

## **Effect of Problem -Based Learning Strategy on Students' Achievement in Senior Secondary Schools Chemistry in Enugu State**

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**Abstract:** *This purpose of the study is to determine the effect of problem-based learning method on students' achievement in senior secondary school Chemistry. Specifically, the study aimed at investigating the effect of the strategy on senior secondary school students' achievement in Chemistry and the effect of gender on the academic achievement of students in Chemistry. Two research questions and two hypotheses were formulated to guide the study. A quasi-experimental pre-test, post-test, non equivalent control group design was adopted for the study. The sample consisted of 201 senior secondary class two (SS II) Chemistry students from four single-sex schools (two male, two female) in Udi Educational zone. Intact classes were used. The classes were assigned randomly to experimental and control groups. Experimental groups were taught selected topics in Chemistry using problem-based learning method. Control groups were taught the same topics using expository method. Pre-test was administered to both groups before the commencement of the treatment. Treatment was administered for a period of six weeks after which a posttest was administered. Instrument for data collection (posttest and pretest) was Chemistry achievement test. The reliability was determined using Kuder Richardson's formular:  $20(K - K20)$  and reliability co-efficient of .61 was obtained. Data collected were analyzed using mean, standard deviation and analysis of covariance (ANCOVA). Specifically, mean and standard deviation were used to answer the research questions while ANCOVA was used to test the hypotheses at .05 level of significance. It was found out that students taught with problem-based learning strategy achieved better than those taught with expository method. Also, it was found out that male and female Chemistry students taught using problem-based strategy achieved equally. Based on findings of the study some recommendations were made. Conclusion was equally highlighted.*

**Keywords:** *Achievement, Chemistry, Effect, Problem-based Learning, Strategy*

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### **I. Introduction**

Development has been the priority of every nation of the world. As an integral part of the developmental strategy, formal education emerged. It is a continuously planned strategy that anchors on the development of human ability.

Most nations develop because of the dominant role played by science. Science has been instrumental to the solution of the socio-economic problems facing nations like Nigeria. Such problems include hunger, unemployment, and population explosion [1] However, Nigeria has been making frantic efforts to create scientific and technological awareness in her citizenry [2]

Teaching of science is crucial in development of fruitful understanding of scientific concepts and propositions. It provides meaningful use of scientific procedure for problem solving. One of the major problems confronting an average science teacher in the Nigeria classroom is the problem of using appropriate instructional strategies to teach students. The science teachers are equally faced with how to make curriculum to be relevant to the lives and experiences of the learner and this poses serious hindrances to effective teaching and learning of science [3]. A critical look at the contents of Chemistry curriculum in Nigeria indicates that the traditional teacher-centered approaches are not relevant and appropriate to promote efficient learning of the programme. Nevertheless, efforts should be made to introduce strategies that will not only maximize meaningful understanding of concepts of chemistry but would avail students the opportunities to participate actively in classroom activities. Problem-based learning is among such strategies.

Problem-based learning as a strategy for learning consists of carefully selected and designed problems that demand from the learner acquisition of critical knowledge, problem solving proficiency, self directed learning strategies and team participation skills [4]. It reduces teacher's instruction where learners are seen as active listeners and passively involved in classroom activities as in the case of conventional method. Problem-based learning is an example of constructivist learning strategy which poses significant contextualized real world situations and provides resources, guidance, and instruction to learning as they develop content knowledge and problem solving skills [5].

The first task for the teacher in problem based learning is to guide the student to identify the problems and help them to link with previous knowledge. The student in a small group discuss the problem cooperatively among themselves in a small group, explain what they know, pose research questions, generate hypotheses, develop initial plans and organize their knowledge, attempt to solve the problems with several modifications, derive learning goals and organize further work. Finally, the results are presented to larger groups through the guidance of the teacher, instructor or facilitator and the students are allowed to reflect on the learning that has taken place. Problem-based learning is a form of inquiring-based learning which explains the environment in which learning is driven by a process of inquiry constructed by the students.

Over the years, the predominant method of instruction in schools has been the expository method [6]. By this method, learners were encouraged to master course content through constant repetition of facts and drills. The method guarantees the completion of the course outline on time, but incidentally encourages learners to memorize and regurgitate content of learning experiences instead of digesting and assimilating them that most teachers in Nigerian schools use the expository method, which unfortunately provides little or no room for active student participation in the lesson. Perhaps this may account for the poor achievement often recorded in public examinations.[7] in her report on students' performance in her examination revealed that only few candidates who sat for the May/June SSCE passed Chemistry at credit level and above. This is a pointer that something is wrong with the teaching and learning of the subject. It becomes pertinent that classroom practice should be enhanced using innovative teaching methods which will involve active participation of the learning thereby stimulating learning.

