Enhancing Physics Education Delivery Using Model Lead Test (MLT) Instructional Strategy in Nigeria Secondary Schools

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Abstract
Physics as a science subject is a foundation upon which the scientific and technological advancement of any nation rests. Physics instruction at secondary education is activity and practical-oriented and needs activity base method for teaching the subject. The paper discussed the use of Model-lead-Test (MLT) instructional strategy in enhancing physics delivery in secondary education. MLT is an activity and practical oriented method of teaching physics for efficient access to needed information in Physics. It is a transmission –style instruction that is student centered. The MLT strategy comprises three stage processes for teaching. The strategy involves the teacher modeling the problem for the students, leading the students through the problem and then testing the students on what they have learned. The MLT strategy encourages learning independently, emphasizes rapid feedback and guide students to express and reflect on their own. This paper examined the status of Physics instruction delivery in Nigeria, implementation considerations of the MLT strategy as well as principles of operation of the MLT for efficient Physics delivery.

Keywords: *Instruction, Physics, Model-Lead-Test, Strategy, Science, Secondary education,*

Introduction

Science and Technology are viewed as the critical instrument for the upliftment of any nation's economy (Ogunleye & Babajide, 2011). This assumption is collaborated by Adepitan (2003) and Olagunju, Adesoji, Iroegbu and Ige, (2003) who stated that the economic and political strength of any nation depend on her scientific and technological achievement. Furthermore, Onasanya and Omosewo (2011) stressed that science is regarded as the foundation upon which the bulk of present day technological breakthrough is built. The impact of science is felt in every sphere of human life so much that it is intricately linked with a nation's development (Okwelle, 2014).

The field of science comprises basic disciplines including physics, chemistry, mathematics and biology (Oladejo, Olosunde, Ojebisi & Isola, 2011); all taught as component subjects at secondary education. The objectives of studying physics in schools as contained in Nigeria's national education scheme designed for secondary school physics (1985) include among others, to provide basic literacy in physics for functional living in the society and to acquire essential scientific skills and attitudes as a preparation for the technological application of physics. Jegede and Adedajo (2011) believe that physics education is a major factor in enhancing technology development. Similarly, Ogunleye and Babajide, (2011) assert that Physics is a *sine qua non* to the technological development of any nation and it is the foundation upon which the scientific and technological advancement of any nation rests. They went further to state that the subject is the foundation of scientific knowledge as it has contributed immensely to the existence and activities of man towards improved standard of living and growth in wealth.

Thus, physics as a science subject is activity or practical-oriented and the appropriate methods of teaching it is activity base. This suggests that the mastery of physics concepts cannot be fully achieved without the use of student – oriented instructional strategies. A common technique required for successful knowledge attainment in secondary school physics is active academic responding (Heward, 1994). In the same vein, Greenwood, Delquadri, & Hall (cited in Shouse, Weber, McLaughjin, & Riley, 2012) reported that the more time students spend actively responding to learning tasks, the greater the students' acquisition and maintenance of material in and out of the classroom.

Status of Physics Instruction at Secondary Education

Learning in physics has many different aspects. According to Redish and Hammer, (2009), the goal of physics instruction is often to guide students to more expert-like understanding of and beliefs about physics. Reif (1995) stated that in order for students to effectively use their conceptual knowledge of physics, it must be organized in such a way that allows efficient access to needed information. Unfortunately, students' knowledge of physics, often even after instruction, is typically disorganized and incoherent; students tend to view physics concepts as a set of unconnected facts (Wieman & Perkins, 2005). In addition, it is not enough for students to demonstrate an ability to use physics knowledge to solve problems and explain phenomena during instruction. If students have truly gained a conceptual understanding of physics, they should also be able to add new knowledge to their existing organizational structures and retain and use that knowledge after instruction is over. By contrast, physicists' knowledge tends to be arranged in a very hierarchical structure, with many ideas and concepts subordinate to a few main ideas (Reif, 1995; Redish, 1994). There is some evidence that knowledge organized in this manner is more easily accessed and used by students to perform various tasks as well as being retained for longer periods of time (Eylon & Reif, 1984).

