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EFFECT OF SCAFFOLDING STRATEGY ON WAVES AMONG LOW AND HIGH ABILITY LEVELS SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND RETENTION IN ABUJA

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Abstract

This study investigated the 'Effect of Scaffolding Strategy on Waves among Low and High Ability Levels Secondary School Students' Achievement and Retention in Abuja'. Three research questions guided the study and three null hypotheses were formulated. The study adopted quasi-experimental research design with pre-test, post-test, post post-test, experimental and control groups. The population of the study comprised 6,699 SS 2 students that offer Physics in all the 53 public co-educational secondary schools (SS) in Abuja as at 2018/2019 first term. Stratified random sampling technique was used to select two co-educational SS comprising seven intact science classes. The sample for the study consisted of 514 students from two co-educational schools. One research instrument consisting of 30 items was used for data collection. The instrument was validated by experts. Pilot-testing of the instrument was conducted on 35 SS2 students. The reliability coefficient of the instrument was established as 0.81 using the Kuder-Richardson (KR-20) formula. Data collected was analysed using descriptive statistics of mean and standard deviation to answer the research questions. The research hypotheses were tested using inferential statistics of Analysis of Covariance at significance level of 0.05. The results from the analysis among others showed that there is a significant difference in the mean achievement scores of students taught waves using scaffolding and conventional method. It was recommended that ministry of education should organize seminars, conferences and workshops on scaffolding strategy for all physics teachers.

Keywords: Scaffolding, Ability Level, Achievement and Retention.

Introduction

Physics is one of the major science subjects taught at secondary level of education. Physics is the study of matter and energy and their interaction. The study of Physics is very important because it generates/creates basic knowledge needed for technological advancement (Oluwasegun & Ekomaye, 2018). The relevance and importance of Physics among science subjects is formidable, hence the need for proper teaching of the subject in the secondary schools. This is to ensure that students' achievements in internal and external examinations are high, thereby making the candidates' entrance into higher schools easier.

Physics is perceived to be a difficult subject because of the abstract nature of some of the concepts (Adeyemo, 2010; Otuka, Fatokun, & Oluwasegun, 2019). As a result of the difficulty of studying Physics many students fail the subject. Results from external examinations have shown the extent of poor achievement of students in Physics in Nigeria (Asikhia, 2010; WAEC, 2018) see Table 1.

Table 1: Students' Enrolment and Achievement in May/June WAEC in Physics (2014–2018)

Year	Total Entry	% Credit Pass (A1-C6)	% Fail (D7-F9)
2014	207,380	47.72	52.28
2015	274,958	51.60	48.40
2016	368,460	49.51	50.49
2017	391,883	47.22	52.78
2018	398,254	47.60	52.40

Source: Statistics Section; West African Examination Council (WAEC) National Office, Lagos, Nigeria.

According to Osuolale (2014), a lot of factors contribute to the poor achievement of students in Physics such as availability of teaching aids, teaching-learning strategies, learning environment etc. While other factors cannot be ignored, studies have shown that if teaching-learning strategies are improved, achievement can be enhanced (Elvis, 2014; Oluwasegun, 2019; Raimond, 2012). Physics curriculum at the secondary school level is broken down into mechanics, heat, waves, motion, light, electricity and atomic Physics. Report from WAEC external examiner (2016 and 2017) noted a general weakness in the ability of students to answer questions in waves. Obafemi and Onwioduokit (2013) found out that waves rank highest in level of difficulty by both teachers and students. The findings of this study also agree with Fisher (2009) who found that the concepts of projectile motion, simple harmonic motion and diffraction of light waves were difficult for the students. Waves is a major branch of secondary school physics in Nigeria.

A wave is a disturbance that transfers energy through matter or space without any permanent displacement of the medium. Waves is an extremely important part of Physics. An understanding of waves is essential for one to understand a wide range of physical phenomena including light and the wave properties of matter including electrons and atoms (Oluwasegun, 2019). To enhance higher achievement of students in waves; teaching and learning strategies need to be improved and appropriate teaching strategies employed as the teaching-learning situation may demand. Poor teaching strategies adopted by teachers at senior secondary school level in Nigeria have been identified as one of the major factors contributing to poor achievement of students (Ahmed & Abimbola, 2011; Okoronka & Wada, 2014). However, there is need to understand that for different topics in Physics, the teaching strategies may differ depending on the complexity and structure of the topics. Conventional or traditional teaching method is the usual method of teaching Physics in secondary schools in Nigeria. Conventional teaching involves the use of demonstration and lecture teaching methods. King'Aru (2014) stated that in conventional method, there is very little interaction between the teacher and the students or among the students themselves in the classrooms.

