Effects of Scaffolding and Jigsaw Instructional Strategies on Students' Achievement in Mole Concept by Gender in Nasarawa State, Nigeria

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Abstract

This study investigated the effects of Scaffolding and Jigsaw I instructional strategies on students' achievement in the Mole Concept in Nasarawa State, Nigeria. A quasi-experimental design was used, with a sample of 150 Senior School II Chemistry students selected through multi-stage random sampling. The students were assigned to three experimental groups (scaffolding, Jigsaw, and a control group taught with conventional methods). The Mole Concept Achievement Test (reliability = 0.85) was used to assess students' achievement. The study spanned four weeks, and data were analyzed using means, standard deviations, ANCOVA, and effect size (Cohen's D). Results indicated that students taught using scaffolding and Jigsaw strategies achieved significantly better than those taught with the conventional method. However, gender did not significantly affect achievement of students' achievement in the Mole Concept, as no notable difference was observed between male and female students. The effect sizes for the Scaffolding Instructional Strategy (SIS) and Jigsaw I Instructional Strategy (JIS) were 0.65 and 0.64, respectively. The study suggests that both strategies are effective for enhancing students' achievement in chemistry, and teachers are encouraged to incorporate these active learning methods into their teaching practices.

Keywords: Chemistry, Achievement, Gender, Scaffolding, Jigsaw, Nigeria

Introduction

Trends of development in the developed and developing countries show that Science, Technology and Mathematics (STM) have been employed by many countries for rapid economic and technological transformation. The technological development of any nation lies in the study and application of science. Science deals with the study of nature around us and an attempt to explain the pattern and regularities of nature (Aliyu, 2011). Science is discovery. Science is a tool from which man learns from his environment. It is a dynamic human activity concerned with the understanding of the workings of our world. This understanding helps the scientist to probe further into nature for things and events and to control and harness such things and events for the benefit of humankind. Science and technology is incomplete without chemistry.

Chemistry is one of the branches of pure science that occupies a pride of place in senior secondary school (SSS) curriculum in Nigeria. It is a scientific discipline concerned with elements and compound composed of atoms, molecules and ions, their composition, structure, properties, behaviour and the changes they undergo during reactions with other substances (Brown, Lemay,

Bursten, Murphey, Woodward, Stoltzfus and Lufaso, 2018). It occupies a pivotal position in science and technology. The importance of chemistry as a basic requirement for economic, scientific and technological development of any nation cannot be over-emphasized especially in Nigeria where the national income rests on petroleum and petrochemical industries. The development and sustenance of any form of technology will not be a reality unless a solid foundation is laid for effective and efficient chemistry education and this solid foundation cannot be laid unless SSS students choose to offer chemistry and perform well in both national and international examinations and apply what they have learnt in their everyday lives. This is because chemistry as a subject is a pre-requisite for many science and technology related courses such as medicine, engineering, pharmacy among others in tertiary institution.

The knowledge of chemistry of chemistry spans across human affairs as it is a tool towards solving daily problems. Chemistry has contributed greatly towards proving basic needs and improving the quality of lives. This can be felt and seen in food, medicine, clothing, housing, transportation, detergent, fertilizers, among others. However, chemistry has often proven to be a difficult subject for many learners. It is a molecular and conceptual subject in which many of the concepts and processes are not abstract, making the learning and teaching of the concepts difficult. The West African Examination Council (WAEC) Chief Examiner's report 2010, 2011 and 2012 pointed out the inability of students to tackle most of the numerical questions, to write good expressions and use proper chemical terms. They were also unable to write formulae and correct balanced chemical equations. The students were equally observed to be deficient in the use of mole concept and its application to stoichiometry.

Mole concept is a fundamental concept in chemistry. It is the basis for tackling questions in stoichiometry, which expresses the mole ratio between reactants and products in chemical reactions. The mole concept has since be recongnized as one of the basic chemical cincept in chemistry as suggested by Ababio (2016). It is an abstract concept that is mathematically inclined (Boniface, 2018). Mole concept provides a bridge between atoms and macroscopic number of materials that the chemist works with in the laboratory.

