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Impact of Constructive Simulation Based Teaching Strategy on Academic Performance In Light Wave Concept in Physics

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Abstract. *The performance of senior secondary school students in physics has been very poor over the years in Nigeria. Teachers' make use of inappropriate instructional approach and students varied knowledge has been identified responsible for this problem. This study examined the impact of constructive simulation based teaching strategy on academic performance in light wave concept in physics among senior secondary school students in Katsina Educational Zone of Katsina State, Nigeria. A pretest/posttest quasi-experimental research design was adopted for the study. A population of 3,414 SS II students was used for the study. Simple random sampling technique was used to select two classes comprises of 57 males and 43 females as sample size of the study. Two research objectives,*

research questions and hypotheses were formulated to guide the study. One instrument Light Wave Concept Academic Performance Test (LWCAPT) was faced validated by experts in the field; the reliability coefficients for the instruments were found to be 0.82 via test retest. Mean and standard deviation were used to answer the research questions, while the Analysis of Covariance (ANCOVA) was used to test the hypotheses at coefficient alpha level of 0.05. The results revealed that students taught light wave concepts in physics using constructive simulation strategy have higher academic performance than those taught using conventional method. It also shows that there is no significant difference of performance scores between male and female students when taught light wave concepts in physics using constructive simulation strategy. Based on the findings, it was recommended among others that physics teachers should be encouraged to use constructive simulation strategy in teaching Physics concepts in physics in senior secondary schools because it improves students' academic performance and is gender friendly.

Key words: ***Constructive simulation, Performance, Teaching and*** **Light Wave.**

INTRODUCTION

Secondary education in Nigeria follows a two-way structure outlined in the National Policy on Education. The initial three years fall within the nine-year junior secondary education phase referred to as the Basic level, with the subsequent three years constituting senior secondary education (Federal Republic of Nigeria, 2013). Bichi, Hafiz and Abdullahi (2017) emphasize the significance of effective teaching in the secondary school level in Nigeria, highlighting subjects such as Chemistry, Biology, Mathematics, English language and Physics offered during this phase.

Physics was formerly called natural philosophy; it is concerned with those aspects of nature which can be understood in a fundamental way in terms of elementary principles and laws. In the course of time, various specialized science broke away from physics to form autonomous fields of investigation. In this process, therefore, physics retained its original aim of understanding the structure of natural world and explaining natural phenomenon. In other words, physics can be described as a physical science that deals with the behaviour of matter in relation to energy. Also it can be said to be science of measurement (Farinde, Ehimetalor & Dada, 2015).

Ersin and Aslan (2010) observed that many students do not immediately see the use or applicability of Physics to their lives and to the world of work around them; so they wonder why they should be

serious with the study of the subject. To these young minds, Physics still remains a mystery that has no place in reality. Sabitu, Ayodeji and Olarewaju (2022) opined that learning science was imperative in every society if the citizens cope with the fast-changing development in science and technology using different approach of making impactful and learning strategy.

Exploring alternative yet practical options could involve considering instructional strategies rooted in constructivism. Constructivism, a facet of scientific thought which mean the creation of knowledge through the synthesis of new fact via the interaction between past experiences and current reality within a learning environment (Akinsete, 2006).

Vaishali and Pradeep (2019) argue that constructive-oriented methods foster teachers' commitment and students' active participation in teaching-learning process. Also, it has been argued that students can learn effectively through the use of constructive oriented methods. Nayak and Senapaty (2011) observed that constructivist approaches are significantly able to improve learners' academic performance and self-concept and also help the learners to get opportunities to develop their intellectual, social, and psychological aspects. As one of the prominent educational philosophy, constructivism greatly influences modern learning and teaching processes (Qureshi, Khaskheli, Qureshi, Raza, & Yousuf, 2021). The sources of constructivism educational theory can be traced back to the works of Dewey (1929), Bruner (1961), Vygotsky (1962), and Piaget (1980). Two essential components of constructivism learning theory are the definition of learning and the approach to learning (Li, 2022).

