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Effect of Scaffolding and Hands-on Instructional Approaches on Senior Secondary School Student's Achievement and Interest in Chemistry

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Abstract: The study investigated the effect of scaffolding and hands-on instructional approaches on senior secondary school student's achievement and interest in chemistry. The study was carried out in Anambra State, Nigeria. The study was quasi-experimental. The sample size was made up of 195 chemistry students. The Chemistry Achievement Test (CAT) and chemistry interest scale were used for data collection. Means, standard deviation and Analysis of Covariance (ANCOVA) were used to analyze the data. The findings showed that students who were taught using scaffolding and hands-on instructional approaches had significant achievement compared to their counterparts taught with conventional method. Scaffolding and hands-on instructional approaches increased student's interest in chemistry more than the conventional method. There was no significant influence of gender on the mean achievement and interest scores of students in chemistry. Finally, there was no significant interaction effect of methods and gender on student's achievement and interest in chemistry.

Key words: Scaffolding, hands-on, conventional method, chemistry, instructional, approaches

INTRODUCTION

Over the years, chemistry has been seen as a vital subject for preparing and producing scientists who are essential for national development. Chemistry is a branch of science that deals with the study of matter, its composition, properties and uses (Ohia Amasiatu *et al*., 2009). Chemistry provides the major part of manpower needs of a nation. Chemistry is important in our everyday life and in our collective understanding of both the biological realm and physical world (Averill and Eldredge, 2017). In Nigeria, the government in recognition of the vital role of chemistry in the development of the nation has continued to put in much effort in order to promote chemistry education. The objectives of the school chemistry curriculum according to the Federal Ministry of Education is for the students to develop interest in the subject of chemistry, acquire basic theoretical and practical knowledge and skills, acquire basic scientific knowledge and skills, apply chemistry-oriented skills to meet societal needs of creating employment and wealth, be positioned to take advantage of the numerous career opportunities offered by chemistry and to be adequately prepared for further studies in chemistry (Federal Ministry of Education (FME., 2009).

According to Akpoghol *et al*. (2013), despite the importance of chemistry, the achievement of students in the subject has been very poor. The West African Examination Council (WAEC., 2015) Chief Examiners Reports (2011-2015) have shown a consistent trend of poor achievement of students in chemistry. Igboanugo and Njoku (2015) also reported that student's achievement in chemistry in Anambra State has been poor. The overall poor achievement of senior secondary school students in chemistry has continued to be a major cause of concern to all, particularly chemistry educators, researchers and the government. Stakeholders are worried about the future of science and technology in Nigeria having in mind the role of chemistry. The problem has been attributed to student's beliefs that certain topics in chemistry are difficult, lack of equipment and teaching materials used by the teachers, use of conventional methods, lack of interest and sometimes influence of gender (Nbina, 2012; Ajeyami and Owoyemi, 2014). Okeke (2010) and Igboanugo and Njoku (2015) have stated that a major factor for effective teaching and learning to take place is the use of instructional approaches that engages the students and enables them to participate actively in the teaching/learning process to ensure improvements in student's interest and achievement. Scaffolding seems to be one of such instructional strategies.

Anonymous (2015) defined scaffolding as a variety of instructional techniques used to move students progressively toward stronger understanding and ultimately, greater independence in the learning process.

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Scaffolding is often used to bridge learning gaps i.e., the difference between what students have learned and what they are expected to know and are able to do at a certain point in their education. One of the main goals of scaffolding is to reduce the negative emotions and self-perceptions that students may experience when they get frustrated intimidated or discouraged in attempting a difficult task without the assistance, direction or understanding they need to complete it. Alake and Ogunseemi (2013) stated that for a teacher to carry out scaffolding strategy he/she must first identify and determine what students can accomplish independently; what students can accomplish with guidance (in other words, teacher determines the student's zone of proximal development) and finally, the teacher then provides the instructions that are just enough to support the learner in task beyond reach without teacher's support. According to Pinantoan (2013), the facilitative tools for the effective application of instructional scaffolding are; the breaking of task into smaller, more manageable parts, use of 'think aloud's or verbalizing thinking processes when completing a task, use of cooperative learning which promotes teamwork and dialogue among peers and use of concrete prompts, questioning, coaching, cue cards or modeling.

