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ROLE OF PROBLEM SOLVING TECHNIQUE ON TEACHING AND LEARNING PHYSICS IN SECONDARY SCHOOLS.

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ABSTRACT

This paper takes a critical review of the role of problem solving technics on teaching and learning of physics in secondary schools. This is because the application is very important because it emphasizes the benefits of the instruction of problem solving strategies and will be beneficial in the literature of physics. This paper also highlight the steps involve in problem solving techniques and the important of structured, systematic methodology to solve problem solving. Physics teachers should be trained regularly by the federal ministry of education on the application of strategies in the teaching and learning of Physics for senior secondary school students. Educators in Teacher Education Institutions should employ the technique in teaching pre-service teachers to enable them learn how to apply same in their respective classrooms.

***Keywords**: Problem solving technique, teaching, learning and physics*

INTRODUCTION

Education is the bed rock of every nation. Education is a path way of fostering a nation economy and a way of sustaining a peoples' culture which is transfer from one generation to another. Then teaching methods becomes an important path-way that should not be under mind by Science teachers and should be apply appropriately in order to enhance learning outcomes of students.

The problems the educational system is facing, it's not because the schools lack professional teachers alone, professional teachers may be there but how do these professional teachers teach?

That is, what approach or Methods do they use in teaching? Teaching methods is considered as most important aspect in teaching science subjects (physics) especially, in senior secondary schools.

The status of science education in Nigeria schools in terms of scientific concepts and development methods of teaching, learners interest in the subject continues to dwindle (Adediwu and Tayo, 2007, Ugwuadu, 2011) several researcher reports indicate that Learners perform poorly in science subjects (Agbi, 2006. Hassan, 2010). Several factors have been identified as the objectives of science instruction but the commonest factor documented by researchers is inappropriate and uninspiring teaching methods adopted by science teachers (Aremu, 1999; Jimoh, 2003; Ezeoba, 2010). These researchers express their views that teachers shy away from inquiry method, discovery method, problem solving method, concept mapping and others, which are known to be effective and rely on teaching methods that easy to implement in the classroom but must time inadequate and inappropriate. Problem-solving has been an aspect of science (Physics) teaching and learning that has attracted the attention of educators. Problem-solving has long been recognized as a skill that also foster a better understanding of Physics and Chemistry concepts. It can be an excellent tool to encourage the learning process (Danjuma & Aishatu, 2010).

Problem-solving is the highest form of learning (Babatunde, 2008). Oneshakepokaiye (2011) cited Kolawole and Oluwatayo (2005) that effective teaching implies productive, purposeful, result oriented, qualitative, meaningful and realistic teaching. The essence of being an effective teacher views on what to do to foster student learning. Physics teachers should therefore adopt teaching methods that will enable the students to understand whatever concepts topic or principles being taught. Various methods of teaching Physics are known, such include guided discovery problem-solving, discussion, expository individualistic methods. These methods depend on various forms of teacher –student-activities through some methods are more activity oriented than others. Consequently, physics instructors face the problem of finding suitable advice on how to approach the teaching of physics in the most efficient way and an answer to the question of how much time should be spent on intuitive conceptual reasoning and how much time in developing quantitative reasoning (Klein, 2007).

Problem-solving is a systematic approach that reviews learning competencies, comprehending and composing critical and creative thinking these features are most important dimensions of thinking and learning in regardless of the acknowledgement of the importance of developing problem-solving skills, relatively little research has been conducted on the theme in the field of instructional design (Jonalsen, 2004). It is against this background that this research sought to examine the problem- solving/inquiry methods of teaching and learning difficult concepts in secondary school Physics.