The relevance of chemistry to life is such that every Nigerian student enrolled in it is expected to do well and contribute meaningfully to the advancement of the society. Over the years, however, this expectation has dwindled because of poor achievement of students in chemistry. Some researchers have traced the causes of low achievement and attributed it to several factors such as lack of teaching materials and equipment, inappropriate and ineffective teaching methods, lack of interest on the part of the students and lack of quality teachers. Among these factors, inappropriate teaching method seems to be a major factor responsible for the observed low achievement. Ezeudu and Ezinwanne (2013), Wanbugu, Changeiywo and Ndiritu (2013) attributed low achievement in chemistry to the method of teaching the subject which does not bring chemistry to real life experience of learners, centred on rote learning and does not encourage the active participation of the learner in the learning process therefore hindering independence in the appreciation of chemistry knowledge.

Research in recent times has also revealed that the conventional method (CM) is predominantly used in teaching chemistry. Okuwuduba and Okigbo (2018), Omoniyi (2016), Aina

and Keith (2014) evaluated what goes on in most chemistry classrooms and overwhelmingly concluded that most of the teachers employed the conventional method to teach chemistry. Duru, Osuala and Ogomaka, in Fatokun, Egya and Uzoechi (2016) also reported that 60% of Nigerian secondary school teachers use the conventional method with occasional teacher domination of experiments. The conventional method is a method of imparting knowledge which requires the learners to listen attentively as facts are dished out by the teacher, giving little or no attention to students' involvement.

According to Egya (2019) the desire to enhance students' achievement demand a shift from the perception of what the teacher does to what the students' does in the teaching and learning process. Students should be active participants in the process of chemistry knowledge acquisition. Therefore, to improve on the image of chemistry (in terms of achievement) there should be a departure from the old-fashioned conventional approach where the teachers benefit while the students are disadvantaged. Instead, problem-based, activity-oriented teaching strategies should be identified and adopted. Uzoechi (2014) stressed that science education programmes must focus attention on innovative teaching method that can promote creative thinking in scientific problem solving. Achumugu (2013) stated that a major factor for effective learning to take place is the use of instructional approach that enables participation of students in the teaching/learning process. Omoniyi (2017) suggested a shift from conventional method of teaching chemistry to some innovative and activity-based instructional strategies.

Activity-based methods as a teaching strategy is a process whereby learners are actively involved in the teaching/learning process, rather than passively absorbing whatever the teacher says or does. It is based on the core premise that learners should be involved in doing some hands-on and minds-on activities rather than just listening to lessons. Examples of such innovative methods which are activity-based include the scaffolding instruction strategy (SIS) and the Jigsaw 1 instructional strategy (JIS). Studies (Alake and Olatubosun, 2013; Olubunmi and Ese, 2015; Uduafemhe, 2015; Egbulefu, Amaele and Sunday, 2015; Iweke, 2017; Agu and Samuel, 2018; Ndukwe and Timayi 2018; Joda, 2019; Mmegwe, 2019; Odo and Nwachukwu 2020) have showed that activity – based methods such as scaffolding, and jigsaw instructions enhances students achievement in sciences.

According to Reiser (2004), scaffolding refer to the process by which a teacher, an instructor or a more knowledgeable peer assist a learner, altering the learning task so that the learner can solve problem or accomplish tasks that would ordinarily be impossible for the learner. During scaffolding instruction, a teacher adds supports for students to enhance learning and aid mastering of task. The teacher does this by systematically building on students' experiences and knowledge as they are learning new skills. These supports are temporary and adjustable. As students master the assigned tasks, the supports are gradually removed. The notion of scaffolding has expanded to include tools, strategies, and guides to support learning processes (Sherin, Reiser and Edelson, 2004). The teaching strategy emphasizes on the role of teachers and more skilful persons in supporting the learner's development and providing support structures to get to the next level (Nonye and Nwosu, 2011). Scaffolding can also be seen as the assistance (parameters rules or suggestions) a teacher gives to the students in a learning situation. Instructional scaffolding is a learning process designed to promote a deeper level of learning.