Hands-on instructional approach is a method of instruction where students are guided to gain knowledge by experience have opportunity to manipulate the objects they are studying and become active participants in the classroom (Ekwueme *et al*., 2015). Erin opined that hands-on instruction is the use of physical assignments or activities that engage the students in learning; the teacher and the learners have to do something more than hearing or reading about it. Candler (2016) opined that in hands-on instruction; students manipulate objects investigate ideas and conduct experiments in order to learn. The student's also discuss the importance of each part of the activity at key points during the lesson with a partner or small groups, relate the activity to real world examples and reflect on what the activity is supposed to demonstrate.

According to Prekash interest is a powerful stimulus which draws our attention to a particular thing, person or an activity. Though some students may be intellectually and physically capable of learning, they may never learn until their interest is stimulated. Hence, Onah *et al*., (2015) maintained that once the students are stimulated, they will continue to learn as long as the teacher is capable of sustaining their interest in the subject matter. This is because interest is a precursor of attention, once there is direct interest, attention is guaranteed and learning is assured. In addition to interest another variable that may interfere with student's achievement is gender. Gender is the communally constructed features of women and men (WHO., 2016). According to Ogunleye and Babajide (2011), science subjects which include chemistry are given masculine outlook by educational practitioners. Boys, therefore, appear to have positive attitudes to technical and science subjects while girls show negative attitude and this negative attitude appears to be due to the acceptance of the myth that boys are better in science subjects while girls show negative attitude (Ogunleye and Babajide, 2011). In addition, studies by Ezeudu and Obi-Theresa (2013) and Anazor (2015) reported that male students have a higher achievement and interest in chemistry than females. But, Mbaba (2010) and Oludipe (2012) reported no significant difference in the achievement of boys and girls in science subjects. Due to these concerns, the major aim of this study is to investigate the effects of scaffolding and hands-on instructional approaches on student's achievement and interest in chemistry. Specifically, this study sought to determine:

- The effect of scaffolding instructional approach, hands-on instructional approach and conventional teaching method on student's achievement in chemistry
- The influence of gender on student's achievement in chemistry
- The effect of scaffolding instructional approach, hands-on instructional approach and conventional teaching method on student's interest in chemistry
- The influence of gender on student's interest in chemistry
- The interaction effect of methods and gender on student's achievement in chemistry
- The interaction effect of methods and gender on student's interest in chemistry

Research questions:

- What is the effect of scaffolding instructional approach, hands-on instructional approach and conventional teaching method on student's achievement in chemistry?
- What is the influence of gender on student's achievement in chemistry?
- What is the effect of scaffolding instructional approach, hands-on instructional approach and conventional teaching method on student's interest in chemistry?
- What is the influence of gender on student's interest in chemistry?
- What is the interaction effect of methods and gender on student's achievement in chemistry?
- What is the interaction effect of methods and gender on student's interest in chemistry?

Hypothesis:

- H_{O1}: there is no significant difference between the mean achievement scores of students taught chemistry using scaffolding instructional approach, hands-on instructional approach and conventional teaching method
- H_{O2}: there is no significant influence of gender on the mean achievement scores of student's in chemistry
- H_{O3}: there is no significant difference between the mean interest scores of student's taught chemistry using scaffolding instructional approach, hands-on instructional approach and conventional teaching method
- H_{O4}: there is no significant influence of gender on the mean interest scores of student's in chemistry
- H_{O5}: there is no significant interaction effect of methods and gender on student's achievement in chemistry
- Ho_6: there is no significant interaction effect of methods and gender on student's interest in chemistry

MATERIALS AND METHODS

The quasi-experimental research design was used for this study. Specifically, the pretest, post test non-equivalent control group design was adopted for the study. This design was considered appropriate for this study because intact classes (non-randomized groups) will be used for the study. The design is illustrated as showed in Table 1:

The study was carried out in Aguata education zone of Anambra State. The zone consists of three local government areas namely; Aguata Orumba North and Orumba South. There are forty-eight public senior secondary schools in the zone. The choice of this area of study is based on the fact that student's achievement in chemistry in Anambra State has been poor (Igboanugo and Njoku, 2015). The population of the study was made up of 1,715 students (845 males and 870 females). This comprised all the senior Secondary School one (SSI) chemistry students in Aguata Education Zone, Anambra

Table 1: The pretest, post test non-equivalent control group design

Group	Pretest	Treatment	Post-test
Experimental group 1 (EG_1)	O_1	X_1	O_2
Experimental group 2 (EG_2)	O_1	X_2	O_2
Control group (conventional method)	O_1	X_3	O_2

