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The Use of Manipulatives Materials in the Teaching of Physics in Secondary Education in Nigeria: An Overview

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ABSTRACT: In order to succeed in physics especially in the Nigerian educational system, students must expand an understanding of abstract concepts. Elementary instructors often use manipulatives to represent concretely the abstract concepts that students are learning and to connect these concepts to previous knowledge as relates to physics. Traditionally, instructors and learners used concrete manipulatives, however, in many contemporary classrooms instructors and students also use manipulatives (pictorial and virtual). This review article will begin by defining, and providing examples and potential applications of manipulatives. Next, this review article will present the theoretical foundations and importance for teachers and students to use manipulatives in physics education in Nigerian educational system. Finally, this review article will review the literature on the impacts of teachers and students using physics manipulatives. The authors hope that this review article reveals the factors and conditions that may contribute to instructors' and learners successes and struggles with use the manipulatives.

KEYWORDS: Physics, Manipulatives, Teaching, Secondary Education, Nigeria.

1 INTRODUCTION

The majority of pupils in the primary school in Nigeria like sciences but they start developing decreasing interest in science at the lower post primary level (Junior Secondary School) and finally, they have zero interest in the higher post primary level (Senior Secondary School) because of the abstractness of the science subjects i.e. chemistry, physics, mathematics etc. The hate for mathematics at this level is of the same magnitude for physics, since mathematics is actually the language of physics. Teachers should always try to find ways to actively engage their students not only for understanding concepts but also to create elements of fun and excitement so that students' interest can be kindled. A manipulative material is an object(s) that can be handled by an individual in a sensory manner during which process, conscious and unconscious thinking will be fostered [6]. Using manipulative materials has become one way of involving students in fun learning that encourages motivation of students. Manipulatives have also been useful in making abstract ideas concrete for learners and thereby making for conceptual understanding [5]. The pedagogical context of this study is to promote effective learning through helpful teaching techniques using manipulatives in physics classrooms in Nigeria educational system. That means the teacher should not be a transmitter of knowledge but should instead act as a facilitator to the construction of knowledge for all learners. The fact that every classroom consists of students with different levels of cognitive ability, mathematical concepts means that teachers should focus on using multiple teaching strategies so that all students can benefit [3]. Manipulatives are different from teaching aids/ instructional material while the first is learners centered and the second is teachers centered.

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1.1 OBJECTIVES

The objectives of the study are to review the available literatures, discuss its importance and also recommend its uses in the Nigeria educational system.

2 LITERATURE REVIEW

So much has been done in the uses of manipulatives materials in the physical sciences available online in reputable journals. But the uses of these materials are not common in physics from the available literatures. As a result of empirical and anecdotal evidence that shows greater student achievement when manipulatives are used, districts throughout the country encourages their teachers to attend workshops that acquaints them with how to properly use manipulatives as instructional tools [5] [4]. It is important for children to have a variety of materials to manipulate and the opportunity to sort, classify, weigh, stack and explore if they are to construct mathematical/physical knowledge. "*In order to have opportunities to learn mathematical phenomena, children need firsthand experiences related to mathematical phenomena, interaction with other children and adults concerning these experiences and time to reflect on the experiences*" [16]. [8] applied a systematic method in his study of manipulatives, he took 55 sixth graders coming from three different classes of a primary school in Nicosia, Cyprus. All students of all three classes were taught about Electric Circuits during their science classes by the same teacher for 3 weeks (2 hours per week), with different condition and the results gotten was good. [10] Investigated how using physical or virtual manipulatives affected undergraduate students' conceptual understanding of heat and temperature in the context of the Physics by Inquiry curriculum. The study involved quantifying students' conceptual understanding into conceptual knowledge gains and the identification of students' concepts about temperature and changes in temperature. The aim of the latter identification was to examine whether the type and nature of student conceptions differed between experimentation with physical and virtual manipulatives. This present study of manipulatives is in the whole area of physics as a subject offered at the ordinary level of Nigeria educational system [7] [9] [11].

