

# PAPER 40

## EFFECTS OF PROBLEMATIC ANALOGY STRATEGY ON STUDENTS' ACHIEVEMENT AND RETENTION IN BALANCING CHEMICAL EQUATIONS CONCEPTS OF SECONDARY SCHOOL CHEMISTRY

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### Abstract

This study determined the effect of problematic analogy on achievement and retention of senior secondary students in balancing chemical equations in Bosso Local Government Area, Niger State. Quasi-experimental design of pre-test, post-test, control group, non-randomize, non-equivalent type was adopted for the study. Four null hypotheses were formulated and tested at 0.05 level of significance. Simple random sampling technique was used to select four secondary schools from Bosso Local Government Area and eighty-one (81) SS1 students offering chemistry as participants. Intact class was used. Chemical Equation Achievement Test (CEAT) in form of thirty (30) multiple choice questions was used as instrument for data collection. Data collected were analysed using mean, standard deviation and Analysis of Covariance (ANCOVA). The findings of the study shows that there is a significant difference in the mean achievement scores of students taught balancing of chemical equation using problematic analogy method and those taught using conventional (lecture) method in favour of those taught using problematic analogy method. There was also significant difference in the mean retention scores of students taught balancing of chemical equation using problematic analogy method and those taught using conventional method. Gender was not a significant factor in the students' achievement as well as retention in balancing of chemical equations. It was recommended among others that; science educators and curriculum planners should incorporate innovative strategies such as problematic analogy strategy into the teaching of chemistry concepts in secondary schools.

**Key Words:** Problematic Analogy, Achievement, Retention, Chemical Equation.

### Introduction

Writing and balancing of chemical equations are very important concepts in chemistry and are the basis for understanding chemical language. In fact, they are one of the basic fundamentals or stepping stone in understanding chemistry. Usoro (2011) defined chemical equations as changes that take place when there is breaking and formation of bonds during a chemical reaction. It is a statement in formula which shows the relative number of moles of particles involved in a chemical reaction. Adigwe (2015) defined a balanced chemical equation as a cognitive map of the nature of the reactants and products, their stoichiometric relationship, physical states and direction of the reaction, reversible or irreversible. The Chief Examiners' Report in Chemistry, West African Examination Council (2014 and 2015) revealed that most of the chemistry candidates



displayed inability to accurately write chemical formulae and balance chemical equations. This deficiency may be attributed to students' inability to use of symbols, formulae and the nomenclature involved in writing a balanced reaction (Adeyegbe, 2009; Bello, 2010 and Eniayehu, 2010). Another factor attributed to students' inability to write balance equation is the way the concepts are taught in class which makes it difficult for the students to comprehend (Attah, 2014; Bello, 2010 and Eniayehu, 2010). Therefore, there is the need to adopt a strategy that will help students build conceptual bridges between what is familiar and what is new such as problematic analogy to teach balancing of Chemical equations in secondary schools.

Johnson (2010) defined analogy as a process of identifying similarities between two concepts. Novak (2015) also defined analogy as a learning strategy that was developed as a research tool to represent learner's prior relevant knowledge and later as a tool to enhance meaningful learning. There are different forms of analogy; one of them is the problematic analogy. As the name implies problematic analogy often generate alternative conceptions that remain popular and are frequently used in science teaching (Harrison, 2012). According to Eze (2015), problematic analogy is defined as the teaching strategy which bridges between two concepts, one which is familiar and the other which is new and unfamiliar.

Several studies have been conducted on problematic analogy and have shown that it enhances students' achievement in science. Owolabi (2013) conducted a study on the use of problematic analogy as vehicle for achieving effective physics delivery in some selected senior secondary schools in Lagos and discovered that the experimental group performed significantly better and retained more of the concepts than the control group after post-test. Sani (2006) in a study on effect of problematic analogy on conceptual understanding of chemical equilibrium among SS2 students found out that the experimental group taught with analogy performed significantly better than the control group taught with lecture method. Similarly, Abimbola (2009) and Attah (2014) in separate independent studies reported that when a competent teacher presents any concept using analogy strategy systematically, the resultant students' understanding is compatible with a scientist's view. This implies that problematic analogy can lead the mind to understand scientific concept. Problematic analogy does not only improve students achievement but also retention of the concepts taught.

Retention on the other hand is the continued possession of something or the continued existence of something. Research findings have shown that problematic analogy enhances achievement and retention of concepts in science. Owolabi (2013) reported that problematic analogy improved students' achievement and retention while Lagoke (2006) reported that the use of problematic analogy arouses students' interest and imagination and therefore lead to understanding and retention of concepts in science.