The jigsaw I instructional strategy centres on organizing students group work that helps students to collaborate and rely on one another to succeed. Jigsaw I strategy was originally developed by Aronson and his colleagues in 1971 (Sarah and Cassidy, 2006). According to Hanze and Berger (2007) Jigsaw I instructional strategy is a co - operative learning method that brings about both individual accountability and achievement of team goals. The processes derived its name from the jigsaw puzzle as the process involves in putting the parts of the assignment together to form a whole picture of the assignment which is similar to the jigsaw puzzles. The jigsaw I instruction breaks classes into groups and breaks the topic into pieces as the same number of the groups. The group assemble the topic to complete the (jigsaw) puzzle.

Achievement refers to the degree of student's accomplishment of his/her tasks and studies. The well-known indicator of measuring academic achievement is grade which reflects the student's scores for the subjects and overall tenure. Achievement is the action of accomplishing a task successfully. Achievement is useful in testing the retention of information and stills. The purpose of achievement is to find out the stand of students in each task. It is also a determinant of efficacy and efficiency of a given instruction (Kabutu, olayede and Bandele, 2005). Fatokun and odagboyi (2010) viewed gender as a significant factor in students' achievement in chemistry due to interaction patterns.

Gender is often used to indicate the distinction between human beings on the basis of masculinity and femineity in relation to their expected roles. Azman (2014) in his study of selected education institutions in Sub-Saharan Africa documented that gender played a role in the choice students make and their achievement. Ogunleye and Babajide (2011) observed that science subjects such as chemistry are given masculine outlook by many educationists. Nwezi (2010) is of the view that there is gender disparity with the female being at a disadvantage. Gender inequality sometimes begins from home where parents play a central role in the creation of sex-differentiated values and self-perception. Parents are unaware of things they are doing which often discourage girls from studying science. Consequently, their gender-role stereotyped behaviour and expectations are often immune to modification based on their children's actual talents and performance. Parent train and encourage the boys to toe the technical line by given them technical tools and the girls are given dolls. Boys are encouraged to use tools such as hammer, saw, file, electric drill, while girls are warned not to hurt themselves.

There are varying opinions on whether male or female achieves better. Some results from research findings have revealed that the male students perform better in chemistry, physics, and biology generally (Ukozor, 2011). In their studies, Udo and Udofia (2014) reported that gender had significant influence on students' achievement in formulae and equations in chemistry with the male outperforming their female counterpart. The study of Ezeudu (2013) shows that gender was not a significant factor on students' achievement in organic chemistry. While researchers such as Aniodoh and Egbo (2013), Ishaq (2015) revealed significant differences in achievement in favour of females. However, researchers such as (Udosoro, 2011), Danjuma (2015), Fatokun, Egya and Uzoechi (2016), showed that gender has no significant differences in achievement. Uduafemhe (2015), Gongden and Gongden (2019) found no significant difference in gender achievement in scaffolding instruction, Odo and Nwachukwu (2020), Mmegwe (2019), Qaseem (2017), Timayi, Bolaji and Kajuru (2015) found no differences in gender achievement in jigsaw instruction. The

study of Akani (2015) reported that male students performed better than female students when taught using scaffolding instruction. Odaboyi (2015) found significant difference in achievement of male and female with jigsaw in favour of male. Studies on gender differences and students' achievement are however inconclusive. It is therefore necessary to investigate the influence of teaching methods and gender on students' achievement.