Constructive simulation approach relied on some guided discoveries where the teacher avoids direct instruction and attempts to guide the students through questions and activities so as to discover, discuss, appreciate and verbalize the new knowledge (Okekeokosisi, 2012). It implies that constructive simulation teaching strategy is dependent on learning as an active exchange of ideas between student and teacher. According to Okeke, (2015) a constructive simulation classroom environment gives rom for students to express, collaborate and exchange ideas with their peers which will in turn, aid their perception about the content they are learning.

Okeke, (2015) sees gender as a challenge in performance among male and female students in science activities. Nevertheless, some factors have been identified to account for students' poor academic performance in Physics concepts such as gender and poor method of teaching.

Statement of the Problem

Science is a systematic enterprise that involves the methodical gathering of knowledge about the world. This process includes the organization and assimilation of information into testable laws and theories, allowing for a deeper understanding of the natural phenomena that shape our understanding of the universe (Honrby, 2010). Physics stands as a vital discipline, demanding a thorough grasp of intricate concepts, adapt critical thinking skills, and the ability to apply knowledge in practical contexts. Conventional lecture-oriented classroom settings may fall short in fully engaging students, potentially leading to reduced retention of physics principles. Hence, alternative teaching method, such as constructive simulation strategy, has emerged as potential methods to promote active student involvement and deeper understanding of physics concepts.

Objectives of the Study

The objective of this study is to find out the impact of constructive simulation based teaching strategy on academic performance in light wave concept in physics. Specifically, the objectives of

this study are to:

1. Determine the Effect of Constructive Simulation Strategy on the academic performance of students in light wave concept of physics among Senior Secondary Schools in Katsina State, Nigeria.
2. Determine the Effect of Constructive Simulation Strategy on male and female students' academic performance exposed to light wave concept in physics among Senior Secondary Schools in Katsina State, Nigeria.

Research Questions

The following research questions were posed to guide the study:

1. What is the difference in the mean Academic performance scores of students taught light wave concept using Constructive Simulation Based Teaching Strategy and those taught the same concept using conventional method?
2. What is the difference in the mean Academic performance scores of male and female students' when taught light wave concept with Constructive Simulation Based Teaching Strategy?

Research Hypotheses

The following null hypotheses were formulated and tested at $p < 0.05$ level of significance.

$H0_1$: There is no significant difference between the mean academic performance scores of students taught light wave concepts using constructive simulation based teaching strategy and those taught the same concepts using conventional method.

$H0_2$: There is no significant difference in mean Academic performance scores of male and female students taught light wave with constructive simulation based teaching strategy.

Methodology

Research Design

The design for this study is quasi-experimental design. Specifically pretest and posttest non-equivalence control group design. The design is considered suitable for this study because intact classes were used to avoid disruption of students' natural classroom settings. Pretest (0_1) was administered to both experimental group (EG) and control group (CG) to ensure group equivalence. Thereafter, these groups were exposed to treatment for six (6) weeks; posttest (0_2) was administered at the end to determine students' academic performance before and after treatment to determine students' perception in light wave concepts.

The research design is illustrated below:

$$\begin{array}{cccccccc} EG & \rightarrow & O_1 & \rightarrow & X_1 & \rightarrow & O_2 \\ CG & \rightarrow & O_1 & \rightarrow & X_0 & \rightarrow & O_2 \end{array}$$

Where:

EG = Experimental Group (constructive simulation based teaching strategy)

CG= Control group

X_1 = Treatment (teaching using constructive simulation based teaching strategy)

X_0 = Treatment (teaching using conventional teaching method)

O_1 = Pretest for both groups

O_2 = Posttest for both groups

Area of the Study: This study covered Katsina Educational Zone of Katsina state.

Population of the Study: The population for this study comprised all the secondary school students in Educational zone of Katsina state. The target population of the study consists of all SSII students in Public Secondary Schools in Katsina educational zones numbering 19,572 (Katsina state Ministry of Education 2023).

Participants

The total number of Secondary Schools in Katsina Educational Zone is sixty-eight (68) of which twenty-five (25) are public schools and forty-three (43) are private schools. Simple random sampling technique was used to select two Governments senior secondary schools from Katsina Educational zone for this study. The schools sampled for the study are: Government Day Senior Secondary School Kofar Yandaka and Sir Usman Nagogo College of Islamic and Arabic Studies, Katsina. The experimental group comprised 26 male and 24 female students and the control group comprised 31 male and 19 female students, making a total of 100 students. Intact class of SSII was used in each of the two schools to avoid distortion in their normal school schedules and classroom settings.

