EFFECTS OF WAVE-MODEL INSTRUCTIONAL MATERIALS ON PHYSICS STUDENTS' PERFORMANCE IN COLLEGES OF EDUCATION, PLATEAU STATE, NIGERIA

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Abstract

This study investigated the effects of wave-model instructional materials on Physics students' performance in Colleges of Education, Plateau State, Nigeria. Three research questions and three null hypotheses were respectively raised and formulated for the study. True experimental pre-test, post-test research design was used for the study. The population comprised 170 Nigerian Certificate in Education two (NCE II) students (100 male and 70 female) offering Physics from two colleges of education in the state. The two schools were purposively selected on the basis of government-owned and Nigerian Certificate in Education (NCE) awarding institutions in Physics. One hundred NCE II students (73 male and 27 female) from the two colleges of education were used as sample for the study. The instrument used for data collection was Physics Performance Test (PPT) which was validated by two experts from the University of Jos. The test-retest method was employed to obtain the reliability of PAT and its coefficient was computed as 0.80 using Kuder- Richardson Formula 20. The research questions were answered using the mean and standard deviation, while the hypotheses were tested at 0.05 level of significance using the independent t- test of difference. The findings revealed that students who were taught wave concepts using wave-model instructional materials performed significantly higher than those who were taught without the use of the instructional materials ($p<0.05$). It was also revealed that that there was no significant difference between the performance of male and female students who were exposed to learning using wave-model instructional materials ($p>0.05$). Another finding was that there was no significant deference between the performance of students from state-owned and those from federal-owned Colleges of Education who were exposed to waves using wave-models instructional materials ($p>0.05$). Based on the findings of the study, it was recommendations, amongst others, that curriculum planners should encourage the use of wave-model instructional materials in schools at all levels of education in order to help improve students' performance in wave concepts.

Keywords: Instructional Materials, Physics, Students' Performance, Students' Gender, School Type, Wave-model

Introduction

Physics is of great benefit to society as its benefits are found in spheres of human endeavours such as in telecommunication industries where radio waves are used for communication, transportation sector where

Newton's laws of motion play a part in the flying of airplanes, military where concepts such as projectile motion are utilized, health where concepts of radiation are put to use in gadgets, and entertainment sector which uses sound waves. The art of transferring the knowledge of Physics is therefore very important and this is the role of the qualified Physics teacher who plan lessons. In planning a lesson, after identifying the lesson topic, a major area is the identification or selection of instructional materials to be used in the teaching. The effective use of these instructional materials increases students' understanding of concepts in Physics. Isma'il and Lukman (2022) defined instructional materials as tools that a teacher may utilize during lesson delivery in other to enhance learning outcome. Aina (2013) posited that instructional materials are audio, visual and audio-visual materials which supplement teacher's explanation of concepts making the lesson real to the students. The wave-model instructional materials are designed to help students to visualize wave phenomena such as polarization, amplitude and wavelength. They also facilitate students' understanding of the basic wave phenomena.

This research was anchored on cone of experience theory propounded by Edgar Dale in 1969. The theory asserts that the least method of learning involves those from information presented through verbal symbols (listening to spoken words), while the most effective is direct purposeful learning experience (reality or closest thing to real, everyday life). It is depicted by a cone; at the top of the cone, learners remember only 10% and 20% of what they read and hear respectively. Learners are only able to define, list, describe and explain concepts. As learners progress down the cone, the greater the learning and the more information they retain. They are able to remember 70% of what they learn because they engage in hands-on and collaborative activities; they are able to remember 90% of learnt concepts because they simulate or model a real experience and design or perform a presentation. The learning outcome at the bottom of the cone is that learners are able to analyse, design, create and evaluate their learning.