In response to the problem of poor performance in secondary school Chemistry, the WAEC Chief examiner's report recommended the use of effective teaching method which is in tune with the modern science and technological dispensation as the only remedy to students' poor performance in Chemistry. Hence, problem-based learning will be used to enhance students' achievement in Chemistry.

[8] stated that the students' active participation in a lesson aids understanding and achievement. [9] , confirmed that statement when they said that schools are provided with curricular that have to be learnt and which are within the limits of the learner's own understanding. [10]. on gender held that teaching methods should facilitate the learning process for both genders. Teachers ought to be mindful that unless the teaching methods match the different learning styles observed to be the dominant modality for each gender, students may not comprehend.

The aim of the present study was therefore, to discover a teaching-learning strategy that will result to better achievement in male and female students in Chemistry subject. There is therefore the need to determine the effect of the problem-based learning strategy on students' achievement in Chemistry.

### 1.1 Purpose of the Study

The purpose of this study is to investigate the effect of problem-based learning strategy on senior secondary class II students' achievement in Chemistry. Specifically, the study aimed at investigating the effect of problem-based learning strategy on senior secondary class II students:

- (i) achievement in Chemistry
- (ii) Achievement in Chemistry with regard to the gender of the student.

### 1.2 Research Question

The following research questions guided the study.

1. What are the mean achievement scores of SS 2 Chemistry students who were taught with problem-based learning method and those taught same topics using expository method.
2. Mean Achievement scores and standard deviation of students in the experimental Group in Chemistry Achievement test by Gender.

### 1.3 Hypotheses: The following research hypotheses guided the study:

- (1) There is no significant difference in the mean achievement scores of SS II Chemistry students who were taught with problem-based learning method and those taught using expository method.
- (2) There is no significant difference in the mean achievement scores of male and female SS II Chemistry students who were taught using problem-based learning method.

## II. Methodology

Quasi-experimental pretest-posttest control group design was adopted. Intact classes were used. The classes were assigned randomly to experimental and control groups. Experimental groups were taught selected topics in Chemistry using problem-based method while control groups were taught the same topics using expository method. Pretest was administered to both groups before the commencement of the treatment. Treatment was administered for a period of six weeks after which a posttest was administered. Instrument for data collection (post test and pretest) was Chemistry Achievement Test. Data collected were analyzed using

mean, standard deviation and analysis of covariance (ANCOVA). Specifically, mean and standard deviation were used to answer the research questions while ANCOVA was used to test the hypotheses at 0.05 level of significance.

### III. Results

#### 3.1 Research Question One:

What are the mean achievement scores of SS 2 Chemistry students who were taught with problem-based teaching method and those taught same topics using expository method.

**Table I: Mean Achievement Scores and Standard Deviation of Students in Chemistry Achievement Test by Method.**

N = 201 cases

	Problem-based N = 101		Expositing N = 100	
	mean	S.D	Mean	S.D
Pretest	9.55	5.46	10.65	3.84
Post-test	28.90	6.72	19.63	5.76

In TABLE 1, the data revealed that the experimental group got the mean score of 9.55 and 28.90 in the pre-test and post-test respectively. Also, in the pretest and post-test, the students obtained standard deviation of 3.46 and 6.72 respectively. The control group got a mean score of 10.65 and 19.63 respectively in the pretest and post-test. The control group in the pretest and post-test also got standard deviation of 3.84 and 5.76 respectively. Above analysis, is an indication that students in the experimental group achieved higher than their counterparts in the control group in Chemistry achievement test by a mean score of 19.35. This shows that the use of problem-based learning method promotes achievement in Chemistry. It therefore concludes that students achieve more if Chemistry topics are taught using the said learning method.

#### 3.2. Research Question Two:

What are the mean achievement scores of male and female SS2 Chemistry students who were taught using problem-based teaching method?

**Table 2: Mean Achievement Scores and Standard Deviation of Students in the Experimental Group in Chemistry Achievement Test by Gender.**

No. of cases = 103 Method-problem based

	Male N = 53		Female N = 50	
	Mean	S.D	Mean	S.D
Pretest	9.38	3.81	10.85	3.41
Post-test	24.17	9.46	24.41	8.14

TABLE 2 above showed that in pre-test and post-test, male students taught with problem-based learning method had mean achievement scores of 9.38 and 24.17 with standard deviation of 3.81 and 7.46 respectively. On the other hand the female students taught with same method had mean achievement scores of 10.85 and 24.41 with standard deviation of 3.41 and 8.14 respectively in the pretest and posttest. Above result revealed that female students achieved higher than the male students by a difference of 0.24 in their mean scores which is not significant. As shown above, the problem-based method had almost same effect on male and female students.