EG_1: Experimental group 1 (scaffolding instructional approach), EG_2: Experimental group 2 (Hands-on instructional approach), O_1: Pretest for the groups, O_2: Post test for the groups, X_1: Treatment for experimental group 1, X_2: Treatment for experimental group 2, X_3: Conventional method (control group), ---- : Non equivalent of the three groups

State. The distribution of the schools within the three local government areas of the zone are as follows; twenty-one in Aguata, fourteen in Orumba North and thirteen in Orumba South. Out of the 48 government owned secondary schools in the education zone, eight are single schools while forty are co-educational schools. The sample size comprised 195 SSI chemistry students, (102 male and 93 female) drawn from two intact classes in each of the three selected co-educational schools. The choice of two intact classes was to ensure proper management of students. Purposive sampling technique was used to select the two intact classes and three co-educational schools, one each from the three local government areas that made up the zone. The three co-educational schools were selected because gender is a variable of the study and that the School S offer chemistry as an SSCE subject. The sampled schools were randomly assigned to experimental group 1, experimental group 2 and control group. The experimental group 1 comprised 60 students (22 males and 38 females) while the experimental group 2 comprised 64 students (27 males and 37 females) and the control group comprised 71 students (53 males and 18 females).Two Instruments were used for data collection. The instruments used for data collection were Chemistry Achievement Test (CAT) and Chemistry Interest Scale (CIS). The chemistry achievement test consisted of 30 multiple-choice objective test items developed by the researchers from the school syllabus. A table of specification showing the distribution of the test items on the topics and cognitive skills tested was made.The cognitive skills tested were based on knowledge, comprehension, analysis, synthesis and evaluation. The interest scale was adapted from Ojo (2011) modified Likert-type scale. In order to meet the demand of the present research, some modifications in terms of language structures and subject matter were done as the study was done in mathematics while the present study is to be done in chemistry. The chemistry interest scale was a twenty-item interest scale that will be scored on a four point scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). These instruments were administered as pre-test and post-test for the treatment groups and control group. However, the post-test was reshuffled in order to minimize the student's tendency of becoming familiarized with the test items.The instruments were subjected to trial testing to enable the researchers determine its appropriateness done using 20 SS1 chemistry students of a school different from the area of study. The reliability estimate of Chemistry Interest Scale (CIS), items was done using Cronbach alpha formula which gave a reliability index of 0.78 while 0.82 was obtained for the Chemistry Achievement Test (CAT) using Kuder Richardson (K-R-20).

In this study, three instructional approaches were used, namely, scaffolding instructional approach, hands-on instructional approach and conventional method. The chemistry teachers in each sample schools were

trained and used as research assistants to carry out the teaching. The three chemistry teachers for each kind of treatment were trained by the researchers, so as to master the treatment procedures. For experimental group 1, the chemistry teacher was trained on how to teach using scaffolding instructional approach and the chemistry teacher in experiment 2 was trained on how to teach using hands-on instructional approach while in the control group the chemistry teacher was trained on how to teach using the conventional method. The researchers demonstrated the pattern and procedures for the study to the teachers using their already made lesson notes which was made available to the research assistants. After the session, the research assistants were allowed to practice what they had learnt and the researchers watched them and gave corrections where necessary. The two intact classes each from the sampled schools were pre tested using CAT and CIS just before the treatment commenced. The pre-test was used to establish initial group equivalence. The experiment lasted for 5 weeks. The students were taught for 4 weeks after which the CAT and CIS were administered in the fifth week as the post-test. After the test the scripts were collated based on the variables of achievement, interest and gender.The data obtained from the pretest and post-test were analyzed using mean and standard deviation to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypothesis at 0.05 level of significance. The research related to human use has been complied with all the relevant national regulations institutional policies and in accordance the tenets of the Helsinki Declaration and has been approved by the Research Ethics Committee at the Department of Science Education, University of Nigeria, Nsukka. This study was also conducted in adherence to the researchethics of the American Psychological Association. Informed consent was obtained from all individuals included in this study.

RESULTS AND DISCUSSION

Research question 1: What is the effect of scaffolding instructional approach, Hands-on instructional approach and conventional teaching method on student's achievement in chemistry?

