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Effect of Problem Solving Instructional Technique on Secondary School Students' Interest in Chemistry in Anambra State

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Abstract
The study investigated the effect of problem solving instructional technique on students' interest in chemistry in Anambra State. Two research questions and two hypotheses guided the study. The study adopted a quasi-experimental specifically pretest-posttest non-equivalent control group design. The population of the study consisted of 541 senior secondary school two (SS2) chemistry students in Awka South local government area. A sample consisting of 87 chemistry students from the two sampled schools was used for the study. The design of the study was quasi-experimental. Chemistry Interest Scale was used as instrument for data collection. Reliability estimate of 0.87 was obtained on CIS using Cronbach's Alphs formula. Mean and standard deviation were used to answer the research questions while analysis of co-variance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. The result revealed that problem solving method is more effective in enhancing the students' interest in chemistry than the conventional lecture method. There was no significant difference on students' interest in chemistry due to gender. Based on the findings of this study, it was recommended that secondary school teachers should be given adequate training through workshops, symposia, conferences and seminars to help them in update their knowledge on the new teaching techniques and apply or used them in their teaching and learning processes.

Keywords: *Problem-solving, chemistry, electrolysis, interest, technique*

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I. Introduction

Science is one of the major sources of development. Thus, a nation without scientific knowledge and skills is like a man without a future because technological development of a nation depends on the level of scientific potentials possessed by her citizenry. Robert (2009) was of the view that for a country like Nigeria to compete with the international community, she must cultivate in her citizenry appropriate scientific knowledge and technological skills needed to create tomorrow's innovation. These skills are cognitive and psychomotor skills employed in problem solving. They are the scientific thinking skills and critical thinking ability employed in the processes of doing science or used in problem identification, objective inquiry, data collection, data transformation, interpretation and communication. These skills are those needed in our daily lives as we try to find solution to our everyday problems and life activities. Studying of chemistry is the channel through which these skills are acquired because chemistry learning involves practical activities and experimentations.

Learning should not be dependent on the teachers alone. Students should be actively involved in every stage of teaching and learning. Akudolu (2012) opined that to prepare learners for effective life in this 21st century, teachers should adopt instructional technique that is flexible, creative, innovative and learner-centered in their teaching. Such methods of instruction should develop in the learner, the spirit of inquiry, an attempt to make students fully aware as well as understand the way scientists work. It places the learner in charge of his or her learning. Learning could also be made more effective, lasting and enjoyable and topics that appear abstract to students could be made clearer, easier and meaningful for better understanding of the concept if students are full involved in the learning and teaching process.

Problem solving is a student- centered approach to learning, where the teachers and students play an equal active role in the teaching and learning process. The teacher's primary role is to coach and facilitate student learning and overall compression of materials while the students construct new ideas and concepts based on their current or past knowledge. Problem solving skill is a life skill that will serve you well throughout your life because it will help one tackle a task. Galadima (2002) defined problem solving as a complex process to learn and consists of series of tasks and thought process that are closely linked together to form a set of heuristic pattern. Heuristic, according to him, is defined as a set of suggestions and questions that a person must follows and asks questions in order to resolve a dilemma. Therefore, students need to learn this process if they are to deal successfully with problems they will meet in schools and indeed real life. On the other hand, Ameen

(2011), opined that problem solving is a process which begins with the initial contact with the problem and ends when they obtained answer is reviewed, in the light of the given information, it is a problem that required the learners to sift through previously acquired knowledge and select an appropriate plan in solving the problem. In other words, it embraces a continuous, meaningful, well integrated activity beginning with a problematic situation and then ends when the problem has been solved and the solution checked.

According to Danjuma (2011) problem solving has been recognized as a skill that foster a better understanding of scientific and mathematic concepts. It can be excellent tool to encourage the learning process. This is based on the fact that problem solving is an involved process that incorporates varying level of thinking, judgment, comprehension, analysis, critical thinking, visualization and conceptualization. Problem Solving is, and should be a very real part of the curriculum. It presupposes that students can take some of the responsibility for their own learning and can take personal action to solve problems, resolve conflicts, discuss alternatives and focus on thinking as a vital element of the curriculum. It provides students the opportunities to use their newly acquired knowledge in meaningful, real-life activities and assists them in working at higher level of thinking.

According to Babatunde, (2008), problem solving is the highest form of learning since the individual determines new ideas based on this process. Babatunde further explained that problem solving is a prominent feature in the learning of science and its neglect could have negative effect on students' learning outcome in science. If students are placed in problem solving situation, they will learn from their successes and failures. This implies that active involvement with science will likely lead students to be more creative in science, develop more interest and have more positive attitude towards science and chemistry in particular.