Vygotsky social learning theory (1978) states that knowledge is co-constructed, and that individual learn from one another. In Vygotsky's opinion the learner must be engaged in the learning process. Vygotsky zone of proximal development also explores the idea that what children can achieve with the assistance of other (social interaction) may be more indicative of their mental development than what they can do alone. Vygotsky (1978) emphasized on social interaction as the best way of leaning. Bruner (1961) proposed that learners' construct their own knowledge and do this by organizing and categorizing information using coding system. Bruner asserted that the most effective way to develop a coding system is to discover it rather than being told by the teacher.

Bruner also emphasized the concept of discovery learning using spiral curriculum which implies that students construct their own knowledge for themselves. According to Bruner, the role of the teacher should not be to teach information by rote learning, but instead to facilitate the learning process. Bruner stressed on learning by doing. The teacher's resources should be focused on the encouragement, aiding, and allowing the students to uncover the main principles on their own. This research work is therefore anchored on these two theories of learning.

Research Questions

The following questions guided the study:

1. What are the mean achievement scores of students taught mole concept using scaffolding, jigsaw I and conventional strategies?
2. What are the mean achievement scores of male and female students taught mole concept using scaffolding instructional strategy?
3. What are the mean achievement scores of male and female students taught mole concept using the jigsaw I instructional strategy?
4. What is the interaction effect of teaching strategy and gender on students' achievement in mole concept?
5. What are the effect sizes of scaffolding and jigsaw instructional strategies?

Objectives of the Study

The purpose of this study was to find out the effects of scaffolding and jigsaw I instructional strategies on students' achievement in mole concept in Nasarawa State. Specifically, the study sought to achieve the following objectives:

1. Find out the extent to which the use of scaffolding, jigsaw I and conventional strategies will affect the achievement of students in mole concept.
2. Compare the mean achievement scores between male and female chemistry students taught mole concept using scaffolding instructional strategy.
3. Compare the mean achievement scores between male and female chemistry students taught mole concept using jigsaw I instructional strategy.

4. Determine the interaction effect between teaching methods and gender as measured by achievement test.
5. Determine the effect sizes of scaffolding and jigsaw I instructional strategies.

Statement of Hypotheses

The following hypotheses were formulated to guide this study and were tested at 0.05 level of significance.

Ho_1: There is no significant difference between the mean achievement scores of students taught mole concept using scaffolding, jigsaw I and conventional strategies.

Ho_2: There is no significant difference in the achievement mean scores of male and female taught mole concepts using scaffolding strategy.

Ho_3: There is no significant difference in the achievement mean scores of male and female taught mole concepts using jigsaw I strategy.

Ho_4: There is no significant interaction effect of teaching methods and gender on students' achievement in mole concept.

Methodology

The research design used for the study was quasi-experimental pre-test-post-test, post-post-test control group design. There was no randomization of subjects. Intact classes were used.
The population of this study comprised 23,524 (13,077 male and 10,447 female) senior secondary one chemistry students from public secondary schools in Nasarawa State, Nigeria.
The sample for the study was taken using a multi-stage random sampling technique. The sample comprised 150 SS II (68 male and 82 female) students offering chemistry drawn from three public co-educational secondary schools in the West Senatorial District of Nasarawa State. The Mole Concept Achievement Test (MCAT) developed by the research was used as pre-test, post-test.

The pre-test was used to serve as covariance for the study. Post-test was used to determine achievement after treatment in all the groups. The items were re-shuffled for each use. The instrument is 30 multiple choice objective tests selected from past SSCE questions and distributed among the six intellectual levels of Bloom's taxonomy of the cognitive domains in moles and chemical equations, percentage composition, empirical and molecular formulae, mass volume relationships in chemical reactions, moles, and titration. The Mole Concept Achievement Test (MCAT) was validated by three experts, two in Chemistry Education and one in Measurement and Evaluation. The validators' ensured face and content validity. They were requested to scrutinize the items on the instrument in terms of their appropriateness of the level for the students, to assess the coverage and relevance of content and clarity of statement to ensure face and content validity.