Wave-model instructional materials are suitable for learning wave concepts in Physics as they are associated with Dale's cone of experience theory; when students learn wave concepts using the wave-model instructional materials, they could retain 90% of what they learn because they interact with the materials, collaborate with other students in the classroom as they learn, simulate and model real experiences. Consequently, the students' performance in wave concepts is enhanced. In Nigeria, College of Education (COE) is among tertiary institutions that are saddled with the responsibility of awarding the Nigerian Certificate in Education (NCE), which is the minimum teaching qualification. Physics is taught as a single major course in COEs, which implies that students offering Physics as a course combine it with other courses such as Biology, Chemistry and Mathematics. Students' performance in Physics, irrespective of course combination, is important because of the relevance of Physics to national development. Despite its relevance, students perceive some physics concepts such as waves as difficult. Achor (2012) concurs that wave concepts are

difficult, but can be taught using innovative methods for students' easy understanding,

Students' performance in Physics is an outcome of testing and/or evaluation; and it is in the place of testing and evaluation that teachers weigh their students' performance. In COEs, students' performance depends on many factors which includes teacher-factors, student-factors and environmental factors. One of the teacher-factors which could influence the students' learning and performance is the teacher's choice and use of instructional materials during lesson delivery. Otor, Ogbeba and Ityo (2015) found that teachers' use of instructional materials enhances students' learning and that the students taught using instructional materials performed significantly higher than those taught without using instructional materials. Effiong and Igiri's (2015) study revealed that the use of instructional materials by teachers in the classroom impacts students' learning in Biology. In an earlier study on instructional materials, Aina (2013) revealed that Physics teachers do not use instructional materials when teaching lessons.

Further researches of Olayinka (2016), Edoho, Ebuara, Agbudu and Inah (2020) found out that students who were taught Social Studies and Mathematics, respectively, using instructional materials performed significantly higher than their counterparts who were taught without instructional materials. In the area of Agriculture, Asogwa, Isiwu, and Ugwuoke (2021) found out that students who were taught Fisheries using instructional materials had a higher mean performance score than that of their counterparts who were taught without instructional materials. Another finding of theirs was that the students who were taught Fisheries using instructional materials performed significantly higher than those who were taught without instructional materials. In Social Sciences, Olayinka (2016) had found out that students, regardless of gender, who were taught Social Studies using instructional materials performed higher than students who were taught without instructional materials.

Gender issues are contemporary and topical and may influence students' performance in Physics. Otor, Ogbeba and Ityo's (2015) finding indicates that both male and female students perform significantly higher in Chemistry when taught using instructional materials. Another gender study by Aina and Akintunde (2013), however, shows that male students perform higher than the female students in Physics. Other studies, such as those of Okoronka and Wada (2014) in Physics and Olayinka (2016) in Social Studies, found no significant difference between the performance of male and female students. Another moderating variable which may influence students' performance in Physics is school type. In this study, school type is delineated into Federal-owned and State-owned Colleges of Education. Research outcomes show inconsistency on the superiority of the school type in terms of students' performance. Lubienski and Lubienski (2014) posited that students' performance does not depend on school type, demographic factors being constant. However, in the study conducted by Soliu, Badmus, Akanbi and Omosewo (2017), a significant difference in students' performance in Physics was found to exist with students from private schools performing

better than their counterparts in public schools.

Based on the afore-mentioned inconsistency in the findings of studies on gender and school type, this study, therefore, focused on effects of wave-model instructional materials on Physics students' performance in Colleges of Education, Plateau State, Nigeria. Moreover, most literature, have categorized school type into both public and private schools or mixed (co-educational) and single-sex schools.

Statement of the Problem

Students in tertiary institutions have been perceiving the concept of waves as difficult. This problem emanated from secondary school students' perception of wave concepts as being difficult. In their study, Obafemi and Onwioduokit (2013) found out that students identified wave concepts as difficult. Furthermore, various Chief Examiner's Reports between 2009 and 2020 (West African Examinations Council, WAEC, 2018) submitted that students at the secondary school level of education in Nigeria have not been performing high in wave concepts such as polarization, interference, total internal reflection, transverse and longitudinal waves. Without any form of remediation, such students get admitted to study Physics as a course in higher institutions of learning such as Colleges of Education.