#### 3.3. Hypotheses Testing

Ho<sub>1</sub>: There is no significant difference in the mean achievement scores of SS II Chemistry students who were taught with problem-based teaching method and those taught using expository method.

**Table 3: ANCOVA Result**

Source of Variation	Type of III Sum of square	Df	Mean Square	F	Sig	Decision
Covariates	4406.5139	4	1101.628	27.867	.000	S
Main effects	13651.560	1	13651.560	345.329	.000	S
Achievement	4.451		4.451	.113	.738	NS
Gender	9.162		9.612	.232	.631	NS
Location	1688.097		1688.897	32.230	.000	S
Method	4240.287		4240.287	107.262	.000	S
Method Vs Gender	35.635		35.635	.901	.344	NS
Error	7827.339		39.532			
Total	132011.000					

S = Significant, NS = Not significant at 0.05 level of probability.

From the result of ANCOVA in TABLE 3, it is observed that the significant of (f) (107.262) for method is .000. This value is less than .05 probability level set for the study. Hence, the null hypothesis is rejected. This implies that the method influenced the students' achievement in Chemistry. This led to the conclusion that there is a significant difference between the mean scores of students taught with problem-based method and those taught with expository method.

Ho<sub>2</sub>: There is no significant difference in the mean achievement scores of male and female Chemistry students who were taught using problem based method.

For hypothesis 2, The result of ANCOVA in TABLE 3 shows that the significance of "F" (.232) for gender is .631. This value is greater than .05 probability level set for the study. Here, the null hypothesis is not rejected. It was therefore concluded that there is no significant difference in the mean achievement scores of male and female SS 2 Chemistry students taught using problem-based teaching method.

#### **IV. Result/ Discussion**

Result of data analysis on TABLES 1 and 3 have shown that students taught with problem-based learning method performed significantly better on the achievement test than their counterparts who were taught using expository method. The higher achievement could be as a result of the students' active participation in the teaching/learning process which characterizes the problem-based method. It demands from the learner acquisition of critical knowledge, problem solving proficiency, self directed learning strategies and team participation skills. Also, problem-based learning reduces teachers' instruction and learners are seen as active participants in the classroom activities. The findings of this study supports the views of [11] who stated that high performance occurs in a learning situation where instruction must be concerned with the experiences and contexts that make students willing and able to learn (readiness). Also, the study agreed with the findings of [1] where he explored the effect of action learning and expository methods on students' achievement in physics, and found action learning more effective. Action learning and problem-based learning are both activity methods. Above has proved that students achieve more academically when they are active participants in the lesson.

The results of data analysis on TABLES 2 and 4 revealed that there is no significant difference in the mean achievement scores of male and female SSII Chemistry students taught using problem-based teaching method. Problem-based learning strategy emphasized on learning by participation and this could explain the non-significant gender related difference in achievement. The learning situation that the problem-based strategy creates can allow students to learn in variety of different ways. Students (male and female) identify problems and link them with previous knowledge. The students in a small group discuss the problem cooperatively among themselves. The above finding differs from the results of studies in [12]) which found out those male students achieved scientifically higher than female students in sciences and mathematics.

This result also showed that problem-based teaching method is non-sex discriminatory especially in terms of enhancing students' achievement in Chemistry. Therefore, it can be used for both boys and girls in physical classroom. This result is in line with findings of [1] who asserted that any good instructional strategy does not discriminate between sexes in science teaching and learning.

#### **V. Conclusion**

The findings of this study show that students taught with problem-based learning strategy performed significantly better in the achievement test than their counterparts who were taught using the expository method. Also, there was no significant difference between the mean Chemistry achievement scores of male and female SSII students taught Chemistry with problem-based learning strategy.

#### **VI. Recommendations**

The following recommendations are deemed necessary:

1. Government agencies and professional bodies such as science Teachers' Association of Nigeria (STAN) should sponsor further researches on the efficacy of problem-based learning strategy.
2. Teachers should be encouraged to adopt problem-based teaching method since it enhances students' achievement in Chemistry.
3. Science teachers should be encouraged to use problem-based learning strategy in teaching senior secondary school Chemistry. The use of problem-based learning strategy should not be limited to Chemistry as a subject, but should be incorporated in other science subjects.

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