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EFFECT OF INSTRUCTIONAL SCAFFOLDING ON STUDENTS' ACADEMIC ACHIEVEMENT IN SECONDARY SCHOOL CHEMISTRY IN MBAITOLI LOCAL GOVERNMENT AREA OF IMO STATE

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ABSTRACT
The study investigated on the effect of instructional scaffolding and gender on the academic achievement of students in chemistry in Mbaitoli local government area of Imo State. In other to effectively carry out the study, it adopted the quasi experimental design particularly the pre-test, post-test, non-equivalent control group. The population of the study consisted of all the students in Senior Secondary School two (SSII) in Mbaitoli local government area of Imo State with total of one thousand two hundred (1200) in the eighteen (18) public secondary schools located in the area. The sample of the study consisted of eighty-one (81) students selected from two public schools out of the 18 public schools in the area using purposive sampling technique. The instrument for data collection was Chemistry Achievement Test (CAT). The instrument was validated by two experts; one in Science Education Department, Nnamdi Azikiwe University, Awka and one from Alvan Ikoku College of education, Imo State. Test-retest method was used to establish the reliability of the instrument which yielded reliability co-efficient of 0.78. Two research question and two hypotheses guided the study which was tested at 0.05 level of significance using ANCOVA. Research questions were answered using mean and standard deviation. Findings revealed that the instructional scaffolding improved the achievement of the students significantly. Based on the finding it was recommended among others that school authorities and government should organize seminars and workshops on regular basis for teachers to update their knowledge on innovative teaching technique which are effective in teaching science as provided by research and literatures and from time to time teachers should apply the gained knowledge on innovative method and strategies towards effective teaching of chemistry to enhance better performance male and female students in chemistry.
Keyword: Scaffolding instructional strategy, academic achievement, chemistry, gender.

Introduction

The introduction of science education into the school curriculum in Nigeria was a way of solving societal problems such as creating employment opportunities, medical and health care services, technology related issues and many others and no country can make meaningful difference without science and technology. Science education is the scholarly and practical discipline concerned with the teaching, learning and assessment of science content, science process as well as nature of science (Obialor, 2018). According to Taber and Akpan in Obialor and Osuafor (2019) science education is a major field of practice, with science (and individual science disciplines) being taught and learnt at various levels, both formally (for example in schools) and through more informal approaches (such as learning that takes place when people visit science museums) all around the world. The subjects includes in science education are biology, physics, mathematics, computer studies, basic science and technology and chemistry.

Chemistry is one of the important science subjects that its efficacy cut across all other science subjects, and therefore important towards improvement of Science Technology and Mathematics (STM) education. Ababio, (2005) regarded chemistry as the study of matter, what it is made of, how it behaves, its properties and how it changes during chemical

reaction. Aniodoh and Egbo, (2013) asserted that Chemistry is a branch of science which deals with the studies of the structure, composition, properties and reactions of matter in different forms. Chukwuagu (2016) opined that chemistry is a science subject that is concerned with substance of which matter is composed of, the investigation of their properties and reactions, and the use of such reactions to form other substance.

The major objective of teaching chemistry in school is to produce individuals who can define problems around them, make observations, formulate hypotheses, conduct experiments, make inferences, make analysis and apply the knowledge and skills that are acquired to solve problems in everyday life. According to the Federal Ministry of Education (FME, 2009) Nigerian senior secondary school chemistry curriculum is aimed at enabling students to: develop interest in the subject of chemistry, acquire basic theoretical and practical knowledge and skills, develop interest in Science, Technology and Mathematics. (STM), acquire basic science technology and mathematics (STM) knowledge and skills, develop reasonable level of competence in information computer and technology (ICT) application that will engender entrepreneurial skills, apply skills to meet societal needs of creating employment and wealth, be positioned to take advantage of numerous career opportunities offered by chemistry and be adequately prepared for further studies in chemistry. Looking at the theoretical aims and objectives of teaching chemistry and considering its importance to real life, it is expected that in practical, the implementation of these objectives and aims will produce chemists who are adequately prepared and equipped to face the challenges of science and national development.