If the above-mentioned problem persists. Thus, graduates of Physics who find themselves in the class may be unable to teach the concept effectively. Such graduates and those of Physics-related courses may also not be able to work efficiently in electric energy transmission industries, telecommunication industries, manufacturing and microelectronic industries and in fields such as medicine and architecture. This situation may have negative effects on the economic, health, technological and industrial development of the nation.

Physics teachers in higher institutions of learning rarely use instructional materials when teaching Physics concepts. This could be a basis for the perception of wave concept as difficult by the students. In recent time, Yusuf, Akanbi, Mohammed and Mustapha (2023) attested to students in higher institutions of learning perceiving wave concepts as one of the difficult Physics concepts. This study, therefore, sought to provide answers to this broad question: Will the use of wave-model instructional materials positively affect Physics students' performance in wave concepts in Colleges of Education, Plateau state, Nigeria? Colleges of Education are teacher-training institutions of higher learning.

Purpose of the Study

The specific objectives of the study were to:

1. determine the performance of Physics students in the concept of waves in Colleges of Education before and after treatment;
2. find out the performance of male and female Physics students in the concept of waves in Colleges of Education before and after exposure to treatment; and
3. ascertain the performance of Physics students in the concept of waves in Colleges of Education, based on school type, before and after exposure to treatment.

Research Questions

The following research questions guided the study:

1. What is the mean performance score of NCE II Physics studentswho were exposed to Wave-model Instructional Materials (WIM) and those who were not?
2. To what extent does the mean performance score of NCE II male Physics students who are exposed to WIM differ from that of their female counterparts?
3. What is the extent to which the mean performance score of NCE II Physics students in Federal-owned Colleges of Education taught wave concepts using WIM differ from that of their counterparts in State-owned Colleges of Education?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

1. There is no significant difference between the mean performance scores of NCE II Physics students who were exposed to WIM and those who were not.
2. There is no significant difference between the mean performance scores of NCE II male and female Physics students who were exposed to wave concepts using WIM.
3. There is no significant difference between the mean performance scores of NCE II Physics students who were taught wave concepts using WIM in Federal-owned Colleges of Education and State-owned Colleges of Education.

Methodology

True experimental pre-test post-test research design was used for the study. The population for the study comprised 170 Nigerian Certificate in Education two (NCE II) students (100 male and 70 female) offering Physics from two Colleges of Education in the state. The two schools were purposively selected on the basis of government-owned and Nigerian Certificate in Education (NCE) awarding institutions in Physics. One hundred 100 NCE II students (73 male and 27 female) from two Colleges of Education were available for the study. They were from Federal College of Education, Pankshin (50 students) and College of Education, Gindiri (50 students). The criterion used for the selection of the school population was that a school must be either a Federal-government or State-government designated College of Education (Federal-owned Colleges of Education or State-owned Colleges of Education) and must be a Nigerian Certificate in Education (NCE) awarding institution offering Physics. Fifty students from each of the two institutions were randomly selected for the study, using the simple random sampling technique of the ‘bowl containing water and live fishes’ type. These students were then randomly selected into the two groups of experimental and control in each of the two institutions.

Physics Performance Test (PPT) which was developed by the researchers and validated by three experts from the University of Jos, Nigeria, was used for data collection. The PPT, which is a 50-item multiple-choice test, had two sections (A and B). Section A is student’s bio-data eliciting students’ information on student’s number, gender,

school code and school type. Section B consists of 50 multiple-choice questions on the concept of waves. Each question has four options lettered A-D, with only one correct option. The reliability coefficient of PPT was calculated as 0.80, using Kuder-Richardson formula 20 (K-R 20), on the Statistical Package for Social Sciences (SPSS) Version 25. The K-R 20 was employed because it measures internal consistency of test instruments and is applicable to tests that are scored dichotomously (one point for each correct option and zero point for each wrong option).