To ensure the reliability of the MCAT, a pilot test of the instrument was carried out. The MCAT was administered to 30 students in a co-educational school which was part of the population but was not part of the sample used in the study. The Spearman-Brown prophecy formula using the split half method was used to determine the reliability of the instrument. The coefficient of reliability index was 0.85.

The pre-test was administered to all the groups to measure their knowledge in mole concept after which the experimental groups were taught mole concept using Scaffolding Instructional Strategy and the Jigsaw I Instructional Strategy respectively for four weeks. The control group was taught mole concept with conventional method also for four weeks. At the end of four weeks of

the treatment, the pre-test items were re-shuffled and administrated as post-test to the entire subjects in both the experimental groups and the control group.

Results

Research Question One

What are the mean achievement scores of students taught mole concept using scaffolding, jigsaw 1 and conventional strategies?

The mean achievement scores, standard deviations of chemistry students taught mole concept using SIS, JIS and CM are presented in Table 1

Table 1: Means, Standard Deviations of Achievement of Chemistry Students Exposed to SIS, JIS and CM

Group	N	Pre-test		Post-test	
		Mean	SD	Mean	SD
SIS	50	25.68	8.353	68.10	8.662
JIS	50	25.90	8.202	67.16	8.054
CM	50	26.06	7.681	54.14	7.407

Table 1 shows mean scores and standard deviations in achievement of chemistry students exposed to SIS, JIS and CM. It was observed that the mean scores of students in the SIS group were 25.68 and 68.10 in pre-test and post-test respectively, while their standard deviations were 8.353 and 8.662 respectively. Students in the JIS group had mean scores of 25.90 and 67.16 in pre-test and post-test respectively, and their standard deviations were 8.202 and 8.054 respectively. The students in CM group had 26.04 and 54.14 in pretest and post-test and their standard deviations were 7.681 and 7.407 respectively

Null Hypothesis One

There is no significant difference between the mean achievement scores of students taught mole concept using scaffolding, jigsaw 1 and conventional strategies.

Table 2: Results of Analysis of Covariance on Chemistry Students' Achievements Taught Mole Concept using SIS, JIS and CM

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9483.327	3	3161.109	75.069	.000	.607
Intercept	29844.508	1	29844.508	708.734	.000	.829
Pretest	3395.234	1	3395.234	80.628	.000	.356
Group	6238.161	2	3119.081	74.070	.000	.504
Error	6148.006	146	42.110			
Total	613504.000	150				
Corrected Total	15631.333	149				

Table 2 reveals a significant difference in the mean achievement scores of chemistry students exposed to SIS, JIS and CM. An F-ratio of 74.070 was obtained, with a p-value of 0.000. Since the p-value is less than the significance level of 0.05, the null hypothesis was rejected, indicating a significant difference in achievement scores.

Based on the established difference in the achievement scores of the groups, Bonferroni Multiple Comparisons was used to determine the direction of the difference. The result of this analysis is shown in Table 3

Table 3: Bonferroni Multiple Pairwise Comparison Results of Students'Mean Achievement Scores of SIS, JIS and CM

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
SIS	JIS	1.071	1.298	1.000	-2.073	4.214
	CM	14.186*	1.298	.000	11.042	17.330
JIS	SIS	-1.071	1.298	1.000	-4.214	2.073
	CM	13.115*	1.298	.000	9.972	16.258
CM	SIS	-14.186*	1.298	.000	-17.330	-11.042
	JIS	-13.115*	1.298	.000	-16.258	-9.972

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

The Post Hoc Analysis using Bonferroni test to determine the direction of superiority of means achievement by Pair-wise Comparison is shown in Table 3. The Table shows that there was no significant difference in the mean achievement scores of students exposed to SIS and those exposed to JIS ($P = 1.000 > \alpha = .05$). There was a significant difference observed between the mean achievement scores of those exposed to SIS and CM ($P = .000 < \alpha = .05$). Likewise, a significant difference was observed between the mean achievement scores of those exposed to JIS and CM ($P = .000 < \alpha = .05$).