Gender has also been identified as another factor that affects students' achievement in Chemistry. Eze (2015) stated that gender issue is an important factor in educational setting and could be a militating factor to high achievement of learners in Chemistry. There is also the long-held view that gender difference in achievement in science in favour of the males is caused primarily by biological inheritance (Nkpa as cited by Eze, 2015). Other studies confirmed the superiority of female students' performance over male students (Mari, 2010; Aba, 2011; Shuaibu & Mari, 2011) as cited in Lawrence (2014). However, Eze (2015) also argued that so far there is no biological evidence that boys have innate superior intellectual abilities more than girls. Therefore



differences in achievement occur, they may be caused by other factors. Thus, the need for the inclusion of gender in this study.

### Statement of the Problem

The poor achievement of students in Chemistry has been associated with the use of poor teaching methods, lack of retention and sometimes influence of gender. In view of these, researchers in science education have continued to search for effective teaching strategies that will enhance students' achievement and promote their retention. This study determined the effects of problematic analogy strategy on the achievement and retention of secondary school students in balancing chemical equation concepts of chemistry in Bosso Local Government Area of Niger State.

### Objectives of the Study

The objectives of this study are to:

1. Determine the effect of problematic analogy strategy on achievement of senior secondary students in balancing chemical equations.
2. Determine the effect of gender on problematic analogy strategy on the achievement of senior secondary students in balancing chemical equations.
3. Determine the effect of problematic analogy strategy on the retention of senior secondary students in balancing chemical equations.
4. Determine the effect of gender on problematic analogy on the retention of senior secondary students in balancing chemical equations.

### Hypotheses

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

H<sub>01</sub>: There is no significant difference in the mean achievement scores of students taught balancing of chemical equations using problematic analogy strategy and those taught with conventional lecture method.

H<sub>02</sub>: There is no significant difference in the mean achievement of male and female students taught balancing chemical equations.

H<sub>03</sub>: There is no significant difference in the mean retention scores of students taught balancing of chemical equations using problematic analogy strategy and those taught with conventional lecture method.

H<sub>04</sub>: There is no significant difference in the mean retention scores of male and female students taught balancing of chemical equation.

### Methodology

The study adopted the pre-test, post-test, non-randomized, non-equivalent control group quasi-experimental design. Four schools were randomly selected from Bosso Local Government Area and were randomly assigned to experimental and the control group. Four intact SS 2 classes comprising of 81 students offering chemistry participated in the study. Chemical Equations Achievement Test (CEAT) with thirty (30) multiple choice questions was used as instrument for data collection. CEAT is a 30 item multiple choice test with options A-D on Chemical reaction concepts developed by the researchers from past WAEC questions. The face and content validity of CEAT was determined by experts in Chemistry Education in the Department of Science Education, Federal University of Technology, Minna and a reliability coefficient of 0.88 was



established using test re-test method. Data collected was analysed using mean, standard deviation and Analysis of Covariance (ANCOVA) test.

### Results

**H<sub>01</sub>:** There is no significant difference in the mean achievement scores of students taught balancing of chemical equations using problematic analogy strategy and those taught with conventional lecture method.

**Table 1:** Analysis of Covariance (ANCOVA) of the effects of Problematic Analogy Strategy on students' Achievement in Balancing of chemical equations

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	33176.158 <sup>a</sup>	4	8284.040	56.496	0.000	
Intercept	12570.592	1	12570.592	85.730	0.000	
Pre-test	13.746	1	13.746	0.094	0.760	
Treatment	29715.037	1	29715.037	202.654	0.000	*S
Gender	114.616	1	114.616	0.782	0.379	*NS
Group *	1009.483	1	1009.483	6.885	0.011	
Error	11143.842	76	146.629			
Total	180441.000	81				
Corrected Total	44280.000	80				

a. R Squared = .748 (Adjusted R Squared = .735) \*S=Significant \*NS=Not Significant

Table 1 shows that the probability associated with the calculated value of  $(F(1, 76) = 202.65, P < 0.05)$ . The null hypothesis was rejected. Hence, there is significant difference in the mean achievement scores of students taught balancing of chemical equation using problematic analogy strategy and students taught using conventional lecture method.

**H<sub>02</sub>:** There is no significant difference in the mean achievement scores of male and female students taught balancing of chemical equations.

Table 1 shows that the calculated value  $(F(1, 76) = 0.782, P > 0.05)$  for gender on students' achievement in balancing of chemical equation. This implies that gender is not a significant factor in explaining the students' achievement in balancing of chemical equation. Therefore, the null hypothesis was retained.

**H<sub>03</sub>:** There is no significant difference between the mean retention scores the students taught balancing of chemical equations using problematic analogy strategy and those taught using conventional lecture method.

