



Effect of Problem Solving Method on Academic Performance in Bonding among Senior Secondary Chemistry Students in Lapai Education Zone, Nigeria

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ABSTRACT

This study investigated the effect of the Problem-Solving Method on Academic performance in bonding among senior secondary chemistry students in the Lapai Education Zone. Utilizing a stratified random sampling technique, 60 SSII Chemistry students were selected (30 in the experimental group and 30 in the control group) from two Senior Secondary schools in Lapai Education Zone, Nigeria. Two null hypotheses were formulated and tested at a significance level of 0.05. The instrument employed was the Bonding Concept Performance Test (BCPT). The experimental group was taught using problem-solving methodology while the control group received instruction through traditional lecture methods. Both groups underwent testing post-treatment, and the data were analyzed through mean score differences and inferential methods. The results revealed a significant disparity in academic performance between the experimental and control groups, favoring the experimental group. This stresses the significant influence of problem-solving strategies on students' academic achievement in bonding at the senior secondary level. Consequently, the study recommends the integration of problem-solving techniques into chemistry teaching practices.

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INTRODUCTION

The word Science comes from Latin word "scientia" meaning "knowledge" and in the broadest sense it is any systematic knowledge-base or prescriptive practice capable of resulting in prediction. Science is the disciplined process of inquiry, driven by intellectual honesty and rigorous methodology that enables us to uncover the wonders and workings of the natural world, Dawkins, (2020). According to the Michio, (2021), science is the systematic exploration of the universe, fueled by observation, experimentation, and theoretical frameworks, to decipher the laws that govern the physical and natural realms. Science education is the process of imparting scientific knowledge and skills to individuals to develop a scientific mindset, critical thinking abilities, and an understanding of the scientific

method. Science education is the systematic and intentional teaching of science concepts, practices, and principles to develop students' scientific literacy, inquiry skills, and understanding of the nature of science, National Research Council (2012).

Paulo (2014) also define Science education as a process of critical consciousness-raising that enables students to question and challenge traditional scientific knowledge and its implications on social and environmental issues. Chemistry the branch of science that deals with the properties, composition, and structure of substances (defined as elements and compounds), the transformations they undergo, and the energy that is released or absorbed during these processes. Every substance, whether naturally occurring or artificially produced,

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consists of one or more of the hundred-odd species of atoms that have been identified as elements Alebiosu, and Bamiro, (2017). John, (2003) defined chemistry as the science that seeks to understand the behavior of matter by studying how atoms and molecules behave, as well as the changes they undergo during chemical reactions.

Problem solving method is the process of identifying an existing problem, determining the root cause or causes of the problem, deciding the best course of action in order to solve the problem, and then finally implementing it to solve the problem. Another problem-solving meaning is that it is simply a methodology for solving everyday issues Achugbu, and Eke, (2011). Mayer, (2014) Mayer's Cognitive Theory of Multimedia Learning, described in his book "The Cambridge Handbook of Multimedia Learning, examines problem-solving as a process where learners actively construct knowledge by integrating various media and information sources.

Academic performance is the measurement of student achievement across various academic subjects (specifically Chemistry). According to Narad and Abdullah (2016) academic performance is the knowledge gained which is assessed by marks by a teacher and/or educational goals set by students and teachers to be achieved over a specific period of time. Gender refers to the state of being male or female in relation to the social and cultural roles that are considered appropriate for men and women Aniodoh, and Egbo, (2013).

Bonding or Chemical bonding refers to the formation of a chemical bond between two or more atoms, molecules or ions to give rise to a chemical compound. These chemical bonds are what keep the atoms together in the resulting compound.

STATEMENT OF THE PROBLEM

The effectiveness of problem-solving methods in teaching chemistry, especially the concept of bonding, has gained attention in recent years. Problem-solving methods encourage students to actively engage with the subject matter, apply critical thinking skills, and develop a deeper understanding of the content Adesoji,

(2017). However, there is a gap in understanding whether the implementation of problem-solving methods can significantly impact students' academic performance in bonding within the context of senior secondary schools because the grade of Chemistry students at SSCE (Senior School Certificate Examination) at both WAEC (West African Examination Council) and NECO (National Examination Council) have not been motivated in the last few years. Chemistry is a natural subject that students face many challenges as a result of incorrect teaching methods and strategies Udo, (2015).

Poor teaching methods adopted by chemistry teachers serve as the factors that have been identified that contributes to the continued low interest rates and low levels of chemistry practical (Ogundre 2015). Bamidele and Oloyele (2013) opined that, the poor performance has been traced to several factors which may include the methods of teaching employed by the teacher which is not in line with the methods that involve the use of information technology and some other interesting techniques that can make the students learn the subject meaningfully.

Okonkwo (2007) also outlined several factors contributing to this problem. They include insufficient number of qualified chemistry teachers, insufficient instructional materials, overloaded chemistry syllabus, abstract nature of many chemistry concepts, inappropriate use of teaching strategy, poor teaching methods and lack of interest among the chemistry students Adebola, and Saraki, (2016). As a result, it become clear that the lecture method which is the most common teaching method in the current secondary school in Nigeria is inappropriate and unproductive for achieving the purpose of the chemistry program. Therefore, the study examined the effectiveness of problem-solving method on academic performance in bonding among senior secondary chemistry students in Lapai Education Zone.