THE IMPORTANCE OF A STRUCTURED, SYSTEMIC METHODOLOGY TO SOLVE PHYSICS PROBLEMS

To further motivate the subsequent discussion, let us summarize our introductory commentaries. We are essentially pointing out three major problems in the learning and teaching of physics:

1) The demand by physics instructors for effective teaching strategies that would explain how much time should be spent on teaching intuitive conceptual reasoning and how much time on developing

students' quantitative reasoning, and how to teach both aspects holistically;

2) The students' need for suitable textbooks that will help them develop mathematical abilities reasoning, which are essential for enhancing their knowledge of conceptual physics; and
3) A deficiency in the teaching of physics leading to students not being taught a coherent physics problem- solving strategy that would enable them to engage in both mathematical and conceptual reasoning.

A moment of thought about the above summarized difficulties leads us to postulate the need for a systemic (Bunge, 2000) approach which from an operational point of view, could help instructors and students to achieve a better performance in the process of teaching and learning physics. On the instructor's side the need for a systemic approach in the teaching of physics could be justified by the advantage of using a methodology which would help them to incorporate both conceptual and mathematical reasoning systematically in their teaching. In this way, students will obtain the necessary training in their computational skills while learning how to use mathematical formulae to obtain the physics in the equations, even when they can obtain the mathematical solutions to a problem by rote procedures. In other words, students could apply "higher-order thinking skills." (Rigden, 1987) via the mathematical understanding of a physics problem, which in turns involves meaningful learning which goes beyond the mere application of rote procedures. Moreover, using properly designed quantitative problems that require students to illustrate their conceptual learning and understanding will reveal much to instructors about their students' learning and will provide invaluable feedback (Dunn *et al.*, 2000). Such problems. In How to Solve It, Polya set four general steps to be followed as a problem-solving strategy:

P_1Understanding the problem,
P_2 Devising a plan,
P_3 Carrying out the plan, and
P_4 Looking back. Surprisingly,

These steps encompass "the mental processes and unconscious questions experts explore as they themselves approach problem solving" (Lederman, 2009). These four steps also form the basis for some computational models devised to "model and explore scientific discovery processes" (Lederman, 2009). Nevertheless, even though the aforementioned four steps seem very simple, their generality makes it hard for novices to follow them. Thus, in order to have a more approachable problem-solving strategy for students, we extended the four-step problem-solving strategy into a six-step strategy. We made our choice based on empirical observations after experimenting with a five-step strategy reported in (Heller, 1992). Justification for having a more detailed problem-solving strategy can be found in the words of Schoenfeld: "First, the strategies are more complex than their simple descriptions would seem to indicate. If we want students to use them, we must describe them in detail and teach them with the same seriousness that we would teach any other mathematics" (Schoenfeld, 2016). In addition, we shall further rationalize below the need for explicitly including the new step in our proposed methodology (see item 5 below). Accordingly, our proposed six step problem solving strategy is as follows:
1. **Understand the problem**: some considerations to develop at this step involve drawing a figure and asking questions like what is the unknown? What is the condition? Is it possible to satisfy the condition? Is the condition sufficient to determine the unknown? Or is it insufficient? Or redundant? Or contradictory? That is, at this stage students need to actually be sure what the problem is. In addition to making drawings to get a grasp of the problem, students might need to reformulate the problem in

their own words, making sure that they are obtaining all the given information needed for solving the problem. This is a crucial step in the sense that if we do not know where are we going, any route will take us there.

2. **Provide a qualitative description of the problem:** at this stage students need to think and write down the laws, principles, or possible formulations that could help them to solve the problem. For instance students need to consider any possible framework of analysis that could help them to represent or describe the problem in terms of the principles of physics (i.e. Newton's law, energy conservation, momentum conservation, theorem of parallel axis for computing inertia moment, non-inertial reference system, etc.) If necessary, the drawings of the previous step could be complemented by the corresponding free-body and/or vector diagram.

3. **Plan a solution:** some considerations to have in mind in order to develop this step involved looking at the unknown and trying to think of a familiar problem having the same or a similar unknown. Some questions to be asked are: Have you seen this before? Or have you seen the same problem in a slightly different form? Once the student as all the many possibilities of approaching approach the problem, he/she only needs to pick one strategy of solution and write down the corresponding mathematical formulation of the problem, avoiding as much as possible plugging numbers into the respective equations. Also, they need to think whether the information at hand would be enough to find a solution (i.e. if a set of algebraic equations is under-or over-determined, or if the number of boundary conditions provided is enough to solve a differential equation).