**Table 2:** Analysis of Covariance (ANCOVA) test of the effects of Problematic Analogy Strategy on students' Retention in Balancing of chemical equations



Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	33154.585 <sup>a</sup>	4	8288.646	56.621	0.000	
Intercept	3346.386	1	3346.386	22.860	0.000	
Post-test	32.173	1	32.173	0.220	0.631	
Treatment	11623.372	1	11623.372	79.402	0.000	*S
Group						
Gender	117.240	1	117.240	0.801	0.374	*NS
Group * Gender	934.292	1	934.292	6.382	0.014	
Error	11125.415	76	146.387			
Total	180441.000	81				
Corrected Total	44280.000	80				

a. R Squared = .749 (Adjusted R Squared = .736) \*S=Significant \*NS=Not Significant

Table 2 shows that the probability associated with the calculated value of  $(F(1, 76) = 79.402$  at  $p < 0.05$ ) for the effect of teaching method on students' retention. The null hypothesis was thus rejected meaning that there is significant difference in retention between the students taught balancing of chemical equations with problematic analogy strategy and those taught with lecture method. This implies that the retention ability of the subjects taught using problematic analogy is significantly higher than those taught using conventional lecture method.

$H_0$ : There is no significant difference in the mean retention scores of male and female students taught balancing of chemical equations.

Table 2 shows that the calculated value of  $(F(1, 181) = 0.801, p > 0.05)$  for gender on students' retention mean score. The null hypothesis was retained.

### Discussion of the Results

The result of testing hypotheses one showed a significant difference in the mean post-test performance scores of the experimental and control groups. The experimental group achieved significantly higher than the control group in the post-test scores. The significant difference in favour of the experimental group suggests a greater effectiveness of the problematic analogy strategy which was used to teach the experimental group over the lecture method used to teach the control group. This might be due to change in method of instructions that is teacher-centred (lecture method) to students-centred (problematic analogy strategy), where the concepts taught were explained and related to familiar similar concepts outside the classroom. The findings of this study corroborated the findings of Lagoke (2006); Sant (2006); Owolabi (2013) as well as that of Treagust, Harrison and Venville (2012) who discovered that problematic analogy teaching strategy improves students' achievement

Hypothesis two states that there is no significant difference in the mean score of male and female subjects taught balancing of chemical equations using problematic analogy. The results showed that there is no significant difference in the mean scores of male and female students. The finding is in agreement with the findings of Prince (2006); Beilo (2011); Nussbaum (2013); Danmole and



Adebayo (2014) and Durotole and Femi-Adeoye (2016) who discovered that there is no significant difference between male and female performances when exposed to activity-based methods of instruction such as concept mapping, analogy and problem-solving. However, the findings of this study differ from the findings of Learz (2006), Lagoke et al (2006), Crowlari (2013) and Uman (2010) which reported, in their individual studies, that boys performed better than girls on activities that require manipulations and also boys are more mechanically and scientifically inclined than girls.

Hypothesis three states that there is no significant difference in the retention ability of the students taught balancing of chemical equations using problematic analogy. The result showed that there is a significant difference in the delayed post-test mean scores of the experimental group. This experimental group recorded higher retention of the concepts taught than the control group. This shows that the problematic analogy used, enabled the students in the experimental group to retain more knowledge of balancing chemical equations. This is because the strategy allowed new materials, especially abstract concepts, to be easily assimilated with the student's prior knowledge, enabling them to develop a more scientific understanding of the concept. These aid the students' retention thus resulting in higher performance. The finding is in line with the findings of Lagoke (2006) who reported that problematic analogy can clarify students doubt on specific information regarding scientific concepts, thus leading to better performance and retention of concepts compared to the lecture method. Jya (2011); Treagust, Harrison, Venville and Dagher (2012) earlier reported the effectiveness of teaching with problematic analogy strategy as aiding understanding of concepts learnt in terms of using familiar experiences and ideas which acts as a motivating influence in studying unfamiliar concepts. The findings from this study therefore indicate that problematic analogy can enhance academic performance and retention of balancing chemical equations concepts in chemistry.

Hypothesis four, which states that there is no significant difference in the mean retention scores of male and female students taught balancing of chemical equations using problematic analogy. The results showed that there is no significant difference in the mean scores of males and females taught balancing of chemical equations using problematic analogy. The result agrees with the finding of Jya (2011), who found out that there was no gender difference in the academic achievement of students when exposed to activity-based methods such as analogy method.

The findings from this study therefore indicate that problematic analogy strategy can enhance academic performance and retention of SS1 students in balancing of chemical equations concepts in chemistry.

### Conclusion

The study determined the effects of problematic analogy strategy on achievement and retention of senior secondary students in balancing chemical equations concepts. Findings of this study revealed that problematic analogy method of teaching is more effective in enhancing students' achievement in balancing of chemical equations than lecture method. Gender was found not to be a significant factor in both achievement and retention of students.

### Recommendations

Based on the findings of the study, the researchers made the following recommendations.



1. Chemistry teacher should try to key in to the use of problematic analogy strategy of teaching during their delivery of classroom instruction.
2. Science educators and curriculum planners should incorporate innovative strategies such as problematic analogy into the teacher education programmes.
3. Government should utilize the services of various bodies such as Science Teachers Association of Nigeria (STAN), Faculties/Schools and Institutes of Education in Universities to organize in-service training programmes, workshops, seminars and conferences for chemistry teachers to update their knowledge on the use of innovative teaching methods that can enhance students' achievement in concepts in Chemistry.

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