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# EFFECT OF PROBLEM-SOLVING METHOD OF TEACHING ON STUDENTS' ACADEMIC PERFORMANCE IN PHYSICS AND CHEMISTRY IN CALABAR MUNICIPALITY, CROSS RIVER STATE, NIGERIA.

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## ABSTRACT

The study investigated the effect of problem solving approach on students' academic performance in Physics and Chemistry in Calabar Education Zone, Cross River State, Nigeria. The design adopted was Quasi – experimental design. A total of 200 SS2 students constituted the sample of the study. one research instrument physics/ Chemistry Performance Test (PPT and CPT) were used to measure the variance in performance between physics and chemistry students, taught with problem-solving instructional approach. The reliability of Physics and Chemistry Performance test (PPT and CPT) were ascertained using Kudar-Richardson formular 20 which yielded a reliability of 0.85 and 0.89 respectively. Two experimental groups and two control groups were used for the research. The experimental and control respondents were taught the concepts using guided discovery approach. The two groups were pretested before treatment and posttest was administered after treatment. Data obtained were analyzed using mean scores differences. Results of findings revealed that the experimental groups taught with guided problem-solving approach had a higher mean score than the control group taught with conventional method in Physics and Chemistry. It is concluded that the use of problem-solving approach in teaching Physics and Chemistry serves as synergy in enhancing Physics and Chemistry learning in school. Based on findings, it is recommended that Physics and Chemistry teachers should adopt problem-solving approach in teaching difficult concepts.

KEY WORDS: Problem-solving, Physics, Chemistry, students and performance.

## 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 and Chemistry) 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 and Chemistry) 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 & Arshatu, 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. 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 difficult concepts on students' academic performance in Physics in Calabar Municipality, Cross River State, Nigeria.

### **THEORETICAL FRAMEWORK/ LITERATURE UNDER-PINNING.**

#### **Jerome Bruner's (1961) Theory of discovery learning.**

Discovery learning is a method of inquiry-based instruction. Discovery learning believes that it is best for learner to discover facts and relationships for themselves. The theory states that learning is best promoted when one is able to figure things out for oneself. The concept of discovery learning implies that students construct their own knowledge for themselves (also known as constructivist approach). Discovery learning is an inquiry-based constructivist learning

theory that takes place in problem solving situations where the learner draws on his or her own past experience and existing knowledge to discovered facts and relationships and new truth to be learned. Students interact with the world by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments. As a result, students may be more likely to remember concepts and knowledge discovered on their own (in contrast to a transmissions model) Models that are based upon discovery learning model, problem-based learning and others.

This theory is closely relate to work by Jean Piaget and Seymour Papert.

It is believe that discovery learning brings about:

1. Encourage activities encouragement
2. Promotes motivation
3. Promotes autonomy, responsibility, independence
4. Develops creativity and problem solving skills
5. Tailor learning experiences.

Practice in discovery for oneself teaches one to acquire information in a way that makes that information more readily viable in problem solving. Bruner's also expressed a belief that such a practice would result in a shift from extrinsic to intrinsic motivation and that is, what is learned will be more easily remembered. To the degree that one is able to approach learning as a task of discovering something rather than "learning about" it, it that degree will there be a tendency for the student to carry out his learning activities with the autonomy of self-reward or more properly by reward that is discovery itself. The very attitudes and activities that figuring "outer

discovering” things for oneself also seems to have the effect of making material more readily accessible in memory. Problem-solving is the process of investigation where the solution is not obvious to the investigator at the initial stage. The relevant concepts in the cognitive structure of the students must be adequate before the students will be able to solve a given task or problem effectively. As a teaching strategy, problem-solving entails training the students on how to solve problem by proceeding in a logical step by step manner from a problem state to its solution. It is on this premise that theorists in problem-solving have identified –basic stages involved in the strategy (Johanning, 2006 and Smith, 1991). According to Lorenzo (2005) cited by Liyod, William, Megan, Jacinta & George (2014), students using problem-solving heuristic were more confident and had a higher ability to solve difficult physics problems. These researchers (Aremu 1999; Jimoh, 2003, Ezeoba, 2010) report that teachers shy away from activity oriented teaching methods such as guided-inquiry, discovery method, concept mapping and others, which are known to be effective and rely on the teaching methods that are easy to implement in the classroom.