Significant empirical research has shown that student learning can be substantially improved when instructors move from traditional, transmission-style instruction to more student-centered, interactive instruction. (Henderson, Dancy, & Niewiadomska-Bugaj, 2012). Despite the importance of Physics, there are a number of observable problems plaguing the teaching and learning of the subject, especially at the secondary school level. These problems include poor method of instruction (Kalijah, 2002). This is supported by the assertion of Agommuoh and Nzewi (2003) that attributed the deterioration in students' achievement in Physics to ineffective method of teaching Physics. These perhaps may be the reasons for students' poor academic performance in the subject both at the secondary and tertiary school levels. Based on this deplorable trend of poor performance, Physics educators have designed some instructional strategies over the years to curb the problem of underachievement in the subject.

The teaching methods and strategies that have been empirically shown to improve student learning in physics include Peer Instruction, Interactive Lecture Demonstrations, Tutorials, Cooperative Group Problem Solving, and Workshop Physics (Heller & Hollabaugh, 1992; Iroegbu, 1998; Orji, 1998; Mazur & Crouch, 2001). In spite of the scope, depth and supposed efficacy of these varieties of strategies, Physics students at the secondary school level continue to exhibit poor performance in the subject (Ogunleye & Babajide, 2011).

Poor student performance in Physics perhaps may be linked to the use of instructional strategies which have not totally incorporated learners' previous knowledge and how they reasoned (Ezeliora, 2004; Okoronka, 2004; Okoli, 2006; Longjohn, 2009). This is more so as instructional strategies adopted by teachers have not solved the problem probably because those strategies have not actually focused on learners as constructors of their own theories and knowledge. Learners need to be made to construct their own knowledge and ideas in learning because they are the architects of their own learning and constructors of their own ideas and knowledge (Okoronka, 2004). Otherwise, continued use of teacher-centered or teacher-dominated strategies would yield nothing but learning by rote thereby making it difficult for students to recall pieces of information from memories. It is against this background that the present study is designed to adopt the use of Model-lead-test strategy instruction (MLT). The MLT involves active participation of learners and has the potential of engendering improved Physics achievement. This strategy is credited with the possession of potentials for allowing the self-efforts and abilities of learners through active process leading to good performance in Physics.

Concept of the Model-Lead-Test Strategy Instruction (MLT):

The Model-lead-test strategy instruction (MLT) is a three (3) stage process for teaching students to independently use learning strategies (National Center on Educational Outcomes, nd). The stages include:

1) Teacher models correct use of strategy;
2) Teacher leads students to practice correct use;
3) Teacher tests' students' independent use of it

The Model-Lead-Test correction is used in situations that call for student responses that are difficult to produce. This strategy can be used for all students in a general education setting (Jones, Wilson & Bhojwani, 1997). It is another effective technique used with children in error correction which employs a model, a lead through, and a final test of the correct answer. The procedure is employed immediately after each error. More recent research has shown that the model lead and test components can be successfully employed to teach a wide range of skills for students with diverse disabilities (Shouse, Weber, McLaughjin, & Riley, 2012). There are several reasons for adopting this strategy to physics instruction: First, because it brings instruction closer to emulating scientific practice. Second, because it addresses serious weaknesses in traditional instruction. The main distinguishing factor of the MLT procedure is that, the teacher is carefully managing and evaluating the education levels of the students.

Description of Model-Lead-Test Strategy Instruction Practices:

The Model-Lead-Test strategy is an excellent strategy to use in Physics, especially with older students. This strategy involves the teacher modeling the problem for the student, leading them through the problem, and then testing them on what they have learned. In this context, the steps involved are as follows:

Model: this is the first step in this strategy. It shows**: What (Concepts), Why (Propositions),**

How (Strategies), and **How to (Operations).** Here, students witness a ***faultless demonstration*** of:

a) examples of a **concept** (e.g., pressure, work and electromagnetism);

b) a **proposition**, principle, rule, or relationship (e.g., gravitational force, the principles of acceleration and deceleration, Fleming's R.H. Rule)

c) a **strategy** (e.g., for solving a mathematical problem);

d) an **operation** (e.g., how to solve an equation, how to graph data points; how to experimentally verify physical laws such as Faraday's laws of electrolysis, evaluate, identify areas to improve).

At this stage, the teacher will model various physics problems such as measurements, verification of laws, solving mathematical physical problems, etc. with the students. *The teacher will model examples for the students to follow.*

Lead**:** This step is ***guided practice***. Students do the task (e.g., define or use a concept, demonstrate or find a proposition, use a strategy, perform an operation) **with the teacher**. The teacher makes sure everyone is getting it right. It is at this stage that the teacher will then give each student the same problem or task, and lead the students through it. The teacher will allow the students to practice how to correctly assess the problem.