Over the years the above expectation has been dwindled as a result of poor educational output of students in chemistry both in external and internal examinations as measured by their achievement in examinations. Chief examiners reported (2017-2020) indicates poor achievement in chemistry in WAEC, the candidates' weaknesses evident in the following areas: poor communication, technical terms, stiochemistry and chemical reactions, metals and their compounds. Ezano in Afolabi (2019) reported students' incorrect use of symbols for ions, mole concept and stiochemistry as problematic. Many factors have been associated with the students' poor achievement in chemistry. These include lack of qualified teachers, lack of instructional materials, abstract nature of most of the chemistry concepts (Ghassan, 2017), negative attitude of the students towards chemistry, peer influence (Frances 2002), and teachers' method of instruction (Pavlov, 2003). However, the general consensus is that the conventional methods of teaching chemistry have not been very successful but only encourage rote learning of facts and concepts making the subject uninteresting and difficult to students, resulting invariably into poor students' achievement (Ajagu, 2006). Therefore, it has been the subject/aim of this research to find out a means or strategy through which students' achievement in chemistry can be enhanced positively. One of the ways of enhancing students understanding and achievement in sciences as suggested by Eze (2006) is for the teacher to provide a bridge between unfamiliar concept and the knowledge which students already have. This may be applied in chemistry to improve understanding and enhance achievement and students in learning with what is known as instructional scaffolding.

Instructional Scaffolding is a way of teaching in which a learner can be helped out while learning by carefully removing leaning difficulty using a More Knowledgeable Other (MKO). The term scaffolding as used in education was first coined by Wood, Brunner and Rose (1976) based on Lev Vygotsky's theory of learning and the notion of Zone of Proximal Development. They referred to scaffolding as a process that enables the child or novice to solve a task or achieve a goal that would be beyond his unassisted effort. Sawyer (2006) defined instructional scaffolding as the support given during the learning process which

is tailored to the need of the student with the intention of helping the students achieve his/her learning goal. In this context scaffolding has to do with the help given to students by more knowledgeable other (MKO) to ensure that the learner achieves maximum learning over new knowledge. It is the support and assistance giving in any learning situation when the teacher provides temporary support structure that will assist the learners to develop new understanding, skills, concept and abilities (Nzewi & Ibeneme, 2011). Reiser (2004) pointed out that in scaffolding learners receive an assistance to successfully perform certain task and move to more complex ones. If these assistances are not provided, students may not be able to accomplish the task provided in the learning. However with this support students build on the acquired experience and skills, reshape their knowledge and improve their performance (Bassiri, 2012). Vacca (2008) also opined that when guided, supported and provided with the necessary attributes, students become more responsible for their learning, more motivated and more successful. Scaffolding therefore gives students access to improving on their knowledge, skills, abilities and enhances independent learning. Instructional scaffolding as used in teaching and learning environment serves to bridge the cognitive gap between what the learner can do on his/her own and what they can be assisted to achieve, just in the same way scaffolds serves in the building industry.

Apart from the teaching method/strategy used by teachers in teaching the students; gender has also been identified as another factor that affects students' achievement in chemistry. Gender is any physical and behavioural difference between males and females which are social culturally based (Ezeh, 2013; Okeke, 2008). However, there is no agreement on among researchers on the outcomes of studies on gender effect. Some researchers found a significant difference in achievement of male and female students in chemistry (Giginna and Nweze, 2014; Aniodoh and Eze, 2014). While others found no significant difference in the achievement of male and female students in the subject (Bamiro, 2015; Fatokun, Egya and Uzoechi, 2016). In addition, Okeke (2001) asserted that instructional strategies are known to produce different effects on the learner's sexes. Some studies show that males and females respond differently to specific methods and strategies, questions and discussion (West Virgin University for Women Students in Njoku and Attah, 2018). It is therefore important to find out if teaching methods and strategies have differential effects on academic achievement of male and female students in chemistry. Hence, this study was carried out to examine the effect of instructional scaffolding and gender on students' academic achievement in secondary school chemistry in Mbaitoli local government area of Imo state. The purpose of this study was to investigate the effect of instructional scaffolding on students' academic achievement in chemistry in relation to gender.

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores of students taught chemistry with instructional scaffolding and those taught without instructional scaffolding?
2. What are the mean achievement score of male and female students taught chemistry using instructional scaffolding?

Hypotheses

These hypotheses guided the study and were tested at 0.5 level of significance.

1. There is no significant difference between the mean achievement scores of students taught with instructional scaffolding and those taught without instructional scaffolding.
2. There is no significant difference between the mean achievement scores of male and female students taught using instructional scaffolding.