The rationale for using this approach in science teaching lies in the fact that if students involved in activities are challenged to come out with results, they are more likely to learn than if they were simply told or presented with outcome of experiments. This method de-emphasizes rote memorization scientific concepts and principles while emphasizing knowledge and skill acquisition through hand-on-mind –on scientific activities under the guidance of the science teacher (Okoli, 1998). Neji and Meremikwu (2016) aptly state that teaching methods are antidotes that impart significantly on the students’ academic achievement in Chemistry and Mathematics. The problem of poor performance in Physics is a great concern to Physics educators and relevant stake-holders in education. Most of secondary school teachers appear to use lecture method to

teach physics which seems not to help the students understand the various physics concepts and this hindered the development of the analytical reasoning. As a result of poor methods of teaching, most of the students feel that the subject is too difficult and esoteric to understand. Problem-solving is a process of working towards a goal where the part of the goal is uncertain. Chi and Vanlehn (2010) found that when students are trained to identify and understand the concepts behind the problems, the gap between good problem-solvers and weak problem-solvers diminishes.

The students turn from passive listeners or information receivers to active, free self-learner and problem solvers. It shifts the emphasis of educational programme from teaching to learning. It enables the students to learn new knowledge by facing the problems to be solved instead of feeling boredom. (Riatsat, Hukamdad, Aqila and Anwar (2010) According to U.S. state University (2017) problem-solving is a cognitive processing aimed at figuring out how to achieve a goal. Thus, the hallmark of problem-solving is the invention of a new method for addressing a problem. This definition has three parts:

1. Problem-solving is cognitive – that is occurs internally in the mind (or cognitive system) and must be inferred indirectly from behavior.
2. Problem solving is a process – it involves the manipulation of knowledge representation (or carrying computations) and
3. Problem-solving is directed – it is guided by the goals of the problem solver. In sum, problem solving is cognitive processing directed at transferring a problem from the given state to the goal state when the problem solver is not immediately aware of a solution method.

According to Mayer and Wittrock (2006) problem solving is related to thinking reasoning decision making, critical thinking and creative thinking. Thinking refers to a problem solver's cognitive processing, but it includes both directed thinking. Reasoning refers to problem-solving

with a specific task in which the goal is to draw a conclusion from the premises using logical rules based on deduction or induction. Creative thinking and critical thinking refers to specific aspects of problem-solving. Mayer and Wittrock (2006) distinguished among four cognitive processes in problem solving representing in which the problem solver constructs a cognitive representation of the problem planning, in which the problem solver devises a plan for solving the problem, executing in which the problem solver carries out the plan and self-regulating, in which the problem solving evaluates the effectiveness of cognitive processing during calculation and balancing of chemical equations.

Adopting Seyed, Hodjat and Feyzollah (2012) examined the effect of problem-solving styles on academic achievement of Agricultural students in the University of Tehran. The statistical population of this research consisted all of the fourth year agricultural undergraduate students in the University of Tehran (N = 250). Applying proportional stratified random sampling method 103 students were selected for studying. The main instrument of study was a questionnaire validity of which was approved by a panel of experts and its reliability tested by Cronbach's Alpha coefficient ( $\alpha > 0.70$ ). Data were analyzed (Descriptive statistics: frequency, percentage, mean, standard deviation, minimum and maximum and (inferential statistics: correlation analysis and regression analysis) was conducted by SPSS for windows.

A learning environment that support these kinds of cognitive skills enables students to assimilate these skills in other areas of learning. The aim behind the use of inquiry-based method is the belief that science should not be taught to a child but a child should be left to discover things because science is more than knowing facts or concepts but a process of inquiry (Ogunniyi, 1984; Warner & Myer, 2009; & Iyiola, 2010). The adoption of inquiry-based method in teaching embraces the use of scientific method as a basis for investigation and resolution of problems (Ngada, 2004; NTI, 2004; Iyiola 2010). The process include: definition of identified problem, formulation of hypothesis, design of investigation strategies for data collection and

analysis, testing of hypothesis is tested against data, interpretation of results and making conclusion from results to arrive at generalization. If the activity is stimulating and well coordinated by the teacher, the activity may contribute in enhancing students' performance and retention of concepts due to acquisition of practical knowledge and skills.

Ifeanyi-Uche and Ejabukwa (2013) sought to find out the effect of problem-solving method on academic achievement of secondary school students in Home Economics. The study covered the secondary schools in Orumba South Local Government Area of Anambra State. Quasi-experiment design was the design used. Two study groups were randomly sampled from the 15 schools in the Local Government Area and assigned to experimental and control groups respectively. The experimental group was taught with inquiry based method while the control group was taught using lecture method. A thirty five items Home Economics Achievement test developed by the research and validated by researchers colleagues was used to assess the subject achievement. Data collected were analyzed using percentage, mean and t-test statistics.

The findings revealed that the experimental group (problem-solving method) achieved significantly higher than the control group (lecture method). Based on the findings, it was recommended that inquiry based method should be employed in teaching Home Economics.