The PPT was administered by the researchers the week prior to commencement of treatment in order to elicit students' entry performance. Treatment was thereafter administered to the experimental group for four weeks. The experimental group in each of the two institutions was exposed to treatment by research assistants employed by the researchers using the wave-model instructional materials while the control group was merely taught without the use of the wave-model instructional materials by research assistants employed by the the researchers. The PPT was then administered to both groups the week after the treatment ended. The research questions were answered using mean and standard deviation while the hypotheses were answered using the independent t-test of difference at 0.05 level of significance. The t-test was used because the test for equivalence, after the pre-test, showed there was no significant difference between the entry behaviour of the two groups. All analyses were carried out using the Statistical Package for Social Sciences (SPSS) Version 25.

Results

Research Question One

What is the mean performance score of NCE II Physics studentswho were exposed to Wave-model Instructional Materials (WIM) and those who were not?

Table 1: Mean Performance Scores of NCE II Physics Students in Wave Concepts with and without WIM

Group	N	Mean	Standard Deviation
Experimental	50	6.72	2.13
Control	50	6.46	2.77

Table 1 shows that students in the experimental group had higher performance mean score (6.72) than that of those in the control group (6.46) before exposure to waves using wave-model instructional materials. This implies that the wave-model instructional materials could have accounted for the higher mean score of students who were taught wave concepts using wave-model instructional materials.

Research Question Two

To what extent does the mean performance score of NCE II male Physics students who are exposed to WIM differ from that of their female counterparts?

Table 2: Mean Performance Scores of NCE II Male and Female Students in Wave Concepts after Exposure to Wave-model Instructional Materials

Gender	N	Mean	Standard Deviation
Male	39	10.05	2.45
Female	11	9.82	2.27

Table 2 shows that the male students who were exposed to waves using waves-model instructional materials had a higher mean performance score of 10.05 than their female counterparts whose mean was 9.82.

Research Question Three

What is the extent to which the mean performance score of NCE II Physics students in Federal-owned Colleges of Education taught wave concepts using WIM differ from that of their counterparts in State-owned Colleges of Education?

Table 3: Mean Performance Scores of NCE II Students in Wave Concepts, Based on School Type, After Exposure to Wave-model Instructional Materials

School Type	N	Mean	Standard Deviation
State-Owned COE	50	9.56	2.08
Federal-owned COE	50	10.44	2.63

Table 3 shows that the state-owned College of Education had a lower mean performance score of 9.56 compared to 10.44 for the Federal-owned College of Education. The results indicate no much difference between the mean performance scores of students in the Federal-owned and State-Owned Colleges of Education before exposure to waves using waves-model instructional materials. This difference could be attributed to factors other than the use of waves-model instructional materials, since all the groups were exposed to same treatment.

Hypothesis One

There is no significant difference between the mean performance scores of NCE II Physics students who were exposed to WIM and those who were not.

Table 4: Summary of Post-Test Independent t-test Results of Difference between Performance Mean Scores of NCE II Students in the Experimental and Control Groups

Group	N	Mean	Std. Dev.	t-cal.	Df.	p-value	Decision
Experimental	50	9.92	2.42				
				5.705	98	0.000	H_O Sig.
Control	50	7.10	2.53				

$p<0.05$

Table 4 shows that the hypothesis was statistically significant at 0.05 level and so the null hypothesis was rejected. Students who were taught wave concepts using wave-model instructional materials performed significantly higher than those who were taught without the use of the instructional materials. The implication is that the use of instructional materials in teaching waves concepts in the experimental group could have improved their performance in the concepts.

Hypothesis Two

There is no significant difference between the mean performance scores of NCE II male and female Physics students who were exposed to wave concepts using WIM.