Collection Instrument

The instrument for the study was Light Wave Concept Academic Performance Test (LWCAPT), which consisted of 20 multiple-choice objective questions with four options (A – D). It was developed by the researchers drawn from the topics on light wave concept in Physics in the SSII scheme of work for a whole term, which were taught during the study. The LWCAPT was used for both pre-testing, post testing of students' performance.

Validity and Reliability

The Light Wave Concept Academic Performance Test (LWCAPT) was content validated with the use of a Table of Specification (Test Blueprint) in constructing the test items. Having completed the construction of the LWCAPT, it was first content validated by two experts from Department of Science and Technology Education at Umaru Musa Yar'Adua University, Katsina and one Physics teachers at secondary level of education with a minimum of 10 years working experience. The inputs and suggestions of the experts were strictly followed before administering the instruments. The scores obtained from the pilot study were used to determine the reliability coefficient of the LWCAPT. The study employs test-retest method on the scores obtained from the pilot study. After the first test, two weeks' interval was given for the second test which was the retest. The reliability coefficients were found using the Pearson's Product Moment Correlation (PPMC) to be 0.82 for LWCAPT. This confirmed a high reliability of the instrument as the correlation coefficient was close to 1 (Wallen & Fraenkel, 2013).

Administration of the Instrument

Pretest session:

Pretest was conducted before the actual treatment; the sample students were given pre-test. The test was administered by the researcher with the help of physics teacher of the sampled schools. The scripts were then marked by the researcher. The essence of pre-test is to determine the students' entry knowledge in both experimental and control group.

Treatment:

The main focus treatment of this study is teaching of some selected light wave concept to SS II students using constructive simulation strategy. The experimental group was taught using constructive simulation based teaching strategy while control group, on the other hand, was taught using conventional lecture method of instruction.

Posttest Sessions

Posttest administrations of Light Wave Concept Academic Performance Test (LWCAPT) were being conducted to both experimental and control groups in order to determine their performance level. The students' response of the Physics Academic Performance Test was marked using marking scheme. Each correct response was score a point: the score was then being collected and recorded based on each research questions and hypotheses

Method of Data Analysis: The data collected were analyzed using descriptive statistics of mean and standard deviation to answer the research questions while ANCOVA at coefficient alpha level of 0.05 was used to test the hypotheses.

Data Analysis and Results

Research Question One: Is there any difference in the mean academic performance scores of students taught light wave concept using constructive simulation based teaching strategy and those taught the same concept using conventional method?

The descriptive statistics in form of mean and standard deviation was used to answer the above research question one and it is presented in Table 1

Table 1: Mean Performance Scores and Standard Deviation of Physics Students taught using Constructive Simulation Strategy Based Teaching Strategy and Conventional Method.

GROUPS	N	Mean (X)	S.D	M.Df
EXP	50	18.0200	1.91119	
CONT	50	11.3600	2.28357	6.66
Total	100	14.3800	3.94839	

From Table 4.1, the students taught using constructive simulation strategy have mean performance score of 18.02 and standard deviation of 1.91 while those exposed to conventional teaching strategy have mean score of 11.36 and standard deviation of 2.28. The mean difference between the two groups is 6.66 which clearly show that those taught using constructive simulation teaching strategy have high mean performance scores than those taught using conventional teaching method. The standard deviation of experimental group and control group are (1.91) and (2.28) respectively this clearly shows the student response on the test is not close.

Research Question Two: Is there any effect of constructive simulation based strategy on male and female students' academic performance when taught light-wave concept?

Table 2: Post-test Mean Performance Scores and Standard Deviation of Male and Female

Physics Students taught Light-wave Concept using Constructive Simulation Based Teaching Strategy.

GENDER	N	Mean (X)	S.D	M.Df
MALE	26	18.3462	2.20803	
FEMALE	24	17.3333	1.76109	1.02
Total	50	17.8600	2.05049	

Table 2 shows that the mean academic performance score of male 18.35 with standard deviation of 2.21, and the female students' mean score is 17.33 and standard deviation of 1.76. The mean difference between the two genders (Male and Female) is 1.02 and this shows that the mean difference is small across gender and the standard deviation shows that the response of both groups on the test is not closer to each other.