Data in Table 2 showed that students taught chemistry using scaffolding had posttest mean score of 21.83 with a standard deviation of 4.85 and mean gain score of 10.30 while their counterparts taught chemistry using hands-on had posttest mean score of 20.77 with a standard deviation 4.55 and mean gain score of 3.47. The result indicates that scaffolding and hands-on instructional approach improved student's achievement in chemistry than the conventional method. Moreover, hands-on instructional approach tends to enhance higher achievement followed by scaffolding instructional approach in chemistry.

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught chemistry using scaffolding instructional approach, hand-on instructional approach and conventional teaching method. Table 3 showed that the effect of instructional methods were significant on mean achievement scores of students in chemistry. This is because the probability value of 0.000 is <0.05 level of significance, the null hypothesis was rejected indicating that the difference in the mean achievement scores of students taught chemistry using scaffolding, hands-on and conventional teaching methods was significant.

Research question 2: What is the influence of gender on student's achievement in chemistry?

Table 3 revealed that male students taught chemistry had post test mean score of 17.12 with a standard deviation of 6.65 and a mean gain score of 7.79 while

Table 2: Mean and standard deviation of pretest and posttest achievement scores of students taught chemistry using scaffolding instructional approach, hands-on instructional approach and conventional teaching method

		Pretest		Posttest		
Instructional approaches	N	$\bar{X}$	SD	$\bar{X}$	SD	Mean gain
Scaffolding	60	11.53	2.94	21.83	4.85	10.30
Hands-on	64	9.80	2.26	20.77	4.55	10.97
Conventional	71	8.77	2.82	12.24	3.65	3.47

Table 3: Analysis of Covariance (ANCOVA) of the significant difference in the mean achievement scores of students taught chemistry using scaffolding instructional approach, hands-on instructional approach and conventional teaching method

Sources	Type III sum of squares	df	Mean square	F-values	Sig.	Dec.
Corrected model	3891.303[a]	6	648.551	35.171	0.000	-
Intercept	4628.751	1	4628.751	251.020	0.000	-
PreAchi	8.829	1	8.829	0.479	0.490	-
Strategies	2957.258	2	1478.629	80.187	0.000	S
Gender	58.049	1	58.049	3.148	0.078	NS
Strategies * Gender	83.013	2	41.506	2.251	0.108	NS
Error	3466.676	188	18.440	-	-	-
Total	70466.000	195	-	-	-	-
Corrected total	7357.979	194	-	-	-	-

[a]Significant value

Table 4: Mean and standard deviation of pretest and posttest achievement scores of the influence of gender on student achievement in chemistry

		Pretest		Posttest		
Genders	N	$\bar{X}$	SD	$\bar{X}$	SD	Mean gain
Male	102	9.33	2.85	17.12	6.65	7.79
Female	93	10.65	2.82	18.95	5.45	8.30

Table 5: Mean and standard deviation of pretest and posttest interest scores of students taught chemistry using scaffolding instructional approach, Hands-on instructional approach and conventional teaching method

		Pretest		Posttest		
Instructional approaches	N	$\bar{X}$	SD	$\bar{X}$	SD	Mean gain
Scaffolding	60	52.10	6.81	57.52	7.46	5.42
Hands-on	64	55.19	5.99	59.16	6.94	3.97
Conventional	71	51.01	4.53	53.23	3.15	2.22

their female counterparts had post test mean score of 18.95 with a standard deviation of 5.45 and a mean gain score of 8.30. This indicates that female students taught chemistry achieved higher than their male counterparts at posttest.

Hypothesis 2: There is no significant influence of gender on the mean achievement scores of student's in chemistry. Table 2 showed that the effect of gender on posttest mean scores of students in chemistry was not significant. Since, the probability value of 0.078 is >0.05 level of significance, the null hypothesis was not rejected indicating that the posttest mean scores of gender were not significant.

Research question 3: What is the effect of scaffolding instructional approach, hands-on instructional approach and conventional teaching method on student's interest in chemistry?

Data in Table 4 showed that students taught chemistry using scaffolding had posttest mean interest score of 57.52 with a standard deviation of 7.46 and mean gain score of 5.42 while their counterparts taught chemistry using hands-on had posttest mean interest score of 59.16 with a standard deviation of 6.94 and mean gain score of 3.97 and those taught chemistry using conventional method had posttest mean interest score of 53.23 with a standard deviation of 3.15 and mean gain score of 2.22. The result indicates that scaffolding and hands-on instructional approach improved student's interest in chemistry than the conventional method. Moreover, scaffolding instructional approach tends to enhance higher interest followed by hands-on instructional approach in chemistry.