Studies have shown that student achieve and retain better when student-centred teaching and learning strategies that allow students interactions are used (Khan, Egbue, Palkie & Madden, 2017; McKenna, 2014). Student-centred teaching strategies that allows students' interaction such as scaffolding strategy could replace the conventional teaching with the hope of enhancing students' achievement in Physics. Scaffolding is the process in which teachers demonstrate how to solve a problem then, step back, offering support as needed (Firestone, 2018). It is the variety of procedures/plans used to move students progressively toward stronger understanding and ultimately greater independence in the learning process. When using scaffolding strategy, teachers provide successive levels of temporary support that help students reach higher levels of comprehension and skill acquisition that they would not be able to achieve without assistance. The supports are incrementally removed when they are no longer needed, and the teacher gradually shifts more responsibility over the learning process to the student (Hidden Curriculum, 2014). Koes, Kusairil and Muhardjito (2015) determined the effects of scaffoldings in cooperative learning on Physics achievement among senior high school students. Findings revealed that there were significant differences among the three strategies of teaching with regard to Physics achievement but no significant difference between high and low prior knowledge with regard to Physics achievement. The conceptual scaffolding in cooperative learning generated highest students' Physics achievement. Even though students of both high and low ability levels/prior knowledge tended to have similar Physics achievement, there was the effect of interaction between strategies of teaching and prior knowledge on students' Physics achievement. Olubumi and Ese (2008) also

found that scaffolding strategy enhance achievement. However, Adeniran (2013) research findings show that low scoring level students had the highest mean gain score in an optics performance test while Numgwo, Emmanuel, Owodunni and Uduafemhe (2018) ascertained that collaborative instructional approach is more effective than scaffolding strategy.

What is important in education is not just what students know the day of the final examination, but rather what learning they retain and can apply months and years later (Deslauriers & Wieman, 2011). Retention is the extent to which a student can retrieve information from long term memory. Retention can also be defined as the power or ability to keep or hold something. The success of retrieval depends upon effective encoding that involves making associations with existing knowledge that can facilitate future retrieval. Studies have shown that students' centred teaching and learning strategies could influence retention of Physics concepts.

Apart from teaching strategies, other factors such as students' ability levels affect their achievement and retention in Physics. There are wide academic range within each classroom of students with different ability levels/labels such as fast learners, average learners and slow learners. Many researchers agreed that students' ability level have significant influence on their achievement (Atadoga, Mari, & Danjuma, 2016; Sunday, 2010). It is hoped that by using scaffolding strategy students could effectively learn Physics concepts and contribute their individual knowledge to the learning situation which might enhance their achievement and retention.

Objectives of the Study

Specifically, this study seeks to determine the;

1. effects of scaffolding and conventional method on students' achievement in waves;
2. effect of scaffolding strategy on low and high ability levels students' achievement in waves; and
3. effect of scaffolding strategy on low and high ability levels students' retention in waves.

Research Questions

The following research questions were formulated to serve as guide to the study:

1. What are the mean achievement scores of students taught waves using scaffolding strategy and conventional method?
2. What are the mean achievement scores of low and high ability levels students taught waves using scaffolding?
3. What are the mean retention scores of low and high ability levels students taught waves using scaffolding?

Statement of the Hypotheses

To achieve the purpose of this study, the following null hypotheses were formulated and tested at an alpha level of 0.05.

Ho_1: There is no significant difference between the mean achievement scores of

students taught waves using scaffolding and conventional method.

Ho_2: There is no significant difference in the mean achievement scores of low and high ability levels students taught waves using scaffolding strategy.

$H_{O3:}$ There is no significant difference in the mean retention scores of low and high ability levels students taught waves using scaffolding.

Method

The research adopted quasi-experimental research design involving pre-test, post-test, post post-test design with two experimental groups and one control group. The design is symbolically represented thus;

Experimental (Scaffolding) O_1 X_1 O_2 O_3
Control (Conventional) O_1 X_2 O_2 O_3

Where O_1 represents pre-test observation, O_2 represents post-test observation, O_3 represents post post-test observation, $X_1$and X_2 represent treatments for Scaffolding and Conventional groups respectively.

One research instrument consisting of 30 items labelled as Wave Achievement Test (WAT) was used for data collection. WAT was used for pre-test post-test and post post-test. It was reshuffled (both question numbers and options) and used for post-test and post post-test. Pre-test was administered before treatment; post-test was administered after the treatment while post post-test was used to assess the retention six weeks

The population of the study comprised all the SS 2 students that offer Physics as a subject in all the fifty three (53) public co-educational SS schools located in Abuja. As at 2018/2019 academic session; there were 6,699 SS 2 students in Abuja that offer Physics as a subject.