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Research Method

The design of the study was quasi – experimental research design. It adopted the non – equivalent pre-test post-test control group design. This study was carried out in Mbaitoli local government area. The population consisted of one thousand, two hundred students offering chemistry in senior secondary school year two (SSII) in the 18 public secondary schools located in the study area. The sample consists of eight one students offering chemistry in two co-educational schools that constituted the sample of the study. The sample was draw using purposive sampling technique. The instrument used for data collection was Chemistry Achievement Test (CAT) developed by the researchers.The instrument was validated by two experts in chemistry education; one in chemistry department, Alvan Ikoku College of Education and one from Science Education, Nnamdi Azikwe University, Awka. The test-retest method was used to establish the reliability of the instrument which yields a reliability coefficient of 0.78.

However, the regular school teacher of the experimental group was the research assistant to this study. They were briefed on how to use instructional scaffolding. This was done by the researchers after which the lesson plan developed for this study was handed over to them for the commencement of the teaching. The lesson plan was developed based on the topics selected for this study. The topics includes: energy and chemical reaction. The teachers in the control group did not receive any formal instruction they were asked to teach these topics using their expository teaching method.

The treatment lasted for six (6) weeks. The teaching session was done according to the regular school timetable. The timetable allocated one (1) double period (80 minutes) and one (1) single period (40 minutes) for chemistry every week. These periods were used to teach the students for four (4) weeks, where each topic lasted for one (1) week.

The Chemistry Achievement Test (CAT) was administered to the students in the first week of the five weeks as pre-test. This was to ascertain the previous knowledge the students have, on the concept they were exposed to during the study; this took effect in both the control and experimental group. After this, the teachers in both groups commenced the teaching session where the experimental group was exposed to treatment using instructional scaffolding and the control group with the regular teaching method. At the end of the four weeks of teaching, the sixth (6^{th}) week was for the post-test. The students were given the reshuffled CAT again and during these periods there was regular supervision by the researchers on the research assistants. Thereafter, both the pre-test and post-test scores were collated and analyzed using mean and standard deviation and analysis of covariance (ANCOVA) to test the hypotheses at 0.05 level of significance.

Presentation of Results

Research Question 1: Mean achievement scores of students taught chemistry with instructional scaffolding and those taught without instructional scaffolding?

Table 1: Mean, Standard Deviation and Mean gain score of students on CAT for scaffolding and without scaffolding groups

		Pre-test		post-test		mean gain	mean diff
Subject	№	$\bar{X}$	SD	$\bar{X}$	SD		
Scaffolding	38	38.26	12.62	67.11	15.92		28.85
Without scaffolding	43	44.79	16.66	51.21	18.11	6.42	15.90

In table 1 it can be observed that students taught chemistry using instructional scaffolding had the mean of 67.11 and the standard deviation of 15.92 in the post-test and those taught without scaffolding has the mean of 51.21 and the standard deviation of 18.11, scaffolding group had higher mean than without scaffolding group. Also from the table the mean gain scores showed that scaffolding group has 28.85 gain score while without scaffolding group had the mean gain of 6.42. The mean difference of 15.90 is obtained in favour of scaffolding group. This showed that the scaffolding group performed better in CAT than the without scaffolding group.

Research Question 2: The mean achievement score of male and female students taught chemistry using instructional scaffolding?

Table 3: Mean, Standard Deviation and Mean gain score of male and female students on CAT for scaffolding group

		Pre-test	post-test	mean gain		mean diff
Subject	№	$\bar{X}$	SD	$\bar{X}$	SD	
Scaffolding						
Male	22	37.64	12.57	66.18	16.744	28.54
Female	16	39.31	13.02	68.38	15.148	29.07 2.20

In table 3 the male students in the scaffolding group had a mean achievement score of 66.18 in their post-test scores. The female students had the mean of 68.38. This showed a slightly higher mean from that of the male students. Also the male students had a mean gain score of 28.54 while the female students had the mean gain of 29.07. Though the mean gain of female students' differed from the male students by 0.53, it showed that female students performed slightly better than male students in the scaffolding group

Hypothesis 1: There is no significant difference between the mean achievement scores of students taught with instructional scaffolding and those taught without instructional scaffolding.

Table 5: Analysis of covariance on the effect of method on students achievement in chemistry at α =0.05

Dependent Variable: post-test

Source	Type III sum of square	df	Mean of Squares	F	Sig	
Corrected model	25326.45[a]	2	12663.22	339.01	.000	
Intercept	1914.32	1	1914.23	51.249	.000	
Pre-test	20229.14	1	20229.14	541.56	.000	
Method	10090.20	1	10090.200	270.13	.000	
Error	2913.55	78	37.35			
Total	307024.00	81				
Corrected Total	28240.00	80				

In table 5, a significant main effect was observed for method with respect to achievement in chemistry F (1, 78) = 270.13, P=0.000 < 0.05.This showed that there is significant main effect between the mean scores of achievement of students taught chemistry using instructional scaffolding and those taught without instructional scaffolding. As a result the null

hypothesis that there is no significant difference between the mean achievement scores of students taught with instructional scaffolding and those taught without instructional scaffolding does not hold rather the alternative hypothesis.