Hypothesis 3: There is no significant difference in the mean interest scores of students taught chemistry using scaffolding instructional approach, hand-on instructional approach and conventional teaching method.

Table 5 showed that the differences of instructional methods were significant on mean interest scores of students in chemistry. This is because the probability value of 0.002 is <0.05 level of significance, the null hypothesis was rejected indicating that the difference in the mean interest scores of students taught chemistry usingscaffolding, hands-on and conventional teaching methods was significant.

Research question 4: What is the influence of gender on student's interest in chemistry?

Table 6 revealed that male students taught chemistry had post test mean score of 59.25 with a standard deviation of 6.09 and a mean gain score of 6.17 while their female counterparts had post test mean score of 58.82 with a standard deviation of 6.17 and a mean gain score of 6.50. This indicates that female students taught chemistry had higher interest than their male counterparts at posttest.

Hypothesis 4: There is no significant influence of gender on the mean interest scores of student's in chemistry?

Table 5 showed that the influence of gender on the mean interest scores of students in chemistry was notsignificant. Since, the probability value of 0.703 is >0.05 level of significance, the null hypothesiswas not rejected indicating that there was no significant influence of gender on the mean interest scores of students in chemistry.

Research question 5: What is the interaction effect of methods and gender on student's achievement in chemistry?

Data in Table 7 showed that male students taught with scaffolding had mean achievementgain of 11.64 withstandard deviation of 5.29 while their female counterpart had mean achievement gain of 9.53 with a standard deviation of 4.53. The male students taught with hands-on had mean achievement gain of 12.93 with standard deviation of 3.83 while their female counterparts had mean achievement gain of 9.54 with a standard deviation of 4.76. The result also revealed that male students taught chemistry using conventional method had a mean achievement gain of 3.57 with a standard deviation of 3.62 while their female counterparts had a

Table 6: Analysis of Covariance (ANCOVA) of the significant difference in the mean interest scores of students taught chemistry using scaffolding instructional approach, hands-on instructional approach and conventional teaching method

Sources	Type III sum of squares	df	Mean square	F-values	Sig.	Dec.
Corrected model	1252.211[a]	6	208.702	2.617	0.018	-
Intercept	8468.595	1	8468.595	106.187	0.000	-
PreIn	66.518	1	66.518	0.834	0.362	-
Strategies	1001.411	2	500.705	6.278	0.002	S
Gender	11.613	1	11.613	0.146	0.703	NS
Strategies*Gender	16.980	2	8.490	0.106	0.899	NS
Error	14993.307	188	79.752	-	-	-
Total	662748.000	195	-	-	-	-
Corrected total	16245.518	194	-	-	-	-

[a]Significant values

Table 7: Mean and standard deviation of pretest and posttest interest scores of the influence of gender on student interest in chemistry

		Pretest		Posttest		
Gender	N	$\bar{X}$	SD	$\bar{X}$	SD	Mean gain
Male	102	53.08	5.85	59.25	6.09	6.17
Female	93	52.32	6.23	58.82	6.17	6.50

Table8: Mean gain and standard deviation on interaction effect of methods and gender on student's achievement in chemistry

	Scaffolding			Hand-on			Conventional		
Instructional approach	N	Mean gain	SD	N	Mean gain	SD	N	Mean gain	SD
Male	22	11.64	5.29	27	12.93	3.83	53	3.57	3.62
Female	38	9.53	4.53	37	9.54	4.76	18	3.16	3.80

Table 9: Mean gain and standard deviation on interaction effect of methods and gender on student's interest in chemistry

	Scaffolding			Hand-on			Conventional		
Instructional approach	N	Mean gain	SD	N	Mean gain	SD	N	Mean gain	SD
Male	22	4.21	8.19	27	3.89	7.72	53	2.14	3.04
Female	38	6.81	6.98	37	4.03	6.41	18	2.31	3.41

mean achievement gain of 3.16 with a standard deviation of 3.80. At every level as shown in the table above the mean achievement gain of students taught with scaffolding and hands-on instructional approaches are higher than those taught with conventional method. This implies that there is no interaction between methods and gender on student's achievement in chemistry.