The sample for the study consists of 514 students from two (2) co-educational SS schools that are distantly located from one another within Federal Capital Territory. The sample was drawn from 53 co-educational SS using stratified random sampling technique. There are six (6) area councils in Abuja. The area councils serve as the strata. One co-educational senior secondary school was selected from each area council (stratum) making a total of six schools. The selected schools were pre-tested and two (2) schools with closely mean pre-test scores were selected as the sample for this study. The two schools used had seven intact science classes; all the seven intact classes were used for the study. The selected schools were randomly assigned to experimental and control groups in a manner that each school has equal and independent chance of been included in the study. This was done by using hat and draw method.

after post-test. The test items were adapted from SSCE past questions. The test instrument was given to two science education lecturers and a secondary school physics teacher for validation. A trial testing of the instrument was conducted on 35 SS2 students. The reliability coefficient of the instruments was established as 0.81 using the Kuder-Richardson (KR-20). The data used for the study was collected with the aid of research assistants. Data collected were analyzed using

descriptive statistics of mean and standard deviation to answer the research questions. The research hypotheses were tested using inferential statistics of Analysis of Covariance (ANCOVA) at significance level of 0.05.

Data Analysis and Results

Research Question 1: What are the mean achievement scores of students taught waves using scaffolding and those taught using conventional method?

Table 2: Mean and Standard Deviation of Achievement Scores of Students taught Waves using Scaffolding and Conventional Method

Groups	Pre-Test			Post-Test			Mean Gain score
	N	Mean	SD	N	Mean	SD	
Conventional	415	17.95	11.32	404	37.84	12.90	19.89
Scaffolding	99	17.76	11.81	97	58.46	13.70	40.70

Table 2 shows that the mean and standard deviation of both pre-test and post-test of students taught waves using conventional method are 17.95 and 11.32 for pre-test, and 37.84 and 12.90 for post-test respectively while the mean and standard deviation of the students taught waves using scaffolding are 17.76 and 11.81 for pre-test, and 58.46 and 13.70 for post-test respectively. The mean gain for students taught using conventional method and scaffolding strategy are 19.89 and 40.70 respectively. The result indicates that students taught waves using scaffolding strategy had higher mean than their counterparts taught the same topic and conventional teaching method. The standard deviation ranges from 11.32 to 13.70, this indicates a wide spread of scores in all the groups that is, the data points are spread out over a wide range of values.

$\mathbf{H_{01}}$: There is no significant difference between the mean achievement scores of students taught waves using scaffolding and conventional method.

Table 3: Analysis of Covariance (ANCOVA) Statistics on the Achievement of Students taught using Scaffolding and Conventional Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	45032.085[a]	2	15010.695	90.384	.000
Intercept	313392.860	1	313392.860	1887.037	.000
Pre-Test	2621.820	1	2621.820	15.787	.000
Group	42778.702	1	21389.351	128.792	.000
Error	98151.337	492	166.077		
Total	1272947.000	496			
Corrected Total	143183.422	495			

Table 3 shows that $F_{(1,492)} = 128.792$, $P = 0.000<0.05$ set for the study. Thus the difference in mean achievement scores of students taught waves using scaffolding and conventional method is statistically significant. The result is an indication that students taught waves using scaffolding improved in their achievement scores more than those taught waves using conventional method. Thus, the null hypothesis of no significant difference is rejected.

Research Question 2: What are the mean achievement scores of low and high ability levels students taught waves using scaffolding strategy?

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Table 4: Mean and Standard Deviation of Achievement Scores of Low and High Ability Levels Students taught Waves using Scaffolding strategy

Groups	**Pre-Test**			**Post-Test**			**Mean Gain score**
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	
Low Ability	87	14.48	8.31	86	58.62	12.99	44.14
High Ability	12	41.50	1.88	11	57.27	19.14	15.77

Table 4 shows that students taught waves using scaffolding with low ability level had a pre-test mean and standard deviation of 14.48 and 8.31 respectively, and a post-test mean score of 58.62

with a standard deviation of 12.99. The high ability level students taught waves using scaffolding had a pre-test mean and standard deviation of 41.50 and 1.88 respectively, and mean achievement score of 57.27 with a standard deviation of 19.14. The mean gain for both low and high ability level students taught waves using scaffolding strategy are 44.14 and 15.77 respectively. The result of the finding shows that low ability students have higher mean than high ability students taught waves using scaffolding. The standard deviation ranges from 1.88 to 19.14, this indicates a low to wide spread of scores in the group.

H_{02}: There is no significant difference in the mean achievement scores of low and high ability levels students taught waves using scaffolding.

Table 5: ANCOVA Statistics on the Achievement of Low and High Ability Levels Students taught Waves using Scaffolding

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	112.162[a]	2	56.081	.294	.746
Intercept	18797.735	1	18797.735	98.693	.000
Pre-Test Scaffolding	94.557	1	94.557	.496	.483
Ability Scaffolding	100.241	1	100.241	.526	.470
Error	17903.962	94	190.468		
Total	349565.000	97			
Corrected Total	18016.124	96			

Table 5 shows that $F_{(1, 94)} = 0.526$, $P = 0.470 > 0.05$ set for the study. Thus the difference in mean achievement scores of students taught wave using scaffolding strategy is not statistically significant. The result of the finding implies that both low and high ability level students improved in their achievement during the study. Therefore, the null hypothesis of no significance difference is retained.