4. **Carrying out the plan:** at this stage the student will try to find a solution to the mathematical formulation of the problem sketched according to the previous steps, and perhaps will need to go back in order to find an easier mathematical formulation of the problem. This can be facilitated if the

students have written down alternative solutions as they were supposed to do on item 2.

5. **Verify the internal consistency and coherence of the equations used**: at the moment of finding a solution to the mathematical equations involved, students need to verify whether the equations are consistent with what they represent (i.e. are the equations dimensionally correct? Do they represent a volume or a surface?). Though this seems to be an unnecessary step, experience shows that students too often do not verify the internal consistency and coherence of the equations they solve. And this mistake is also found to be performed by textbook writers, as discussed in a recent editorial (Bohren, 2009). After verifying no inconsistencies are found in the mathematical solution to the problem, students could then plug numbers into the obtained results to find, whether required or not, a numerical solution which in turn could be used in the next step to further evaluate the obtained result. In the next section, by means of an illustrative example, we shall show how the right answer to the problem posed could be obtained, even though the internal consistency of an equation used is not right.

6. **Check and evaluate the obtained solution:** once a solution has been obtained, its plausibility needs to be evaluated. Some questions could be asked in this regard: can the results be derived differently? Can the result or the method be applied to solve or fully understand other problems? Can the solution be used to write down the solution of a less general problem? Can the solution be used to further understand the qualitative behavior of the problem? Is it possible to have a division by zero by changing a given parameter? Does it makes sense?, and so forth. A first comment on our six-step problem-solving strategy is that it provides a unified, systemic way of approaching the solution to a physical problem encompassing both qualitative (steps 1-3) and quantitative (steps 4-6) reasoning. In this sense, instructors could place as much emphasis as they choose on any of the set

of steps, providing the students with a structured recipe on how to approach in detail the other side of the problem's solution. That is, if the instructor decides to emphasize steps 1-3, students could still follow steps 4-6 at their own pace, and viceversa. Second, comparing our six- step problem-solving strategy with Polya's four-step scheme, it could be appreciated that we have explicitly divided Polya's step one (P1) into two steps (1-2), and Polya's step three (P3) into two steps (4-5). A further comment on our problem-solving strategy is that we prefer to call the second step (2) Provide a qualitative description of the problem rather than Physics description as in (Heller *et at,.* 1992), because one shares the idea that students tend to think that, by providing a qualitative analysis of a problem, they are also providing the solution required by a physicist, and that the mathematical solution to the problem is just uninteresting mathematics. Instead, we place emphasis on the fact that a physical solution to a problem is a combination of both qualitative and quantitative reasoning. As stressed by the great physicist Lord Kelvin: "I often say that when you can measure something and express it in numbers, you know something about it. When you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind. It may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the state of science, whatever it may be." (Hewitt, 2002) Freeman Dyson was more eloquent: "mathematics is not just a tool by means of which phenomena can be calculated; it is the main source of concepts and principles by means of which new theories can be created" (Dyson, 1964).

CONCLUSION

The paper is of the view that the following conclusions were made: There is significant main effect of the instructional strategy (the use of problem-solving) teaching and learning of Physics. This is because the application is very important because it emphasizes the benefits of the instruction of problem solving strategies and will be beneficial in the literature of physics.

RECOMMENDATIONS

1. Physics teachers should adopt problem-solving method in teaching difficult concepts in Physics.
2. The curriculum planners should consciously design Physics curriculum to accommodate the activities involving problem solving and inquiry-based skills.
3. Physics teachers should be trained regularly by the federal ministry of education on the application of strategies in the teaching and learning of Physics for senior secondary school students.
4. Educators in Teacher Education Institutions should employ the technique in teaching pre-service teachers to enable them learn how to apply same in their respective classrooms.

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