Hypothesis 5: There is no significant interaction effect of methods and gender on student's achievement in chemistry. Data in Table 2 showed that the interaction between methods and gender on student's mean achievement scores was not significant. This is because the probability value 0.108 obtained was >0.05 set as bench mark, the null hypothesis which stated that there is no significant interaction effect of methods and gender on student's achievement in chemistry was not rejected. Hence, the interaction effect of methods and gender on student's achievement in chemistry is not significant.

Research question 6: What is the interaction effect of methods and gender on student's interest in chemistry?

Data in Table 8 showed that male students taught with scaffolding had mean interest gain of 4.21 with standard deviation of 8.19 while their female counterparts had mean interest gain of 6.81 with a standard deviation of 6.98. The male students taught with hands-on had mean interest gain of 3.89 with standard deviation of 7.72 while their female counterparts had mean interest gain of 4.03 with a standard deviation of 6.41. The result also revealed that male students taught chemistry using conventional method had a mean interest gain of 2.14 with a standard deviation of 3.04 while their female counterparts had a mean interest gain of 2.31 with a standard deviation of 3.41. At every level as shown in Table 9 the mean interest gain of students taught with scaffolding and hands-on instructional approaches are higher than those taught with conventional method. This implies that there is no interaction between methods and gender on student's interest in chemistry.

Hypothesis 6: There is no significant interaction effect of methods and gender on student's interest in chemistry. Data in Table 6 showed that the interaction between methods and gender on student's mean interest scores was not significant. This is because the probability value 0.899 obtained was >0.05 set as bench mark, the null hypothesis which stated that there is no significant interaction effect of methods and gender on student's interest in chemistry was not rejected. Hence, the interaction effect of methods and gender on student's interest in chemistry is not significant.

The study investigated the effect of scaffolding and hands-on instructional approaches on senior secondary

school student's achievement and interest in chemistry. The results of data analysis indicates that students taught chemistry using scaffolding and hands-on instructional approaches achieved higher than their counterpart who were taught with the conventional teaching method. However, further analysis as presented in Table 2 revealed that, there is a significant difference in the mean achievement scores of students taught chemistry using scaffolding instructional approach, hand-on instructional approach and conventional teaching method with those taught using scaffolding and hands-on instructional approach performing better than those taught using conventional method. This result is in line with (Federal Republic of Nigeria, 2014) which stress that the teaching of sciences should be learner-centered for self development and self-fulfillment. The finding is also in line with Nworgu (2009) which advocated for the use of students centered instructional approaches for effectiveness in the teaching and learning of sciences. Therefore, ensuring that students participate actively in chemistry lessons is essential as it enhances student's achievement. Hence, the use of scaffolding and hands-on instructional approaches in chemistry is of great importance, since, it ensures participation and direct experience of student's in the learning process and leads to higher achievement.

The results of the data analyses on gender revealed that the female students had a slight edge over their male counterparts. However, the findings showed no significant influence of gender on the mean achievement scores of male and female student's in chemistry. The result is in line with Sani (2015) who revealed that there is no significant difference in the mean achievement of male and female students in chemistry. The researchers concluded that gender has no influence in the achievement of chemistry students. This is contrary to the studies of Akala (2010) and Ezeudu and Obi-Theresa (2013) who reported in their separate studies that male students had a higher achievement in chemistry than female students. Ameh (2015) found out that female students achieved higher than their male counterparts in chemistry which contradicts the findings of the present study. This suggests that there is still need for further research to ascertain the influence of gender on achievement in chemistry, since, the results are contradictory.

The findings revealed that students taught chemistry using scaffolding instructional approach have a highest interest mean gain followed by the group taught using hands-on instructional approach. This is an indication that scaffolding instructional approach and hands-on instructional approach promote student's interest in chemistry than the conventional method. The result also revealed that, there was a significant difference in the mean interest scores of students taught chemistry using scaffolding instructional approach, hand-on instructional approach and conventional teaching method with those taught using scaffolding and hands-on instructional approaches better than those taught using conventional method. This is consistent with Nbina (2012) who indicated that innovative teaching methods (students centered approaches) enhance achievement and promote student's interest in chemistry. Hence, the study shows that scaffolding and hands-on instructional approaches which are students centered approaches promote student's interest in chemistry. Furthermore, the results showed that the female students had a higher mean gain than their male counterpart. However, it did revealed no significant influence of gender on the mean interest scores of male and female students in chemistry. This agrees with Ameh (2015) who found no significant influence of gender on student's achievement in chemistry. The results further showed that the achievement mean gain of male and female students taught with scaffolding and hands-on instructional approaches were greater than the achievement mean gain of their counterparts taught using conventional method with the male students having a higher achievement mean gain. The findings also showed that the interaction effect of the methods and gender on student's achievement in chemistry is higher with hands-on instructional approach and then scaffolding instructional approach. Further analysis in Table 2 revealed that there is no interaction effect of methods and gender on student's achievement in chemistry. This is in line with Uduafemhe (2015) who reported that there is no significant interaction effect of methods and gender in student's achievement.