Research Question 3: What are the mean retention scores of low and high ability levels students taught waves using scaffolding?

Table 6: Mean and Standard Deviation of Retention Scores of Low and High Ability Levels Students taught Waves using Scaffolding

Groups	Post Test			Post Post Test		
	N	Mean	SD	N	Mean	SD
Low Ability	86	58.62	12.99	52	54.48	16.57
High Ability	11	57.27	19.14	9	46.89	10.52

Table 6 shows that low ability students taught using scaffolding had a mean and standard deviation of 58.62 and 12.99 for post-test, and 54.48 and 16.57 for post post-test respectively. The high ability level students taught waves using scaffolding strategy had a post-test mean score of 57.27 with a standard deviation of 19.14 and post post-test mean score of 48.89 with a standard deviation of 10.52. The result of the finding shows that low ability students had higher post post-test mean scores than the high ability students taught waves using scaffolding. The standard deviation ranges from 10.52 to 19.14 which represent the deviation of the data from the mean, the value indicates that the data points are spread out over wide range of values

Ho_3: There is no significant difference in the mean retention scores of low and high ability levels students taught waves using scaffolding.

Table 7: ANCOVA Statistics on the Retention Scores of Low and High Ability Levels Students taught Waves using Scaffolding

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4040.602[a]	2	2020.301	10.877	.000
Intercept	1798.300	1	1798.300	9.682	.003
Post Test Scaff	3859.858	1	3859.858	20.781	.000
Ability Scaff	13.090	1	13.090	.070	.792
Error	10586.998	57	185.737		
Total	188294.000	60			
Corrected Total	14627.600	59			

Table 7 shows that $F_{(1,\ 57)} = 0.070$, $P = 0.792 > 0.05$ set for the study. Thus the difference in mean retention scores of students taught wave using scaffolding strategy is not statistically significant. It implies that both low and high ability level students retained the concepts during the study. Therefore, the null hypothesis of no significance difference is retained

Discussion of Findings

The findings of the study are discussed based on the variables of the study in line with the research questions asked and hypotheses formulated for the study;

The finding of this study revealed that teaching strategy had effects on students' achievement in Waves. The test of hypothesis showed that there is a significant difference in the mean achievement scores of students taught waves using scaffolding and conventional method. This shows that students taught waves using Scaffolding had higher mean achievement scores than those taught waves using the conventional method. This finding of the study is consistent with that of Olubunmi and Ese (2018); Lin and Singh (2015); Koes, Kusairil and Muhardjito (2015) which showed that scaffolding strategy improved students' achievement in Physics while Numgwo, Emmanuel, Owodunni and Uduafemhe (2018) ascertained that collaborative instructional approach is more effective than scaffolding strategy. This result is an indication that the use of innovative teaching strategies such as and scaffolding aids students' learning and improves their achievement.

Students with both high and low ability levels improved in their achievement when they were taught waves using scaffolding strategy. This implies that no significant difference exist in the mean achievement scores of low ability level students and high ability level students taught waves using scaffolding strategy. This is in line with the study of Koes, Kusairil and Muhardjito (2015) who found no significant difference in the Physics achievement of students in their different ability levels after treatment with scaffolding instructional strategy. However, Adeniran (2013) found-out that low scoring level students had the highest mean gain score in an optics performance test. This result therefore shows that both high and low ability levels students can achieve higher in their Physics test when exposed to innovative teaching strategies such as scaffolding strategy.

Both low and high ability level students taught waves using both scaffolding strategy retained the concepts during the study. Thus the difference in mean retention scores of low and high ability level students taught wave using scaffolding strategy is not statistically significant. None of the studies reviewed address students' retention in waves and other related concepts in physics based on ability levels when taught using scaffolding strategy.

Conclusion

Based on the findings of the study, the following conclusions were drawn from testing the hypotheses:

Scaffolding strategy was found to be better than the conventional method in teaching and learning of waves. Physics students taught waves using scaffolding strategy achieved better than their counterparts taught the same topic using conventional method.

Both high ability level students and low ability level students improved in their achievement when taught waves using scaffolding strategy.

Both high ability level students and low ability level students retained wave concepts when taught waves using scaffolding strategy.

Recommendations

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

1. Physics teachers should adopt the use of both scaffolding strategy in teaching waves thereby improving achievement in Physics.
2. Scaffolding strategy should be included in the pre-service teacher training programs of would be Physics teachers especially in colleges of education and in the universities (Faculties of Education).

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