Interest is an important variable in teaching-learning process. The development of students' interest towards chemistry as a school subject is one of the major responsibilities of every chemistry teacher. Interests or feelings towards studying chemistry or science are the student's disposition towards like or 'dislike' chemistry or science. Njoku (2003) defined interest as a response of liking or disliking to an activity, object or a person. Njoku further stressed that, interest is the degree of likeness an individual has for something such as activity, person or situation. It is concerned with the individual's preference for a particular type of activities. Obodo (2002) described interest as a compelling attraction which a learner exhibits towards a specific event. This compelling force, Obodo stressed, can be induced by method of teaching, resources for teaching and the strategies used. According to Okigbo and Okeke (2011), interest is an important variable because when one become interested in an activity, one is likely to be more deeply involved in that activity. For a student to be deeply involved in learning chemistry concepts, he or she must develop positive attitudes and interest in learning chemistry.If a student becomes interested in the teaching or the activities in the class, he or she is likely to be deeply involved in the activity. According to Imoke and Agwaga (2006), interest is the preference for a particular type of activity, that is, a subjective feeling of concentration or persisting tendency to pay attention and participate in certain activities. However, students' interest could be aroused and sustained through the use of appropriate instructional technique like problem solving instructional technique (Okonkwo, 2007). Thus, the prominent aim of this is to make students active, free and self-learning individuals through problem solving and enhance their thinking skills rather than being passive recipients of knowledge improving their interest in chemistry learning.

The persistent lowinterest of the secondary school students in chemistry and the search for more effective technique for the teaching and learning of chemistry that will enhance the performance has been an issue attracting the attention of researchers and science educators over the years. For more than a decade now, different techniques and strategies employed in the teaching chemistry have not improved students' interest in the subject to an appreciable extent. On the same note, many studies have been done by researchers pointing out the effectiveness of different technique like inquiry-based, field-trip, discovery, analogy scaffolding, among others in enhancing the students' interest in chemistry but their efforts deemed not to be successful in improving students' interest in learning chemistry.Problem solving technique from the literature reviewed, has been found effective in enhancing students' academic interest in subject areas like biology, physics and mathematics. Although, the effect of problem solving techniques has been found to be effective in other subject areas, as pointed out in the background, the effect on students' interest in chemistry is not widely known. Thus,the need arose to examine the effect of problem solving technique on students' interest in chemistry.

Objectives of the study

The objectives of this study was to investigate the effects of problem solving instructional technique on secondary school students' interest in chemistry. The study specifically aims at determining:

1. The difference between the mean interest scores of students taught the concept of electrolysis using problem solving instructional technique and those taught with conventional method.
2. The Influence of gender on mean interest scores of students when taught the concept of electrolysis.

Research questions

The following research questions guided the study.

1. What is the difference between the mean interestscores of students taught the concept of electrolysis using problem solving instructional technique and those taught using conventional method?
2. What is the difference between the male and female students' mean interest scores when taught the concept of electrolysis?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance.

1. There is no significant difference between the mean interest scores of students taught the concept of electrolysis using problem solving instructional technique and those taught using conventional method
2. There is no significant difference between the male and female students' mean interest scores when taught the concept of electrolysis.

II. Method

The research design that was used for this study is quasi experimental research design. Specifically, non-equivalent control group design was used. The design is schematically represented in Figure 1 as follows:

Group	Pre – test	Treatment	post – test
E	O_1	X_1	O_2
C	O_1	X_2	O_2

Figure 1: Quasi-Experimental Research Design

Where:

E = Experimental Group
C = Control Group
0_1 = Pre-test for E and C
0_2 = Post-test for E and C
X_1 = Experimental treatment (problem solving technique)
X_2 = Control treatment (conventional method of instruction)

The population of the study is 541 SS 2 chemistry students of 2015/2016 academic session in the eighteen public secondary schools in Awka South Local Government Area in Anambra State. The sample of this study consists of 87 SS 2 chemistry students drawn from two schools out of the 18 public secondary schools in Awka South L.G.A of Anambra State. Experimental group was made up of 35students (14 males and21 females) while control group was made up of 52 students (32males and 20 females).

The instrument for data collection is Chemistry Interest Scale (CIS). The chemistry interest scale (CIS) is a researcher's developed instrument which is made up of 22 items (See, Appendix H page 91). It comprises of positive and negative items with a 5 point Likert response scale ranging from strongly agree to strongly disagree. The CIS was used to measure students' general interest in chemistry. The instrument was given to three experts, two from the Department of Science Education and one from Department of Educational Foundations in Nnamdi Azikiwe University. The reliability of CIS was established using Cronbach reliability technique. Cronbach alpha was used because the items in CIS were not dichotomously score but have multiple rating. The CIS (22 items) was given to the same 30 students for trial testing to respond to. The reliability of the instrument was found to be 0.87.