2.1 THE IMPORTANCE OF MANIPULATIVES IN SCIENCES

If technological development is what we need in the country then the foundation of science and technology should be taken very serious, this necessitates the present study. Manipulatives are very important to the learning of sciences especially the physical sciences (physics). [8] Made references to [12] frame work that involves a series of steps that require to be followed in order to reach a fine blending of Physical Manipulatives and Virtual Manipulatives. According to [10] the "*physical manipulatives in the area of thermodynamic involves the use of real instruments (thermometers), objects (beakers, styrofoam cups, and heaters) and materials (wood, aluminum, and water) in a conventional physics laboratory*". During the experiments feedback is available to students through the behavior of the real system (for example, water boils or not) and through the instruments that are used to monitor the experimental setup (for example, thermometers). In a study by [17] and reported by [1], "*the researcher used manipulatives to help reinforce and introduce mathematical ideas to a group of about 60, fifth-grade boys and girls. These students had been given a pretest which helped identify areas that needed improvement. The researcher found that the students were eager to learn using the manipulatives and experienced an average of 10% gain on the posttest over the same material*". [17] pointed out that many teachers do not use manipulatives because they feel they are too time-consuming, given the amount of material that now has to be covered in an academic year prior to standardized testing but the result gotten after the standardized test will be very good and impressive.

2.2 ITS USES/ APPLICATION IN NIGERIAN SCHOOLS

A brief introduction to the Nigerian secondary educational systems, the structure of this stage according to the government of Nigeria are listed below

- Secondary education shall be of six years duration and given at two stages of three years duration each; a junior secondary stage (or UBE year vii to ix) and senior secondary school.
- Curriculum activities of junior secondary school shall be pre-vocational and academic, and shall include all basic subjects which will enable pupils to acquire for further knowledge and develop skill.
- The senior secondary school shall be comprehensive and shall have a core curriculum designed to broaden student's knowledge and outlook.
- The minister is empowered to issue direction in respect of the curriculum in both stages of secondary education in order to maintain minimum standard.
- The core and optional subjects shall be subject to revision from time to time by the minister [13].

The secondary educational development since the independence was influenced by a number of factors [14]. Some of these factors include

- The expansion in primary education.
- The decision of government to implement the Ashby commission recommendations.
- The implementation of the decisions of Africa states at the Addis Ababa conference by Nigeria.
- The recommendations on the improvement of the content and method of secondary school curricula.

It is said that manipulatives will aids learning experiences at any particular time and space especially in the mathematics and physics, applying this concept discussed into our educational system will aid the developmental quest of the nation. Mathematics and physics are very important foundation to the development of science and technology of any nation, which is why, attention to these subjects from the very foundational level (post primary level), will help the country in the long run.

3 MANIPULATIVES IN PHYSICS

Manipulatives materials here are limited to the upper post primary educational system (senior secondary school) where physics is offered as one of the science subjects. The bases here are taken from the examination body called the West Africa Examination Council [15]. Below are the lay out as available in the syllabus of the above examination body. The materials that are needed in this educational level are enumerated and they will help in the understanding of the Physics.

3.1 INTERACTION OF MATTER, SPACE AND TIME

Here, the concept of matters, fundamental and derived units, position, distance and displacement, mass and weight, time, fluid, motion are discussed and the needed manipulatives ranges from the natures of matters; solid, liquid and gaseous, crystalline and amorphous materials, evidences of length, mass and time, measuring instruments, materials on motions of a body etc can be produced, sighted and be handled by the students when these topics are be taught in the class.

3.2 ENERGY: MECHANICAL AND HEAT

Here, the concepts of energy, work and power and heat are discussed with their respective manipulative materials whenever learning and teaching is taken place. The manipulatives materials needed here are solar, wind etc, thermometers and vacuum flask.

3.3 WAVE

Manipulatives materials needed here for effective learning and teaching experiences are ropes, springs, luminous and non-luminous bodies, pin-hole camera, mirrors, prism, optical fibres, lens, etc. these are designed so that it can be used effectively by the students.

3.4 FIELD

Manipulatives materials needed here for effective learning by the students are the needles, iron fillings, capacitors, resistors, cells, ammeters, voltmeters, conductors and semi-conductors, electrical motors, potentiometers, meter bridge, Wheatstone bridge, steel, alloys, mariner's compass, inductors etc

3.5 ATOMIC AND NUCLEAR PHYSICS

Manipulatives materials that aids learning in this area of physics are but not limited to, are the x-ray; its structure, production, types, properties, uses, hazards etc be represented pictorially for the benefit of the learner.

4 CONCLUSION AND RECOMMENDATION

This work has discussed extensively the important, needs and uses of physics manipulatives in secondary education system in Nigeria. From the above, it is been shown that manipulatives will aids learning experiences in physics at the level of focus. It uses, is highly recommended for the secondary school system in Nigeria if the nations quest for technological development is in view because it gives a good foundation to the development of science and technology at the very

beginning of education. As discuss above, it should be a package that is given to the students as the term begins. The subject matter is actually taken at senior secondary school level so these materials are given to students and are used every time the subject is been taught in the class for effectiveness of the learning process. It will also help in the retention of knowledge and transfer of knowledge at that level.

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