Test**:** This step does two things:

a) It gives students a chance to **practice** with less scaffolding or assistance (the principle of ***"mediated scaffolding"***); and

b) It enables the physics teacher to **identify** how well each student gets it.

After modeling the problem and leading the problem with the students, the teacher will then give the students their own problem to try by themselves. This will allow the students to "test" the type of problems they have been learning at hand. When the students are tested this will enable the teachers to see whether or not the students have understood the problem through the Model-Lead-Test instructional strategy. Once students attain a score of 80% correct on two consecutive tests, instruction on the strategy ceases.

Implementation Considerations of the MTL Strategy:
It is believed that this is an effective strategy to use in classrooms when teaching a difficult topic in physics for the students to understand. For example, if the teacher is teaching *measurement of energy* it would be important for the teacher to model, lead, and then test the student on this topic. This will enable the teacher to teach the students through the *measurement principles* and then test them individually on the process they have learned. The teacher should consider making sure the students understand the topic in modeling enough to being led into the process of the problem and then tested on it. This is important because a teacher should not give a student an assignment that was not thoroughly explained before-hand. Another consideration would be to

consider when the teacher is going to use this process and in which specific area. The authors are of the view that this strategy would be an effective technique for the Physics teacher to work on with the students in order to achieve goals of Physics education at secondary schools. .

Example:
This strategy is more of a teaching strategy as opposed to a task. An example of this strategy would be as follows:

Model: The teacher explains the concept *kinetic energy, then* will model the *kinetic energy* problem for a given object of mass 5 kg moving at a constant velocity of 15m/s (K. E. = ½ mv^2).

Lead: The teacher will give new *kinetic energy* problem to complete with the students using 10 kg and 30 m/s as mass and velocity respectively. The teacher will ask the student's input and will go over the correct answer with the student.

Test: The teacher will then test the students on the formula for determining the kinetic energy of objects to see what the students have learned from modeling and leading through the problem.

This is an example of the problems that can be used.

$$K.E. = \tfrac{1}{2} mv^2 = \tfrac{1}{2} \times 10 \times 30^2 \text{ joules} = 4500 \text{ joules} = 4.5KJ$$

$$K.E. = \tfrac{1}{2} mv^2 = \tfrac{1}{2} \times 5 \times 15^2 \text{ joules} = 562.5 \text{ joules}$$

The Model-Lead-Test instructional methods in physics, share most or all of the following characteristics:

(1) Instruction is informed and explicitly guided by

a) Specific learning difficulties related to particular physics concepts;

b) Specific ideas and knowledge elements that is potentially productive and useful;

c) Students' beliefs about what they need to do in order to learn;

d) Specific learning behaviors;

e) General reasoning processes.

(2) Specific student ideas are elicited and addressed.

(3) Students are encouraged to "figure things out for themselves."

(4) Students engage in a variety of problem-solving activities during class time.

(5) Students express their reasoning explicitly.

(6) Students receive rapid feedback in the course of their investigative or problem-solving activity.

(7) Qualitative reasoning and conceptual thinking are emphasized.

(8) Problems are posed in a wide variety of contexts and representations.

(9) Instruction frequently incorporates use of actual physical systems in problem solving.

(10) Instruction recognizes the need to reflect on one's own problem-solving practice.

(11) Instruction emphasizes linking of concepts into well-organized hierarchical structures.

(12) Instruction integrates both appropriate content (based on knowledge of students'

thinking) and appropriate behaviors (requiring active student engagement).

Conclusion

Model-Lead-Test instructional methods are similar to other instructional methods in that they are ultimately intended to give students a solid conceptual foundation in physics, and to aid them to reason effectively and succeed at problem-solving tasks. However, they differ from traditional lecture-based methods in putting far greater emphasis on engaging students in a variety of specific classroom activities. Model-Lead-Test instructional methods strongly encourage learning independently, emphasize rapid feedback, and guide students to express and reflect on their own reasoning processes. The very purpose of the MLT procedure is to maximize the cognitive and learning abilities of students by increasing their rate of success and their achievements. However, it is only when this strategy is applied in contexts explicitly based on proper planning and implementation into student learning that superior learning gains could be clearly and repeatedly demonstrated.

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