The experimental group teachers (research assistants) was trained by the researcher on how to use problem solving instructional technique before the treatment while the control group teacher was also trained on how to use the normal lesson plan. The training lasted for one week involving three contacts within the week and it covers the purpose of the study, the use of lesson plan, the concepts to be taught as well as the general conduct of the study and the procedure for administering the instrument. This is to ensure the homogeneity of instrument situation across the groups. The programme of activities for the three days was as follows.

Day One

i. The researcher discussed with the research assistants the topic to be taught, the technique to be used, the purpose of the training and the duration of the exercise.
ii. Discussions on problem solving instructional technique;
a. Meaning and steps involved in problem solving technique.
b. Polyas' four steps of problem solving such as; Understanding the problems; Devise a plan; Carrying out the plan and Looking back

Day Two

i. Teaching the research assistants how to incorporate the Polya's four steps into the lesson plan while teaching is going on.

ii. Demonstration by the researcher on the use of Polya's four steps of problem solving. This is to ensure the proper use of the four steps of problem solving.

Day Three

i. Summary of previous days training

ii. Mini-teaching by the research assistants

iii. Corrections and reaction by the research assistants.

iv. Closing.

The experimental group received their treatment using Polya's four steps of problem solving technique while control group received theirs using conventional lecture method. The same subject content was given to the two groups. The study was done during their normal class periods. The two chemistry teachers (research assistants) from the two sampled schools administered the two tests; CATE and CIS (pretesting) in their respective schools. The scores obtained were used to determine the performance lead of the students before the experiment. Immediately after five weeks teaching and revision period, the same instruments were administered to the same students in their classrooms on the sixth weeks. For CATE, the test lasted for 30 minutes, but for the CIS test, there was no time of response but students were advised by their class teacher to finish as soon as possible.

The treatment was in two phases.

Stage One: Teaching of the Students

The teaching lasted for five weeks with one contact of 80 minutes (double period) each week. The experimental group was taught electrolysis using Polya's four steps of problem solving. The control group was taught the same topics as in experimental group during their normal class period. To this group their teacher taught them with conventional method. The extensive teaching and revision lasted for five weeks

Stage Two: Evaluation / Testing period

At the end of extensive teaching and revision period, post chemistry interest was administered to the students immediately on the sixth week.

Scoring of the Instruments

Scoring procedures for the CIS: The CIS is a five rating scale. The score pattern is as follows:

	For positive items	**for negative items**
Strongly Agree (SA)	5	1
Agree (A)	4	2
Undecided (U)	3	3
Disagree (D)	2	4
Strongly Disagree (SD)	1	5

Since CIS was made of 22 positively and negatively worded items, the lowest possible score for each student is 22 while the highest possible score for a student is 110. The data obtained was analyzed using mean and standard deviation to answer the research questions and analysis of covariance (ANCOVA) was used to test all the hypotheses at 0.05 significant levels.This is because they involved more than two groups and it takes care of initial differences of the research group. The p-values were compared with alpha ($\alpha = 0.05$) for appropriate decisions on the null hypotheses tested. Reject the null hypothesis if the p-value is less than alpha level. Otherwise, do not reject the null hypothesis.

III. Results

Research Question 1: What difference between the mean interest scores of students taught the concept of electrolysis using problem solving instructional technique and those taught using conventional method?

Table 1: Pretest and Posttest Mean Interest Scores of Students taught with Problem Solving and those taught with Conventional Method

Source of Variation	N	Pretest Mean	Posttest Mean	Gained Mean
Problem solving Method	35	39.09	81.57	42.48
Conventional Method	52	39.27	55.46	16.19

In table 1, it was observed that the students taught with problem solving method had pretest mean score of 39.09 and posttest mean score of 81.57 with gained mean 42.48 in their interest in chemistry, while the students taught with conventional method had pretest mean score of 39.27 and posttest mean score of 55.46 with gained mean 16.19 in their interest in chemistry. Therefore, problem solving method is more effective in enhancing the students' interest scores in chemistry than the conventional method.

Research Question 2: What difference between male and female students' mean interest scores when taught the concept of electrolysis?