Table 5: Independent t-test Results of Performance Mean Scores of NCE II Male and Female Students Exposed to Wave using Wave-Model Instructional Materials

Group	Gender	Mean	Std. Dev.	t-cal.	Df.	p-value	Decision
	Male	10.05	2.45				
Experimental				0.283	48	0.778	H_O Not Sig
	Female	9.82	2.27				

$p>0.05$

From Table 5, the study failed to reject the null hypothesis, since $p>0.05$; hence, inference was made that there was no significant difference between the mean performance score of male and female students exposed to the wave-model instructional materials. This implies that when students are taught waves concepts using wave-model instructional materials, their gender has no significant effect on their performance.

Hypothesis Three

There is no significant difference between the mean performance scores of NCE II Physics students who were taught wave concepts using WIM in Federal-owned Colleges of Education and State-owned Colleges of Education.

Table 6: Independent t-test Results of Performance Mean Scores of NCE II Students in Waves After Exposure to Treatment Based on School Type

School Type	Mean	Std. Dev.	t-cal.	Df.	p-value	Decision
State-owned	9.56	2.08				
			-1.311	98	.196	H_O Not Sig.
Federal Owned	10.44	2.63				

p>0.05

From Table 6, the study failed to reject the null hypothesis (*p*>0.05); hence, it implies that there was no significant deference between the mean performance score of NCE II students from State-owned and those from Federal-owned College of Education who were exposed to waves using wave-models instructional materials.

Discussion of Findings

The result revealed that the experimental group had a higher mean value of 6.720 while those in the control group had 6.460. It was further revealed that the difference was statistically significant at 0.05 level. The fact that students who were exposed to waves using wave-model instructional materials had a significant higher mean performance score than those exposed to waves without using wave-model instructional materials conforms with the findings of Omebe and Akani (2015), Awolaju (2016) and Olayinka (2016) that students who were taughtusing instructional materials performed significantly higher than their counterparts who were taught without instructional materials. The similarity in the findings may be adduced to the use of instructional materials when teaching the students.

Findings further revealed that male students performed slightly higher with a mean score of 10.051 as against 9.818 for their female counterparts. However, findings showed no significant difference between the mean performance scores of the students based on their gender. This finding is in agreement with that of Josiah (2012) who also found no significant difference in the mean scores of male and female students taught physics.

The result showed that even though students from the Federal Government-owned College of Education who were exposed to wave concepts using wave-model instructional materials had higher mean performance score of 10.440 as against 9.560 of their counterparts from the State-owned College of Education, the difference between their mean performance scores was not significant. This finding is in consonance with Josiah's (2019) finding that school type has no significant effect on students' performance. A possible reason for the similarity in the findings is that instructional materials enhance students' performance when used in the teaching-learning process.

Conclusion

This study ascertained the effects of wave-model instructional materials on

Physics students' performance in Colleges of Education, Plateau State, Nigeria. Results from the study revealed that the use of wave-model instructional materials enhances the performance of pre-service teachers in wave concepts in Federal Government-owned and State-owned schools, in addition to being gender-friendly.

Recommendations

Based on the findings from this study, the following recommendations were made:

1. Curriculum planners should encourage the use of wave-model instructional materials in schools at all levels of education in order to help improve students' performance in wave concepts.
2. Physics teachers in in higher institutions of learning should be encouraged to emphasize the use of wave-model instructional materials in teaching wave concepts, since it has been found to improve students' performance irrespective of gender and school type.

References

Achor, E.E. (2012). Teaching waves and radioactivity in physics using innovative approaches. In R. M. O. Samba & J. O. Eriba (Eds.), *Innovative approaches in teaching difficult science concepts (128-148)*. Makurdi: Destiny Ventures.

Aina, J.K. (2013). Instructional materials and improvisation in Physics class: Implications for teaching and learning. *IOSR Journal of Research & Method in Education*, 38-42.