Objectives of the Study

The following objectives of the study are to:

1. Investigate the effect of problem-solving method on academic performance of students in

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learning bonding as concept of chemistry among senior secondary students in Lapai.

2. compare the effect of problem-Solving method on academic performance of male and female students in learning bonding as concept of chemistry among senior secondary students in Lapai.

Research Questions

The following research questions are raised.

1. What is the significant difference between academic performance scores of the students taught bonding using problem solving method and those taught using lecture method?
2. What is the significant difference between male and female students taught bonding using problem solving method and those taught using lecture method?

Null Hypotheses

The following null hypotheses are formulated and tested at $P \leq 0.05$ level of significance.

H01: There is no significant difference between mean academic performance scores of the students taught bonding using problem solving method and those taught using lecture method.

H02: There is no significant difference between mean academic performance scores of male and female students taught bonding using problem solving method and those taught using lecture method.

Significance of the Study

This study holds significance for various stakeholders in the field of education. Firstly, it will provide valuable insights into the effectiveness of problem-solving methods in teaching chemistry, particularly bonding. This information can help educators and curriculum developers enhance teaching strategies to improve students' understanding of this critical chemistry concept. Secondly, the study can benefit policymakers by informing decisions related to curriculum

development and teacher training. It may also offer guidance to teachers on innovative approaches to teaching chemistry, fostering a more engaging and effective learning environment.

METHODOLOGY

The study adopted Quasi-experimental design to gather valuable data, the use of this design is well supported by Best and Kannam (2016) who pointed out that Quasi experimental design is appropriate to describe conditions that exist. The populations for the study were all chemistry students in some of the selected Secondary schools in study area. However, the target populations for this study were SSII chemistry students in the selected secondary schools five (5) schools in Niger State Lapai. The sample for this study was 60 students which were selected from two coeducation senior secondary schools in Lapa Education Zone. Selection of the students in each class was by simple balloting where a pick of Yes and No method were adopted in other to get those to represent that particular class.

The instrument was validated by three PhD holders from chemistry department for this work, whereby, they examined the instrument whether it is suitable by SS2 students and necessary corrections was taken. A pilot-test was carried out among 60 students of Muhammadu kobo Secondary School Lapai who were among the population of the study but not among the sample and sampling study which was used for pilot testing to determine the reliability of the BCPT. The BCPT was administered to 60 students of Muhammadu Kobo Secondary School Lapai and the items of BCPT were collected back with the help of the teachers in charge of the subject as research assistants. The data collected were analyzed using Pearson Product Moment Correlation (PPMC), the reliability coefficient (r) was obtained as 0.70.

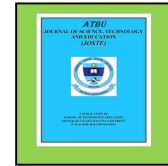
The researchers visited the selected schools and seek permission from the principals to carry out the study. The BCPT was administered to sixty students of the two selected secondary schools as experimental and control

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group for the study. The BCPT was answered by students and returned by research assistants (subject teachers). The study was concluded over a period of 4 weeks. The data was collected and analyzed using descriptive, inferential and statistical method to answer the research questions and null hypothesis.

RESULT

Table 1: Mean and Standard Deviation of Students' Performance in Bonding in Experimental and Control Groups.

Groups	N	Mean	SD	Mean	Difference
Exp	30	23.77	2.51	3.34	
Cont	30	20.43	1.61		

Table 1 shows the analysis of students' performance in bonding concept taught using problem-solving method and those taught using lecture method. The mean performance score of students taught using problem-solving method is 23.77 and those taught using lecture methods is 20.43. The mean difference is 3.34.

Table 2: Mean and Standard Deviation of Male and Female Students' Performance in Bonding Concept in Experimental

Gender	N	Mean	SD	Mean	Difference
Male	30	22.36	2.17	2.64	
Female	30	25.00	2.31		

Table 2 shows the analysis of male and female students' performance in bonding concept taught using problem-solving method and those taught using lecture method. The mean performance score of male and female students taught using problem-solving method is 22.36 and those taught using lecture methods is 25.00. The mean difference is 2.64.

Table 3: Summary of independent t-test analysis of Student's Performance in Bonding Concept in Experimental and Control Groups.

Groups	N	Mean	SD	t _{cal}	Df	P-value	Decision
Exp	30	23.77	2.51	6.11	58	0.01	Rejected
Cont	30	20.43	1.61				

Research Question One:

What is the difference between academic performance scores of students taught bonding concept using problem-solving method and those taught using lecture method?

To answer the research question one, mean and standard deviation were used.

Research Question Two:

What is the difference between male and female students' performance taught bonding concept using problem-solving method? To answer the research question two, mean and standard deviation was used. The summary of the analysis is presented in table 2.

Testing of Null Hypotheses

HO₁: There is no significant difference between the mean academic performance scores of the students taught bonding concept using problem-solving method and those taught using lecture method.