Research Question Two

What are the mean achievement scores of male and female students taught mole concept using scaffolding instructional strategy?

The mean achievement scores, standard deviations of male and female chemistry students taught mole concept using SIS are presented in Table 4

Table 4: Means and Standard Deviations of Male and Female Chemistry Students Exposed to SIS

Group	Gender	N	Pre-test		Post-test	
			Mean	SD	Mean	SD
SIS	Male	29	26.79	8.691	70.00	8.602
SIS	Female	21	24.14	7.806	65.48	8.232

Table 4 shows mean achievement scores of male and female chemistry students exposed to SIS. The male students had a mean score of 26.79 and 70.00 in pre-test and post-test respectively. While their standard deviations stood at 8.691 and 8.602 respectively. The mean scores of the female students were 24.14 and 65.48 in pre-test and post-test respectively. Their standard deviations were 7.806 and 8.232. The standard deviation scores for the pre-test and post-test based on gender were not much variance implying that the efficacy of the treatment is sustainable.

Null Hypothesis Two

There is no significant difference in the achievement mean scores of male and female students taught mole concept using scaffolding instructional strategy.

Table 5: Results of Analysis of Covariance on Chemistry Students' Achievement on MCAT on Gender and SIS

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	872.701	2	436.350	7.315	.002	.237
Intercept	14957.865	1	14957.865	250.738	.000	.842
Pretest	623.439	1	623.439	10.451	.002	.182
GenderSIS	135.479	1	135.479	2.271	.139	.046
Error	2803.799	47	59.655			
Total	235557.000	50				
Corrected Total	3676.500	49				

Table 5 shows an F – ratio = 2.271 with associated exact probability value of 0.139 which is greater than the benchmark probability value of 0.05 (F = 2.271; P = .139 >α = .05). This indicates that there was no significant difference in the mean achievement scores of male and female students exposed to SIS. The null hypothesis was therefore not rejected.

Research Question Three

What are the mean achievement scores of male and female students taught mole concept using jigsaw I instructional strategy?

Table 6: Means Standard Deviation of Male and Female Chemistry Students Exposed to JIS

Group	Gender	N	Pre-test		Post-test	
			Mean	SD	Mean	SD
JIS	Male	21	27.29	8.521	68.00	7.887
	Female	29	24.94	7.961	66.55	8.257

Table 6 shows mean achievement of male and female chemistry students exposed to JIS. The male students had a mean score of 27.29 and 68.00 in pre-test and post-test respectively while their standard deviations were 8.521 and 7.887 respectively. The mean scores of the female students were 24.94 and 66.55 in pre-test and post-test respectively while their standard deviations were 7.961 and 8.257 respectively. The standard deviation scores for the pre-test and post-test based on gender were not at much variance implying that the efficacy of the treatment is sustainable.

Null Hypothesis Three

There is no significant difference in the achievement mean scores of male and female students taught mole concept using jigsaw instructional strategy.

Table 7: Results of ANCOVA on Chemistry Students' Achievement on MCAT on Gender and JIS

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1644.469	2	822.235	25.188	.000	.517
Intercept	10286.005	1	10286.005	315.100	.000	.870
Pretest	1618.921	1	1618.921	49.594	.000	.513
GenderJIS	.710	1	.710	.022	.883	.000
Error	1534.251	47	32.644			
Total	228702.000	50				
Corrected Total	3178.720	49				

Table 7 shows an F – ratio = 0.022 with associated probability value of 0.883 which is greater than the benchmark probability value of 0.05. ($F = .022$; $P = .883 > \alpha = .05$). This indicates that there was no significant difference in the mean achievement scores of male and female students exposed to JIS. Therefore, the null hypothesis was not rejected.