Table 2: Pretest and Posttest Interest Mean Scores of Male and Female Students

Source of Variation	N	Pretest Mean	Posttest Mean	Gained Mean
Male	14	39.50	83.57	44.07
Female	21	38.81	80.24	41.43

Table 2 reveals that male students taught with problem solving method had pretest mean score of 39.50 and posttest mean score of 93.57 with gained mean 44.07 in their interest in chemistry, while the female students in the group had pretest mean score of 38.81 and posttest mean score of 80.24 with gained mean 41.43. Therefore, problem solving is slightly more effective in enhancing the interest of male students in chemistry than in female students.

Null hypothesis 1: There is no significant difference between the mean interest scores of students taught the concept of electrolysis using problem solving instructional technique and those taught using conventional method.

Table 3: ANCOVA on the Posttest Interest Mean Scores of Students taught Electrolysis with Problem Solving and those taught with Conventional Method

Source of variation	**SS**	**df**	**MS**	**Cal. F**	**Pvalue<0.05**	**Remark**
Corrected Model	15877.449	2	7938.725			
Intercept	8609.030	1	8609.030			
Pretest	1616.047	1	1616.047			
Instructional Methods	14364.211	1	14364.211	388.54	0.00	S
Error	3105.447	84	36.970			
Total	397559.00	87				
Corrected Total	18982.897	86				

Table 3 indicates that at 0.05 level of significance, 1df numerator and 84df denominator, the calculated F 388.54 with P-value 0.000 which is less than 0.05. Therefore, the third null hypothesis is rejected. Thus, there is significant difference in the effectiveness of problem solving method and conventional method in enhancing secondary school students' interest in chemistry.

Null hypothesis 2: There is no significant difference between the male and female students' mean interest scores when taught the concept of electrolysis.

Table 4: ANCOVA on the Posttest Interest Mean Scores of Male and Female Students taught with Problem Solving Method

Source of variation	**SS**	**df**	**MS**	**Cal. F**	**Pvalue<0.05**	**Remark**
Corrected Model	312.763	2	156.382			
Intercept	7235.433	1	7235.433			
CI1	219.430	1	219.430			
GENDER	81.797	1	81.797	1.85	0.184	NS
Error	1417.808	32	44.307			
Total	234617.000	35				
Corrected Total	1730.571	34				

Table 4 shows that at 0.05 level of significance, 1df numerator and 32df denominator, the calculated F 1.85 with P-value 0.184 which is greater than 0.05. Therefore, the fourth null hypothesis is accepted. So, there is no significant difference in the effectiveness of problem solving method in enhancing interests of male and female students in chemistry.

IV. Discussion

The findings of this study show that students taught chemistry using problem solving technique achieve a higher mean interest score than students taught using conventional lecture method. There is significant difference between the mean interest scores of experimental group (Problem Solving Instructional Method) and control group (conventional method) in favour of experimental group with higher mean interest score. These findings are in conjunction with the findings of Musntago (2010), Okigbo and Okeke (2011) that found out that student in experimental group had higher interest mean score than students who were taught using conventional method. They also found that the difference in their mean interest score was significant in favour of the students who were taught using problem solving (experimental group).

The high interest shown by the experimental group may have been affected by the fact that problem solving as an exercise of acquiring the skills of problem solving itself is interesting. Most students in the treatment group were always seeking logical answers or finding adequate pattern which solve the problem and as a result of this, their interest may have been aroused and sustained.

The finding of this study reveals that male and female students taught chemistry with problem solving instructional technique had almost equal mean interest scores. These findings are in agreement with the findings of Okigbo and Okeke (2011) that there is no significant difference between mean interest score of male and female students.

Also, the finding of Okeke (2014) reveals that there is no significant difference between male and female students in their interest mean scores. Musntag (2010) also found that gender was not a significant factor in students over all interest mean score when taught chemistry with problem solving instructional technique.

The non-significant difference observed in the interest of both male and female students in the experimental group might be due to the fact that problem solving instructional technique encourages active participation and interactive learning among the students. Through such interaction, both male and female students show equal interest in learning and so problem solving instructional technique is gender friendly and it has the potential of enhancing both male and females interest in learning in chemistry.

V. Conclusion

It can be concluded from the study that the use of problem solving method can effectively improve students' interest in learning chemistry.

VI. Recommendations

Based on the findings of this study, the following recommendations were made:

(1.) The secondary school teachers should be given adequate training through workshops, symposia, conferences and seminars. This would help them in updating their knowledge on the new teaching techniques and apply or used them in their teaching and learning processes.

(2.) School curriculum should be overhauled to accommodate problem solving and activity oriented instructional technique.

(3.) Problem solving should also be used by chemistry teachers to enhance gender equity in interest of all students in chemistry and other related disciplines.

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