Hypotheses Testing

Hypothesis One (HO_1): There is no significant difference between the mean academic performance scores of students taught light wave concepts using constructive simulation and those taught the same concepts using conventional method.

Table 3: Analysis of covariance (ANCOVA) for pretest & posttest mean performance scores of the experimental and control groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Remark
Model	22690.885[a]	3	7563.628	1.698E3	.000	S
PRE_TEST	2.385	1	2.385	.535	.466	NS
GROUP	2960.636	2	1480.318	332.297	.000	S
Error	432.115	97	4.455			
Total	23123.000	100				

The result presented in Table 3 shows that F-Calculated Value for treatments (GROUP) is 332.297 with a significance of F at .000 which is $P < .05$. This result shows that the calculated value is t (97)= 0.00<0.05. Therefore, the null hypothesis is hereby rejected because the calculated value is less than the significant (α) level. Hence, there is significant difference in the mean performance scores of students taught light wave concepts using constructive simulation based teaching strategy and those taught using conventional teaching method, with experimental group having higher performance ($0.00 < 0.05$).

Research Hypothesis Three (HO_2): There is no significant difference between the mean academic performance of male and female students taught light-wave concept of Physics using constructive simulation based teaching strategy.

Table 4: Analysis of covariance (ANCOVA) of the mean perception scores of male and female

students taught Physics using constructive simulation based teaching strategy.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Remark
Corrected Model	13.689[a]	2	6.844	1.673	.199	NS
Intercept	1259.819	1	1259.819	307.862	.000	S
PRE_EXP	.887	1	.887	.217	.644	NS
GENDER	13.688	1	13.688	3.345	.074	NS
Error	192.331	47	4.092			
Total	16155.000	50				
Corrected Total	206.020	49				

The result presented in Table 4 shows that F-Calculated Value for treatments (GENDER) is 3.345 with a significance of F at .074 which is P > .05. This result shows that the calculated value is t(49)=0.74>0.05. Therefore, the null hypothesis is hereby accepted because the calculated value is greater than the significant (α) level. Hence, there is no significant difference between the mean academic performance scores of male and female students taught light wave concept of Physics using constructive simulation strategy.

Discussion of Findings

It was found in this study that there is significant difference in mean perfromance between senior secondary school students taught light wave concepts in Physics using constructive simulation strategy and those taught using conventional method of teaching, with those taught using constructive simulation strategy having higher performance. This means that the use of constructive simulation strategy in teaching light wave concepts in Physics improves students' academic performance.

These findings are in agreement with the findings of Ersin and Aslan (2010) who reveals that the courses taught with interactive simulations have a positive effect on students' beliefs about Physics and Physics performance, and it has been discovered that the groups who study with constructive simulations are more successful than those who study with traditional methods. Also, it was in line with the finding of Okeke, (2015) who reveals that constructive simulation had significant effect on students' performance and retention in Christian Religious Studies. Also, the performance of low achievers within the experimental group improved after they were instructed with constructive simulation teaching strategy and the constructive simulation group performs better than the conventional approach group. The constructivist approach is believed to enhance the creativity of children, found more effective than traditional approach in promoting interest in science, and developing social skills (Nayak & Senapaty, 2011)

Conclusions

Based on the findings of the study, the following conclusions are drawn:

i. Constructive simulation strategy improves Physics students' academic performance as evident in this research findings shows that students taught using constructive simulation strategy showed higher performance than students taught using conventional method;

ii. Constructive simulation strategy shows that both male and female student's performed better in Physics which means that constructive simulation is gender friendly.

Recommendations

The recommendations from the study are as follows:

1. Teacher should be encouraged to apply the use of constructive simulation teaching strategy in teaching Physics at senior secondary level.
2. Government should also organize seminars, workshops, and conferences on the use of constructive simulation teaching strategy.
3. Curriculum developer should develop curriculum which will include the use of constructive simulation teaching strategy into existing teaching strategy in teaching physics concept.

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