Research Question Four

What is the interaction effect of teaching methods and gender on students' Achievement in mole concept?

Table 8: Mean and Standard Deviations of Male and Female Chemistry Students on Mole Concept Achievement based on Interaction Effect of SIS, JIS and CM

Group	Gender	N	Post test		Retention	
			Mean	SD	Mean	SD
SIS	Male	29	26.79	8.691	70.00	8.602
	Female	21	24.14	7.806	65.48	8.232
JIS	Male	21	27.29	8.521	68.06	7.887
	Female	29	24.90	7.961	66.55	8.257
CM	Male	32	26.06	7.649	53.41	6.834
	Female	18	26.06	7.959	55.44	8.375

Table 8 reveals the mean achievement scores of male and female chemistry students exposed to SIS, JIS and CM. The male students in the SIS group had mean achievement scores of 70.00 and their female counterparts had a mean achievement score of 65.48. The male in the JIS had a mean achievement score of 68.00 and the female had a mean achievement scores 66.55. The male in CM had a mean achievement score of 53.41 and the female had a mean achievement score of 55.44.

Null Hypothesis Seven

There is no significant interaction effect of teaching methods and gender on students' achievement in mole concept?

Table 9: Results of Analysis of Covariance on Chemistry Students' Achievement (MCAT) Scores based on Interaction Effect on SIS, JIS, and CM with Gender.

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	9638.227	6	1606.371	38.329	.000	.617
Intercept	29648.010	1	29648.010	707.424	.000	.832
Pretest	3227.467	1	3227.467	77.010	.000	.350
Group	5503.194	2	2751.597	65.655	.000	.479
Gender	3.824	1	3.824	.091	.763	.001
Group Gender	150.339	2	75.170	1.794	.170	.024
Error	5993.107	143	41.910			
Total	613504.000	150				
Corrected Total	15631.333	149				

Table 9 shows F – ratio = 1.794 was obtained with associated probability value of 0.170. Since the associated probability (0.170) was higher than 0.05 (F = 1.794; P = .170 >α = .05). The null

hypothesis was not rejected. The result revealed there was no significant interaction effect on chemistry students' achievement in mole concept when taught with scaffolding, jigsaw I and the conventional strategy with gender. This implies the scaffolding, jigsaw I instruction strategy and conventional method and gender are independent of each other. The null hypothesis was not rejected.

Research Question Nine

What are the effect sizes of scaffolding and jigsaw instructional strategies?

Table 10: Mean and Standard Deviations of SIS, JIS and CM on Effect Sizes

Group	N	Pretest		Posttest	
		Mean	SD	Mean	SD
SIS	50	25.68	8.353	68.10	8.662
JIS	50	25.90	8.202	67.16	8.054
CM	50	26.06	7.681	54.14	7.407

Table 10 reveals the mean achievement scores and standard deviations of chemistry students exposed to SIS and JIS. The students in the SIS group had a mean score of 25.68 and 68.10 in pre-test and post-test respectively, while their standard deviations are 8.353 and 8.662. The student in the JIS group had a mean of 25.90 and 67.16 in pre-test and post-test respectively. Their standard deviations were 8.202 and 8.054. From their means and standard deviations using the Cohen'D formula viz the online calculator SIS has effect size of 0.65, while JIS has effect size of 0.64 respectively.

Discussion of Findings

The findings of this study reveal the effect of SIS and JIS in enhancing teaching and learning mole concept. There was significant difference among students' achievements in scaffolding instructional strategy, jigsaw I instructional strategy and the conventional method in favour of scaffolding instructional strategy and the jigsaw I instructional strategy.