## **STATEMENT OF PROBLEM**

The performance of Physics and Chemistry students in Senior School Certificate Examination on (SSCE) both West African Examination Council (WAEC) and National Examination Council (NECO) is not encouraging in the recent years. Poor performance of students in these subjects is as a result of the teachers not using the appropriate teaching methods during teaching. The methods which teachers use in teaching Physics and Chemistry concepts



contribute to their poor performance. Physics and Chemistry are natural sciences that students face many challenges in learning. They fail to solve calculations and equations problems correctly after doing and exercising many other similar problems as a result of wrong teaching method. Inappropriate use of teaching methods result in students not being able to explore the natural environment; inability of the students to see, feel and touch science resources that will bring about creative thinking and learning of science in their natural state.

### **STATEMENT OF HYPOTHESIS**

There is no significant main effect of the use of problem – solving method of teaching

### **METHODOLOGY**

The design for this study was non-randomized pre-test-post – test, control group, quasi-experimental design. It involves manipulation of the independent variables in order to determine its effect on the dependent variable. It was quasi-experimental because intact class setting was used. The design was considered appropriate since the nature of the study will not allow for and students' academic performance in Physics and Chemistry..

randomization or students into experimental groups; and the control was necessary to provide basis for comparison of the students' performance since the study requires two experimental groups and a control group, the structural representation of the design was as follows:

The research area for this study is Calabar Municipality. Calabar Municipality is one of the eighteen local governments in Cross River State.

The population of this study comprises all SS2 Physics and Chemistry students in secondary schools in Calabar Municipality.

The sampling technique adopted was purposive sampling technique because intact classes were involved. The sample for this study was 200 Physics and Chemistry students drawn from four (4) secondary schools in Calabar municipal, Calabar, Cross River State. The instrument used to gather data was Physics Performance Test (PPT) and Chemistry Performance Test (CPT). The reliability of the instrument was established using Kuder-Richardson's formula (KR-20), which yielded a reliability coefficient of 0.87 and 0.89 respectively. Data was analyzed using analysis of covariance (ANCOVA).

#### RESULTS:

The effect of problem-solving method of teaching on students' academic performance in Physics and Chemistry..

**TABLE 4**

**Summary of descriptive statistics of achievement test according to treatment.**

Treatment	N	Test	$\bar{X}$	SD	Achievement gain
Experimental group 1		Pretest	16.82	3.41	8.59
		Posttest	25.41	4.85	
Experimental group 2		Pretest	17.13	4.19	6.13
		Posttest	23.26	7.39	
Control		Pretest	18.65	3.54	0.80
		Posttest	19.36	3.64	
Total	200	Pretest	17.64	3.06	6.64
		Posttest	24.28	4.74	

Table 1 indicated the summary of descriptive statistics of achievement test according to treatment (use of problem-solving method) on students' academic performance in Physics and Chemistry.. Results revealed that the experimental group 1 taught Physics concepts with problem-solving method had higher mean score ( $\bar{X}=25.41$ ) with achievement gain of (8.59), indication of that the experimental group 1 students performed significantly better in their posttest score than in their pretest scores. The experimental group 2 which are those taught Chemistry with problem solving approach also indicated better performance in posttest than in pretest. However, their control subjects obtained a posttest mean score of (19.36) with achievement gain of 0.80 which shows insignificant difference with the pre-test score.



**TABLE 2**

**Summary of analysis of covariance (ANCOVA) on performance test in Physics on treatment.**

<b>Source</b>	<b>Type III sum of squares</b>	<b>Df</b>	<b>Mean square</b>	<b>F-ratio</b>	<b>Sig.</b>
Corrected model	902.553	2	902.553	10.961	0.000*
Intercept	3446.319	1	3446.319	169.910	0.001
Pretest	12.435	1	12.435	696.405	0.060
Treatment	870.025	1	870.025	41.8	0.000*
Error	4705.263	195	4705.263	.173	0.072
corrected error	4711.155	1	4711.155	.321	.678
<b>Total</b>	<b>51621.000</b>	<b>200</b>			

R= .473 (Adjusted R-squared = .145)

Hypothesis 1 sought to find out the performance of students' when taught Physics and Chemistry with guided discovery/ inquiring methods. Finding revealed that there is a strong effect of the use of problem solving approach on students' academic performance in Physics and Chemistry.

The result in Table 2 revealed that the F-ratio of (41.8) for main effect of treatment. The obtained significant value of .000\* was less than 0.05 level significance used in the study ( $P < .05$ ) with this result the null hypothesis is rejected and the alternate hypothesis retained. Thus, there is a significant effect of the use of problem-solving and inquiry-based methods of teaching Physics on students' academic achievement. The R-squared of .473 was obtained indicating that the rate of main effect of the treatment on students' academic achievement and covariate is 47percent. This suggests that about 47 percent of the variation in the treatment and pretest given. The Bonferoni post hoc test as presented in Table 4 was used to ascertain the point of significance in Physics and Chemistry performance of students taught with problem-solving and lecture method as the control.