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Table 3: revealed that analysis of independent t-test with t_{cal} values of 6.11 and p-value of 0.01 at Df of 58. The p-value is $0.01 < 0.05$. Therefore, we rejected the null hypothesis and conclude that, there is significance differences between the mean academic performance of students in bonding concept taught using problem-solving method and those taught using lecture methods. This show that, use

of problem-solving method has significance impact on students' performance in bonding concept.

HO₂: There is no significant difference between mean academic performance scores of male and female students taught bonding concepts using problem-solving method.

Table 4: Summary of independent t-test analysis of Male and Female Student's Performance.

Groups	N	Mean	SD	t_{cal}	Df	P-value	Decision
Exp	15	12.07	2.87	0.53	28	0.59	Retained
Cont	15	12.67	3.29				

Significant at $P < 0.05$ level

Table 4 revealed that analysis of independent t-test with t_{cal} values of 0.53 and p-value of 0.59 at Df of 28. The p-value is $0.59 < 0.05$. Therefore, this result is showing no significance differences between the mean academic performance scores of students in bonding concept in both groups meaning that they are homogeneous. This indicated that the two groups can be used for the research.

using lecture methods is 20.43. The mean difference is 3.34. This shown that the students exposed to BCPT using problem Solving method had significantly higher academic mean performance score than their counterparts taught using lecture method (Control).This finding is in support of Achugbu, and Eke, (2020) Which revealed that problem-solving method is more effective in enhancing the students' achievement in chemistry than the conventional lecture method. In addition, other empirical studies which gave positive effects of problem-solving on achievement in other science subjects includes Ishaku (2015), Adebola and Saraki (2016). Udo (2015) reported that problem solving helped the learners to think through the various steps to the solution of the problem at hand. Olajengbesi and Aluko (2014) investigated the influence of concept maps and problem solving instructional strategies on secondary school learning outcomes in Chemistry, reported that students' taught with problem solving strategy performed significantly better than those taught with concept mapping.

The result in Table 2 and 4 showed the descriptive analysis of male and female students' performance in bonding concept taught using problem-solving method and those taught using lecture methods. The mean performance score of male and female students taught using problem-solving method, for the male the mean score 22.36 while that of the female is 25.00. The mean difference is 2.64. This showed that the female

DISCUSSION OF RESULTS

The study investigated the effectiveness of problem solving method on academic performance in bonding among senior secondary chemistry students in Lapa Education Zone. The result shown in Table 1 indicated that, analysis of independent t-test with t_{cal} values of 0.53 and p-value of 0.53 at df of 58. The p-value is $0.01 > 0.05$. Therefore, this result is showing no significance differences between the mean academic performance of students in bonding concept in both group meaning that they are homogeneous. This indicated that the two groups can be used for the research.

The result in Table 1 and 3 shows the descriptive analysis of students' performance in bonding concept taught using problem-solving method (Experimental group) and those taught using lecture methods (Control group). The mean performance score of students taught using problem-solving method is 23.77 and those taught

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performance higher in BCPT than the male. This is in support of the reports of Aniodoh and Egbo (2013), Awoniyi, (2000), and Uwaleke (2013). Among the results, Aniodoh and Egbo, Cheung and Uwaleke's study revealed that female students perform better than male in chemistry while Awoniyi, Ifeako, Offiah and Egolum revealed a significant gender difference on student's achievement in favor of males.

The differences in their performance can be attributed to gender stereotyping which encouraged male and female students to show interest in subjects relevant and related to the role expected of them in the society. The result agreed with the findings of Jegede and Fatoke (2014) who reported that gender is not a perfect predictor as far as Chemistry achievement is concerned, whether students are taught using problem-solving or traditional method. This also agreed with the findings of Ishaku (2015) and Akpoghol (2015) who contends that gender is not a relevant factor to be associated with school achievement.

SUMMARY OF MAJOR FINDINGS

The following comprised the major finding from the study:

1. The study revealed that problem solving method is more effective in the teaching of bonding in chemistry compared to the lecture method. There is no significant difference between the mean academic performance scores of the students taught bonding using problem solving method and those taught using lecture method.
2. The problem solving method is a gender friendly method for teaching bonding in chemistry. There is no significant difference between the mean academic performance scores of male and female students taught bonding using problem solving method, therefore, it is gender friendly.

CONCLUSION

One of the significant attributes of sciences is solving problems. Consequently, no science students can do without solving problems.

The findings of this study served as bases for making the following conclusions; problem solving and discussion methods of teaching enhance students' performance in chemistry in Niger education zone. The results of the study also indicated that students could be better problem-solvers if they are of high ability level, but those with low ability could also perfect their problem-solving skills if they are exposed to problem-solving teaching method.

RECOMMENDATIONS

Based on the findings, the following recommendations were made;

1. Teachers of other science based subjects such biology, physics and mathematics, should make use of problem-solving method in the teaching of concepts in the respective subjects.
2. The National Educational Research and Development Centre (NERDC) should encourage the use of problem solving as a method for teaching bonding in chemistry. This would make problem solving method acceptable among teachers and student.

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