The finding on students' achievement in SIS group agree with the earlier findings of Joda (2019), Olubunmi and Ese (2018), Akani (2015), Alake and Olatunbosun (2013). The findings of JIS group agree with the earlier findings of Odo and Nwachukwu (2020), Mmegwe (2019), Agu and Samuel (2018), Ndukwe and Timayi (2018), Qaseen, (2017), Iweke (2017). These findings reported in their various studies that students taught chemistry, biology, physics, mathematics, and basics sciences using scaffolding and jigsaw instructions achieved better than those taught using conventional method.

The trend of improved achievement by the treatment groups could be because of carefully planned instructions which to be engaged students in the treatment groups. Another reason for the better achievement experienced by the treatment groups could be because the students were more focused, attentive, and interested in what they were doing. The treatment allowed the learners from one another, take charge of their learning, and offered opportunities to develop cognition. As argued by Vygotsky 1978 that knowledge is co-constructed and that individuals learn from one another. Vygotsky also stated that learner must be engaged in the

learning process. This agrees with Bruner's (1961) discovery learning theory which stressed on learning by doing, that when students are allowed to discover new ideas for themselves, they learn better.

The result of Bonferroni Multiple Comparison carried out to determine the direction of significant differences showed a significant difference between SIS, JIS, and CM in favour of SIS and JIS. This finding is in line with the finding of the studies in scaffoldings instructions of Joda (2019), Olubunmi and Ese (2015), Uduafemhe (2015), Alake and Olatubosun (2013), and the studies in jigsaw instructions of Odo and Nwachukwu (2020), Mmegwe (2019), Egbulefu, Amaele and Sunday (2015), and Iweke (2017) who reported in their various studies that scaffolding and jigsaw instructional strategy enhances student's achievement in sciences.

There was no significant difference in achievement of male and female students in SIS group. This finding is in agreement with the findings of Gongden and Gongden (2019) and Uduafemhe (2015) who found no significant difference in gender achievement but in disagreement with the finding of Akani (2015) who reported that male students performed better than female students when taught with scaffolding instruction.

There was no significant difference in achievement of male and female in the JIS group. This finding is in agreement with those of Odo and Nwachukwu (2020), Mmegwe (2019), Qaseem (2017), Timayi, Bolaji and Kajuru (2015) who found no significant differences in gender and disagree with Odaboyi (2015) who reported significant difference in achievement of male and female with jigsaw instruction in favour of male.

There was no significant difference in the interaction effect between the male and female students taught mole concept as measured by the MCAT and SIS, JIS and CM. The effect sizes of SIS (0.65) and JIS (0.64) were considerably good compared to the benchmarks of 0.2 (small), 0.5 (medium), and 0.8 (large), Cohen, (1988). Petty (2009) reporting Hatties's (2005) interpretation of effect size from meta-study is as follows: an effect size of 0.25 means student have gained 10% improvement over conventional method while effect sizes of 0.52 means students have gained 20%. Therefore, the effect size of 0.65 and 0.64 obtained in this study for SIS and JIS respectively are fairly good and make the strategies worth learning by teachers to improve student's achievement.

Conclusion

The findings of this study showed that the scaffolding instructional strategy and the Jigsaw I instructional strategies are more effective for teaching mole concept than the conventional method. The findings also showed that boys and girls achieve at a par irrespective of teaching method. These results imply that the teaching methods employed by chemistry teachers might have been responsible for the persistent under-achievement of students in chemistry. The implication of the finding is that chemistry teachers should deviate from conventional method of teaching-to-teaching approaches that promote creative thinking, interaction, and are activity-based.

Recommendations

The following recommendations were made based on the findings of this study.

1. Chemistry teachers should adopt activity-based strategies such as SIS and JIS instructional strategies as these encourage the students in the learning process, promote learning by doing and allowing students to discover facts for themselves.
2. Pre-service teachers should be trained on the use of activity-based methods such as scaffolding and jigsaw I instructional strategies in teaching chemistry concept.

3. Chemistry teachers should employ SIS and JIS in teaching boys and girls, as both strategies are gender friendly.

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