Finally, the results showed that both male and female students who were taught chemistry with scaffolding and hands-on instructional approaches had a higher interest mean gain than their counterparts taught using conventional method with the female students having a higher interest mean gain. The findings also showed that the interaction effect of the methods and gender on student's interest in chemistry was higher with scaffolding instructional approach and then, hands-on instructional approach. Further analysis in Table 5 revealed that there was no interaction effect of methods and gender on student's interest in chemistry. This is in line with Ameh (2015) who revealed no significant interaction effect of methods and gender in student's interest in chemistry.One limitation of the current study is that it covered only senior secondary schools in Aguata education zone of Anambra State using Senior Secondary School one (SS1) students. However, the choice of SS1 was made because the chemistry topics that the researchers intends using for the research are in their scheme of work for the period the experiment was carried out. The content scope covered a unit (Acids, bases and salts) from the Senior Secondary School one (SS1) chemistry curriculum.

CONCLUSION

This study demonstrated that both scaffolding and hands-on instructional approachesare effective in enhancing student's achievement and interest in chemistry. Therefore, for meaningful learning and student's achievement and interest in the subject to improve, teachers should adopt the strategies in the teaching of chemistry and create an enabling environment to enhance student's participation in their teaching process. Scaffolding and hands-on instructional approaches enhance student's achievement in chemistry with hands-on instructional approach having the highest achievement. The methods also avail the students the opportunity of a direct experience and active participation in the learning process. Scaffolding and hands-on instructional approaches promotes student's interest in chemistry than the conventional method with scaffolding having a slightly higher mean interest score than the hands-on instructional. There is no significant influence of gender on the mean achievement and interest scores of students in chemistry. Hence, gender is not an influencing factor in the achievement and interest of student in chemistry. However, the teacher should avoid any gender biased instructional approach in teaching and learning of chemistry. There is no significant interaction effect of methods and gender on student's achievement and interest in chemistry.

RECOMMENDATIONS

The use of scaffolding and hands-on instructional approaches should be encouraged during pre-service teacher training programmes. The use of scaffolding and hands-on instructional approaches should be adopted by science teachers, especially, chemistry teachers. This can be done by recommending and reflecting the two instructional approaches in the curriculum materials such as textbooks, instructional materials among others. Stakeholders in chemistry educations like Ministries of Education, Science Teacher's Association of Nigeria (STAN), education commissions, school principals and state school management board should organize seminars, workshops and conferences where teacher in the field would be trained on how to use scaffolding and hands-on instructional approaches in teaching chemistry. Government in conjunction with international agencies and professional bodies like (STAN) should sponsor further research on the use of scaffolding and hands-on instructional approaches.

REFERENCES

Ajeyami, D. and T.E. Owoyemi, 2014. Strategies for teaching carbon and its compounds, hydrocarbonm and crude oil at junior secondary school. STAN. Chem. Panel Ser., 10: 1-9.

Akala, J.B., 2010. Gender differences in students achievement in chemistry in secondary schools of Kakamega district, Kenya. Master Thesis, Kenyatta University, Nairobi, Kenya.

Akpoghol, T., R.M.O. Samba and K. Asemave, 2013. Effect of problem solving strategy on student's achievement and retention in secondary school chemistry in Makurdi metropolis. Res. J. Curr. Teach., 7: 529-537.

Alake, E.M. and O.E. Ogunseemi, 2013. Effects of scaffolding strategy on learners academic achievement in integrated science at the junior secondary school level. Eur. Sci. J., 9: 149-155.

Ameh, R.F., 2015. Effects of cooperative learning and analogy methods on students achievement, interest and conceptual change in chemistry. M.Ed Thesis, University of Nigeria, Nsukka, Nigeria.

