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The Effect of Problem-Solving Instructional Strategies on Students' Learning Outcomes in Senior Secondary School Chemistry

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Abstract: *This study investigated the use of problems-solving and its effect on student achievement in the mole concept. Ninety six (96) senior secondary II students were randomly selected form Demonstration Secondary School, College of Education Azare. The instrument for data collection was 30-item chemistry achievement test (CAT). The instrument was validated and its reliability determined to be 0.81. Two research questions and two hypotheses guided the study. The data collected were analyzed using mean and standard deviation to answer the research questions, while t-test statistics was used to answer the hypotheses at 0.05 level of significance. The results revealed that student taught using problem-solving performed significantly better than those taught through lecture method. From the findings chemistry teachers are encouraged to attend seminars/workshops on problem -solving in order to facilitate the teaching and learning of chemistry in schools.*
Keywords: *Problem-solving, Mole Concept, Chemistry Education.*

I. Introduction

Problem-solving is a prominent feature in the learning of science and its neglect could have negative effect on students' learning outcome in science. This is no doubt, has made science enterprise more problem based in comparison with other fields of human endeavour.

Problem-solving has been an aspect of chemistry teaching and learning that has attracted the attention of chemical educators. The reasons are that chemist function best in problem-solving (Danjuma, 2011). Science is seen as a dynamic and objective process of seeking knowledge, and an enterprise that involves people searching, investigating and seeking verification of natural phenomena. Since science is both an organized body of knowledge and a process of finding out knowledge, it therefore demands that it should be target through hand-on-method approach. This implies placing the students' in problem-solving situation and surrounding them with appropriate material (Ibe & Nwosu, 2003).

Problem-solving has long been recognized as a skill that foster a better understanding of scientific and mathematics concept. It can be an excellent tool to encourage the learning process (Danjuma & Aishatu, 2010). Its development should therefore be a vital part of education and the chemistry classroom could be the right place for it to happen. This is based on the fact that problem-solving is an involved process that incorporates varying levels of thinking, judgment, comprehension, analysis, critical thinking, visualization and conceptualization (Adams, 1979).

Problem-solving is the highest form of learning (Babatunde, 2008). Since the individuals determines new ideas based on this process. Likewise, it is well known that, when faced with a problem, one needs knowledge of rules. On one hand, and the capacity to use them on the others. Thus achieving transfer of learning, being able to solve problem, then enables person to their environment and modify it in part (Servano, Cantu & Villa, 2003).

Statement of the Problem

Students' can find working with the mole difficult and frustrating to understand. With enough practice, they can memorize a pattern to complete the calculations, but have a difficult time understanding the concept, quickly losing their enthusiasm to work with these calculations, using problem-solving approach, students' can physically measure samples that demonstrate the quality of a "mole" which is a needed concept in mass-mole calculations of a chemical reaction. When students' are able to work with a physical sample, they are in a better position to make a connection and have a conceptual understanding of the mole concept.

In these manner, students' may develop a positive attitude towards a learning process that is more than rote memorization.

Purpose of the Study

The purpose of this study is to determine the effect of explicit problem- solving strategy on senior secondary school students' achievement in chemistry. The study also sought to ascertain the influence of gender on students' achievement in chemistry.

a. Determine whether explicit problem-solving strategy will be better than lecture method in improving students' achievements in the mole concept in chemistry.
b. Find out whether gender influence the students' achievement after expose to explicit problem-solving.

Research Questions

The study was guided by the following questions.

1. Will explicit problem-solving strategy be better than lecture method in improving students' achievement in the mole concept?
2. What is the influence of gender on the students' achievement in the mole concept after exposure to explicit problem-solving?

Research Hypotheses

The following hypotheses were tested at 0.05 level of significance.

Ho1: There is no significant difference in the post-test achievement mean scores of students' taught the mole concept using explicit problem-solving strategy and those taught using lecture method.

Ho2: There is no significant difference between the mean scores of male and female students' on the post-test scores in the mole concept after exposure to explicit strategy.

II. Methodology

Design of the study: The research design adopted for this study was the quasi-experimental design. It was the pre-test, post-test, experimental and control group design.

Sampling techniques: The total number of sample students' involved in the study was Ninety Six (96) senior secondary school students' selected at random based on similar characteristics which includes:

i. Same education level
ii. Same age range
iii. Same curriculum
iv. Same teaching environment

a. Instrument for data collection: The researcher developed the instrument, which was validated by experts and used for data collection, these includes:

i. Pre-achievement test
ii. The post-achievement test

The reliability coefficient was found to be 0.81 using test, re-test techniques, and the result correlated using Pearson product movement correlation coefficient formula.

Data Collection

The experimental group was subjected to instruction on the mole concept using explicit problem-solving strategy (EPSS). While the control group taught the same concept using the lecture method. At the end of the four (4) weeks treatment period, the two groups were post-tested.

Method of Data Collection

The data collected from the pre-test and post-test were analyzed using mean, standard deviation and t-test. The significance of the various statistical analysis was ascertained at 0.05 alpha level.

Data Presentation and Analysis

The result obtained from the pre-test and post-test of the students' responses to which they were related as shown below.

Table 1: t-test comparison of the pre-test mean score of experimental and control groups.

Group N=9b		Pre-test	Post-test	Gain in mean
Explicit problem-solving	X	7.00	19.00	12.00
N=50	SD	3.19	4.75	
Lecture Method	Y	7.00	14.35	7.36
N=46	SD	3.02	4.65	

N = number of students, X = problem-solving mean, Y lecture method mean, SD = standard deviation.

Table 1 shows the pre-test and post-test achievement of the explicit problem- solving and lecture instructional strategy groups as well as their standard deviations.

