined separation lines the students observed when the Caborn IV oxide discharge tube was used is referred to as a band spectrum. The teacher proceeds to explain that the separation lines observed is the experimental evidence for the existence of separate or 'quantised' energy levels in the atom. The lecture method being a technique of inquiry can now be used to explain the quantisation of energy levels in the atom.

2. **RADIOACTIVITY:**

The following hints are provided to students for the investigation:

You will require a radium - 224 source, a strontium - 90 source, a cobalt - 60 source, spark counter, a sheet of thin paper, Geiger - Muller (GM) tube, ratemeter, low - noise pre - amplifier, lead plate (about 1cm thick), very thick lead and a strong magnetic field. Obtain the apparatus from the cupboard.

First, set up the apparatus by placing the radium – 224 source above the spark counter. Write down what you observe. Place the thin sheet of paper between the radium source and spark counter. Write down your observation. Now connect the low – noise pre-amplifier to the ratemeter and connect the ratemeter to the GM tube. Place the radium source in front of the GM tube. Measure and record the count rate. What difference is there in the count rates when the investigation is done without paper and when the paper is introduced? What conclusion can you make?

Secondly, place the lead plate between the strontium – 90 source and GM tube. Measure and record the count rate. Place the strong magnetic field behind the lead plate in a direction perpendicular to the radiation from the strontium source. Direct the magnetic field into the paper and measure and record the count rate. What conclusion is drawn?

Thirdly, use the cobalt – 60 source to replace the strontium – 90 source in the first investigation. Is the count rate high or low without the thick lead placed between the cobalt – 60 source and GM tube? Now place the thick lead between the source and the GM tube. Is the count rate high or low? Introduce a magnetic field between the lead and GM tube. Does the magnetic field cause by change in the count rate?

After assessing the students' work the teacher then explains the three types of emissions from radioactive sources relating them to the above investigation.

When the Radium – 224 source was placed above the spark counter the sparks observed in the spark – counter indicated that particles were emitted. When the thin paper was introduced between the Radium source and spark counter the sparks stopped because the paper absorbed the emitted particles. The count rate observed when the Radium source was place in front of the Geiger-Muller tube was the same as when the paper was in between the source and GM tube. Conclusively, the radiations detected by the spark counter but absorbed by a thin sheet of paper are called alpha particles (α - particles).

When the lead plate was placed between the strontium – 90 source and the GM tube the count rate was observed to be low. When the magnetic field placed behind the lead plate in a direction normal to the radiation emitted was directed into the paper the count rate increased. This indicates that the radiation emitted were strongly deflected. Conclusively, the radiations that are strongly deflected by a magnetic field and are absorbed by about 1cm of lead are called beta particles (β - particles).

When the cobalt – 60 source was used without a paper placed between the source and the GM tube the count rate observed was high. Using a very thick lead between the source and tube the count rate continued to be high. Also, the count rate was not affected by the introduction of magnetic field between the lead and tube. This third investigation shows that the radiations emitted have high penetrating power in air and are undeflected by magnetic fields. Such radiations are referred to as gamma – rays (γ – rays)

The teacher further explains radioactivity as the emission of α - particles, β – particles and γ – rays from heavy elements whose nuclei are unstable.

teacher must develop confidence in his or her ability to identify and implement different teaching methods.

REFERENCES

Abdullahi, A. (1982). Science Teaching in Nigeria. Ilorin: Attoto Press Ltd.

Federal Ministry of Information (1981). The National Policy on Education.

James, T and Awodi, S. (1997). "The Relative Effects of Inquiry and Lecture Methods on the Performance of High and Low Achievers in Senior Secondary School Biology". Journal of the Science Teachers Association of Nigeria. 32 (1, 2) pp. 59 - 64.

Nelkon, M and Parker, P. (1987). Advanced Level Physics. Lagos: Heinemann Education Books (Nig). Ltd.

Olarinoye, R. D (1982). "The Inquiry and Discovery Methods of Teaching Science". Journal of the Science Teachers Association of Nigeria 21 (1). Pp 168 - 180

Renner, W.T, Stafford, D.G. and Ragan, W.R. (1973). Teaching Science in the Elementary School. New York: Harper and Row Publishers.

Science Teachers Association of Nigeria (1988). Science Teacher's Handbook. Ikeja: Longman Nigeria Limited.

Turton , P. (1984). The Northern Nigerian Publishing Company. Cc ıtinuous

Assessment System. Zaria: NNPC Ltd.

UNESCO (1973) . New UNESCO Source Book for Science Teaching.
Paris: The UNESCO Press.

Vasquez, J. (1998). "The Teachers' Role in the inquiry – centred experiences".
Science Teachers Association of Nigeria Bulletin 15 (2). Pp 8 – 10.

Zira, A. M. (2000). "Arousing and Sustaining students interest in the study of Modern Physics". A lead paper presented at the Science Teachers Association of Nigeria Physics Panel Workshop / Seminar on the theme: Strategies for Effective Teaching of Modern Physics. It held at Government College, Katsina from 24th – 29th April.