Hypothesis 3: There is no significant difference between the mean achievement scores of male and female students taught using instructional scaffolding.

Table 7: Analysis of covariance on the achievement of male and female students taught chemistry using instructional scaffolding at α =0.05

Dependent Variable: post-test

Source	Type III sum of square	df	Mean of Squares	F	Sig
Corrected model	7646.14[a]	2	3823.07	77.46	.000
Intercept	1995.65	1	1995.65	40.43	.000
Pretest	7601.59	1	7601.59	154.02	.000
Gender	2.29	1	2.29	.046	.83
Error	1727.44	35	49.36		
Total	180493.00	38			
Corrected Total	9373.58	37			

In table 7, showed that there is no significant difference in the achievement of male and female students taught chemistry using instructional scaffolding F (1, 35) = 0.046, P=0.831 > α = 0.05. Therefore the null hypothesis that there is no significant difference between the mean achievement scores of male and female students taught using instructional scaffolding is retained.

Discussion of Findings

From the findings of this study it is obvious that instructional scaffolding has improved the achievement of students in chemistry as students taught with instruction scaffolding had a higher mean in their post-test scores than students taught without instructional scaffolding. However when the pre-test and post-test were taken into account, the scaffolding group were able to top in the mean gain than the other group. When the hypothesis was considered there was a significant difference at p < 0.001. This finding was in line with the work of Bassiri (2012) who recorded significant difference in the achievement of student taught with instructional scaffolding than those taught with conventional method, as result confirming the claim that scaffolding can promote internal individual learner variables like motivation and this can lead to learners' full engagement.

Nzewi and Ibeneme (2011) found out that cue questioning as instructional scaffolding used in teaching biology to the students significantly improved their achievement. According to them this is because cueing questions as instructional scaffolding involved students' active participation in the class. The students were always active answering or asking questions. The teacher was also able to use cueing questions to identify relevant anchoring ideas the students already possessed in biology. This made it possible to relate the new knowledge to what the students' already know thereby reducing students' dependent on rote memorization. Instructional scaffolding as a result encouraged active student participation in the learning task thereby improving their achievement as observed in this study. The findings of the result also showed that there is slight difference in the mean achievement score of male (66.18) and female students (68.38) placing the female students a bit higher in their performance that male students. But the hypothesis tested on the post-tests mean scores showed there was no significant difference in the achievement of male and female students in the subject chemistry (p>0.05). This showed that

instructional scaffolding when properly applied can enhance the achievement of both male and female student. The findings of the study was also in line with the work of Azih and Nwosu (2011) who observed that students taught financial accounting using instructional scaffolding did not differ in male and female achievement in the subject. Hartman (2002), in his work upheld that research and theory suggest that the educational outcomes of scaffolding can be positive, particularly when the instructor is well prepared and aware of the theoretical basis for the technique irrespective of the gender of the students.

The findings of the study was also contrary to the work of Ezeudu and Obi (2013) who found out that male students performed better in chemistry than their female counterparts. Their study was based on WASSSCE between 2008/2009-2011/2012 academic sessions which was a cumulative result as against this study that particularized on energy and chemical reaction to draw its findings.

Conclusion

After considering and discussing the findings of this study the following conclusions were drawn: instructional scaffolding was effective in improving the achievement of students in chemistry than those taught without it. Gender has no significant effect on the achievement of students who are exposed to chemistry using instructional scaffolding.

Recommendations

From the findings of the study the following recommendations were given:

1. School authorities and government should organize seminars and workshops on regular basis for teachers to update their knowledge on innovative teaching techniques which are effective in teaching science as provided by research and literatures such as instructional scaffolding.
2. Chemistry students should always go for academic help when it seems that the task ahead of them is beyond their present level of knowledge.
3. Since scaffolding is not selective in term of gender it is important that teachers use it to teach from time to time so as it will encourage more participation of male and female students in the subject chemistry.
4. The school authority and Ministry of Education should ensure adequate and regular supervision of schools and instructions to ensure that appropriate instructional strategies relevant for teaching science are used to improve students' performance.

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