It could be seen that their achievement means were equal at the pre-test level and the two groups scored differently (19.00 and 14.35) respectively. For the experimental and control groups in the post-test. The research treatments resulted in gain of 12.00 and 7.35 mean scores respectively.

Research Question 1

Will explicit problem-solving strategy be better than lecture method in improving students' achievement in the mole concept?

Table 2: Achievement means and standard deviations of the explicit problem- solving and lecture method groups.

Group	N	X	SD
Explicit problem-solving	50	19.00	4.75
Lecture Method	46	14.35	4.6

Table 2 shows that the mean differences between the two groups (explicit problem- solving and lecture method) were 19.00 and 4.35 respectively. This showed that students' taught using explicit problem-solving strategy improved better in achievement than those taught using lecture method. Therefore, the answer to research question 1 was that explicit problem-solving strategy had a greater effect in improving students' achievement in mole concept than the lecture method instructional strategy.

Research Question 2

What is the influence of gender on the students' achievement in the mole concept after exposure to explicit problem-solving?

Table 3: Achievement means and standard deviation of male and female students' in explicit problem-solving.

Group	N	X	SD
female	23	19.00	5.35
Female	27	19.00	4.27

Table 3 shows equal means of male and female students' of 19.00 which revealed there was no difference in their achievement. This result shows that gender had no influence on the students' achievement in the mole concept after exposing them to explicit problem-solving.

Hypotheses 1

There is no significant difference in the post-test achievement mean scores of students' taught the mole concept using explicit problem-solving and those taught using lecture method.

Table 4: t-test analysis for achievement post-test scores of explicit problem- solving and lecture instructional strategies.

Group	N	X	SD	t-critical	t-cal
Explicit problem-solving	50	19.00	4.75		
Lecture Method	46	14.35	4.63	2.00	4.86

$P<0.05$, df = 94

In table 4, an independent t-test was conducted to compare the effect of explicit problem-solving and lecture instructional strategies. The different scores for explicit problem-solving (mean = 19.00, SD = 4.75) and lecture method (means 14.35, SD = 4.63) were subjected to t-test analysis. The value oft-calculated (4.86) was greater than the t-critical (2.00) at $P < 0.05$, and df of 94 and hence, hypothesis 1 was rejected.

Hypothesis 2

There is no significant difference between mean scores of male and female students' on post-test score in the mole concept after exposure to explicit problem-solving strategy.

Table 5: t-test analysis of the influence of gender on students' post-test achievement scores after exposing them to explicit problem-solving.

Group	N	X	SD	t-critical	t-cal
male	23	19.00	5.35	2.02	0.00
Lecture Method	27	19.00	4.27		

$P<0.05$, df = 48

Table 5, shows an independent sample t-test which was conducted to compare the achievement of male and female students' after exposing them to explicit problem- solving instructional strategy. The scores obtained were male (mean = 19.00, SD 5.35) and female (mean = 19.00, SD = 4.27) respectively. The value oft-calculated (0.00) was less than the t-critical (2.02) at P <0.05 and df of 48. Hence, hypothesis 2 was accepted. Indicating that there was no significant difference in the achievement of male and female students.

III. Discussion Of Findings

Findings from the results of the two research questions and the two hypotheses tested are the bases answered for the discussion that follows.

Effects of explicit problem-solving and lecture instructional strategies on students' achievement on the mole concept.

The result in table 2 and 4 revealed that students' taught using explicit problem-solving method had a higher achievement mean score than their counterparts taught using lecture method. This showed that students taught using explicit problem-solving strategy improved better in achievement than those taught using lecture method. Therefore, this means that explicit problem-solving strategy was better than lecture method in improving students' achievement in the mole concept. The finding is backed up by the finding in hypotheses 1.

This finding agrees with the view of Kehinde (2005) who showed that students taught using the problem-solving approach performed significantly better than those taught using the lecture method approach. This implies that students taught using problem-solving approach had mastered the strategy of solving chemical problem in chemistry, particularly in the mole concept which is a central theme in chemistry. Other empirical studies which gave positive effects of problem-solving method in achievement on other science subject include Esra, Ijlal, and Gurbuz (2009), Ali, Hukamdad, Akhter & Khan (2010), Ayodele & Agunlaye (2011). This was due to the fact that possession of knowledge was not sufficient to make a student solve a problem, but the ability to select and apply appropriate knowledge and skills.

The Influence of the Teaching Method on the Gender of the Students' in their Achievement on the Mole Concept.

This study showed that gender was not influenced by the teaching method, in students' achievement in the mole concept.

Table 3 shows equal performance of male and female when both were taught the mole concept with problem-solving approach (male X = 19.00, female X = 19.00). These revealed that there was no significant difference between the achievement of male and female students' as found in hypothesis 2.

This result was in agreement with the findings of Abdul-Raheem (2012), and Daniel (2012). However, the result did not agree with those of Inyang & Hannah (2000) and Adeleye (2011), whose works revealed a significant different in the performance of mole and female students in favour of mole.

IV. Conclusion

The way the mole concept has been taught in our secondary schools has called for an appraisal because of its importance in the subject; it also called for an improvement in the teaching and learning the concept. This had led to the focus of the present study to find an alternative method apart from the conventional lecture method commonly used by most schools.

The findings of the study therefore, revealed that explicit problem-solving strategy was significantly better than lecture method in improving students' achievement in the mole concept, the outcomes of the treatment was not influenced by gender.

V. Recommendations

Base on the findings, the following recommendations are made:

i. Chemistry teachers in senior secondary schools should try and use explicit problem-solving strategy while teaching their students the mole concept.
ii. Chemistry apparatus and chemicals should be provided for laboratory activities.
iii. Chemistry teachers should be allowed to attend seminars and workshops on teaching method; this would help them in updating their knowledge.

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