**TABLE 4**

**Bonferoni multiple comparison test of effectiveness of three teaching methods on Physics students' achievement**

<b>Treatment</b>	<b>Comparison group</b>	<b>Mean difference</b>	<b>Standard Error</b>	<b>Sig.</b>
Experimental group 1	Experimental 2	.6700	.60110	1.000
	Control	3.8400	.60110	0.000
Experimental group 2	Experimental 1	.0800	.60110	1.000
	Control	.49200	.60110	0.000
Control	Experimental 1	-5.700*	.60110	0.000
	Experimental 2	-5.8200*	.60110	0.000

Error term is mean square = 8.04  
Mean difference is significant

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Table 4 showed Boniferoni multiple comparison test of effectiveness of problem-solving and lecture methods of teaching Physics and Chemistry on students' academic performance. The comparison of performance of students taught with this method does not significantly differ in their performance. The mean score of (25.41 and 23.26) with the control group ( $\bar{X}=19.36$ ) taught with the conventional method. The results showed that the experimental groups performed significantly better than their counterparts taught with conventional method. This shows that the problem-solving method is more effective methods that can enhance students' academic performance in Physics and Chemistry compared with the conventional method.

## **DISCUSSION OF FINDINGS**

### **Effect of treatment ( the use of problem-solving method on students' academic performance in Physics and Chemistry).**

Finding revealed that there is a significant effect of treatment on students' academic performance in Physics and Chemistry. This findings collaborate with Seyed, Hodjat and Feyzollah (2012) in Tehran, Iran who studied the effect of problem-solving styles on academic achievement. The result of their work showed a significant positive relationship between academic achievement and creative confident problem-solving style. Results of stepwise multiple regression analysis revealed that among problem solving styles had significant effect on academic achievement of students. Hence, problem-solving method of teaching can improve the academic achievement of students.

The finding also agrees with the work by Udeani and Sunday (2011) who conducted a research on the extent of the relationship among teachers' problem solving abilities, students' learning styles and students' academic performance. The outcomes of the finding from the study include:

- i. The relationship between teachers' problem solving abilities and students' academic performance is positive and significant.
- ii. The relationship between students' learning styles and their academic performance is positive and significant.
- iii. The effect of teachers' problem solving abilities students' academic performance are positive and significant.

Based on these finding, it was concluded that teachers' problem solving abilities and students' learning styles have significant effects on the students' achievement.

Similarly, findings of the study of Abdu-Raheem (2012) on the effect of problem-solving method of teaching on secondary school students' achievement and retention in social studies. The result showed that problem-solving method is more effective than conventional lecture method in improving students' achievement in Social Studies.

The findings also reaffirmed the result of Fatede, Mogari and Arigbabu (2013), work on the effect of problem-based learning on senior secondary school students' achievements in Further Mathematics (FM) in Nigeria. The results indicated that there were statistically significant differences in the mean post-test achievement scores on Teacher-Made Test and mean post-test achievement scores on Researcher-Designed Test (RDT) between students' exposed to the problem-based learning and those to the Traditional Method, all in favour of the problem-based learning group. Based on the results, the study recommended that the problem-based learning should be adopted as alternative instructional strategy to the traditional method in enhancing meaningful/learning. Similarly, the work of Ifeanyi-Uche and Ejabukwa (2013) collaborate with the result, their work on academic achievement of secondary school students in Home Economics. The result showed that inquiry-based method achieved significantly higher

than the lecture method. This result agreed with the work of Ndino and Nbina (2007) that carried out a research to examine the effects of guided inquiry learning strategies on senior secondary school students' academic achievement and retention in Biology. The study revealed that both guided inquiry learning strategy enhances students' academic achievement and retention in Biology.

This findings collaborated Jack (2013) who investigated the concept mapping and guided inquiry as effective teaching difficult concepts in Chemistry, effect on students' achievement and retention. The results of the findings showed a significant difference between the performance of students exposed to two experimental groups (concept mapping and guided inquiry) control group (expository method) the result of the sheffe test was a in favour of concept mapping (inquiry method). It was discovered that concept mapping is effective teaching method (inquiry method) for the teaching of difficult concepts in Chemistry since it improved students' performance and retention.

## **CONCLUSION**

Based on the findings of the research study, the following conclusions were made:

. There is significant main effect of the instructional strategy(the use of problem-solving) on students' academic performance in Physics and Chemistry.

## **RECOMMENDATIONS**

With regards to the research findings the following recommendations were considered necessary:

1 .Physics and Chemistry teachers should adopt problem-solving method in teaching difficult concepts in Physics and Chemistry.



1. The curriculum planners should consciously design Physics and Chemistry curriculum to accommodate the activities involving problem solving and inquiry-based skills.
2. Physics teachers should be trained regularly by the federal ministry of education on the application of strategies in the teaching and learning of Physics and Chemistry for senior secondary school students.

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