Anazor, C.L., 2015. Effect of Peer Group Assessment Technique (PGAT) on senior secondary school students achievement and interest in stoichiometry. M.Ed Thesis, University of Nigeria, Nsukka, Nigeria.

Anonymous, 2015. The glossary of education reform. Great Schools Partnership, Knoxville, Tennessee. https://www.edglossary.org/

Averill, B. and P. Eldredge, 2017. General chemistry: Principles, Patterns and Applications. Version 1.0, Flat World Knowledge Education Company, Boston, Massachusetts, USA., ISBN:978-1-4533-2231-4, Pages: 1766.

Candler, L., 2016. Actively engage students using hands-on & minds-on instruction. TeachHUB.Com, USA. http://www.teachhub.com/actively-engage-students-using-hands-minds-instruction

Ekwueme, C.O., E.E. Ekon and D.C. Ezenwa-Nebife, 2015. The impact of hands-on-approach on student academic performance in basic science and mathematics. Higher Educ. Stud., 5: 47-51.

Ezeudu, F.O. and N. Obi-Theresa, 2013. Effect of gender and location on students achievement in chemistry in secondary schools in Nsukka local governmentarea of Enugu state, Nigeria. Res. Humanities Soc. Sci., 3: 50-55.

FME., 2009. National Curriculum for Senior Secondary School. NERDC Publisher, Lagos, Nigeria,.

Federal Republic of Nigeria, 2014. National Policy on Education. 7th Edn., NERDC Publisher, Lagos, Nigeria,.

Igboanugo, B.I. and Z.C. Njoku, 2015. Effects of cooperative learning and peer-teaching on senior secondary school students achievement in some difficult chemistry concepts. J. Sci. Teach. Assoc. Niger., 50: 151-162.

Mbaba, U.G., 2010. Encouraging gender equality in secondary education: Implication of teaching strategies and studies gender on academic performance in introductory technology. J. Curr. Stud., 8: 61-73.

Nbina, J.B., 2012. Analysis of poor performance of senior secondary students in chemistry in Nigeria. Afr. Res. Rev., 6: 324-334.

Nworgu, L.N., 2009. Fundamental Principles of Methods of Teaching Biology. Global Publishers, Enugu, Nigeria,.

Ogunleye, B.O. and V.F.T. Babajide, 2011. Commitment to science and gender as determinants of students achievement and practical skills in physics. J. Sci. Teachers Assoc. Niger., 46: 125-135.

Ohia, G.N.C., G.I. Amasiatu, J.O. Ajagbe, G.O. Ojukuku and U. Mohammed, 2009. Comprehensive Certificate chemistry. University Press, Ibadan, Nigeria,.

Ojo, S.G., 2011. Effects of computer-based instructional packages on achievement and interest of junior secondary school students in algebra. Ph.D Thesis, University of Nigeria, Nsukka, Nigeria.

Okeke, O.J., 2010. Effect of mind mapping teaching strategy on student's interest, retention and achievement in senior secondary school chemistry. Ph.D Thesis, University of Nigeria, Nsukka, Nigeria.

Oludipe, D.I., 2012. Gender difference in Nigerian junior secondary students academic achievement in basic science. J. Educ. Soc. Res., 2: 93-99.

Onah, U.P., E.Z. Umeano and A.B. Ezeanwu, 2015. Effects of adaptive teaching instructional strategy on students achievement and interest in Mathematics in Enugu. Intl. J. Educ. Res., 14: 231-249.

Pinantoan, A., 2013. Instructional Scaffolding: A Definitive Guide. InformED. San Francisco, Califoenia, USA. http://www. opencolleges. edu.au/informed/teacher-resources/scaffolding-in-education-a-definitive-guide/

Sani, U.T., 2015. Effects of cooperative learning strategy on senior secondary school students performance in quantitative chemistry in Kebbi State. J. Educ. Soc. Sci., 1: 30-35.

Uduafemhe, M.E., 2015. Comparative effects of scaffolding and collaborative instructional approaches on secondary school student's psychomotor achievement in basic electronics in North-Central Nigeria. IOSR. J. Eng., 5: 23-31.

WAEC., 2015. Chief examiner's report. West African Examination Council, Lagos Office, Nigeria.

WHO., 2016. Gender equity and human rights. World Health Organization, Geneva, Switzerland. https://www.who.int/ gender-equity-rights/ understanding/gender-definition/en/