Aina, J.K., & Akintunde, Z. T. (2013). Analysis of gender performance in Physics in Colleges of Education. Nigeria. *Journal of Education and Practice, 4*(6), 1-5.

Asogwa, V.C., Isiwu, E.C., & Ugwuoke, C.U. (2021). Effect of instructional materials on students' academic achievement in fishery in senior secondary schools. *Global Journal of Educational Research, 20*,153-161.

Awolaju, B.A. (2016). Instructional materials as correlates of students' academic performance in Biology in senior secondary schools in Osun State. *International Journal of Information and Education Technology, 6*(9), 30-45.

Edoho, E.A., Ebuara, V.O., Agbudu, P.A., & Inah, J.O. (2020). Effect of instructional materials on students' academic performance in Mathematics in Calabar Municipality local government area of Cross River state, Nigeria. *European Journal of Social Sciences, 60*(4), 313-318.

Effiong, O. E., & Igiri, C. E. (2015). Impact of instructional materials in teaching and learning of Biology in senior secondary schools in Yakurr lga. *International Letters of Social and Humanistic Sciences, 62*, 27-33. Doi:10.18052/www.scipress.com/ILSHS.62.27

Isma'il, A., & Lukman, O. M. (2022). Availability and utilization of instructional materials in teaching and learning of biology in senior secondary schools. *Aquademia, 6*(2), 1-8.

Josiah, M.M (2012). School location versus academic achievement in physics: Does computer-assisted instruction (CIA) has any effect? *Journal of*

Educational and Social Research, 2(8), 78-83.

Josiah, M. M. (2019). Jigsaw cooperative learning in Physics: Its impact on secondary school students' achievement in Bukuru metropolis, Nigeria. *Global Journal of Academic Research Forum, 7*(1), 40-50.

Lubienski, C. A., & Lubienski, S. T. (2014). *The public school advantage: Why public schools outperform private schools.* Chicago, IL: University of Chicago Press.

Obafemi, D. T. A., & Onwioduokit, F. A. (2013). Identification of difficult concepts in senior secondary school two (SS2) physics curriculum in Rivers state, Nigeria. *Asian Journal of Education and e-Learning, 1*(5), 317-322. Retrieved from www.ajouronline.com

Okoronka, U. A., & Wada, B. Z. (2014). Effects of analogy instructional strategy, cognitive style and gender on senior secondary school students' achievement in some Physics concepts in Mubi metropolis, Nigeria. *American Journal of Educational Research, 2*(9), 788-792.

Otor, E. E., Ogbeba, J., & Ityo, C. N. (2015). Influence of improvised teaching instructional materials on Chemistry students' performance in senior secondary schools in Vandeikya local government area of Benue state, Nigeria. *International Research in Education, 3*(1), 111-118. Doi:10.5296/ire.v3i1.7181

Olayinka, A. B. (2016). Effects of instructional materials on secondary school students' academic achievement in Social Studies in Ekiti state, Nigeria. *World Journal of Education, 6*(1), 32-39. Doi:10.5430/wje.v6n1p32

Omebe, C. A., & Akami, O. (2015). Effects of instructional resources on students' achievement in physics and chemistry in secondary schools in Ebonyi state, Nigeria. *European Journal of Training and Development Studies*, 2(2), 56-65.

Soliu, I. P., Badmus, O. T., Akanbi, A. O., & Omosewo, E. O. (2017). Influence of school location and school type on senior school students' achievement in physics in Ilorin, Kwara state. *Journal of Curriculum and Instruction, 10*(1), 1-19.

Yusuf, A. A., Akanbi, A. O., Mohammed, R. E., & Mustapha, S. I. (2023). Identification of difficult concept in Physics syllabus as perceived by pre-service teachers in higher institutions in Kwara state. *Journal of Curriculum and Instruction, 14*(1), 161-172.

West African Examinations Council [WAEC] (2018). *WAEC's e-learning tool kit*. Retrieved on 2nd April 2024 from www.waeconline.org.ng.