

The Effect of Demonstration, Guided-Discovery and Expository Instructional Methods on Senior Secondary Students Achievement in Physics in Ikot Abasi Local Government, Nigeria

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ABSTRACT

This study examines the effect of demonstration, guided-discovery and expository instructional methods on senior secondary students achievement in Physics in Ikot Abasi Local Government of Akwa Ibom State, Nigeria. Three hypotheses guide the study. It adopts quasi-experimental using pretest and posttest non-randomized groups design. The population comprised all the Senior Secondary two physics students of the 2021/2022 session in the public secondary schools in Ikot Abasi Local Government Area. A total of 172 students (60 in the first, 58 in the second and 54 in the third experimental groups) constitute the sample selected from 12838 students (male 5614, and female 7224). Physics Achievement Test on Waves (PATW) with a reliability index of 0.87 is used for data collection. Three different teaching packages are prepared and used in the teaching of Waves. The instrument is validated by experts consisting of Physics lecturers from Akwa Ibom State University, Research, Measurement, and Evaluation lecturers from the University of Nigeria, Nsukka, and Physics teachers within the selected schools for the study. The data are analyzed using descriptive statistics, while research hypotheses are tested at a 0.05 level of significance using Analysis of Covariance (ANCOVA). There is a significant difference among the mean achievement scores of Physics students when taught waves using Demonstration, Guided-discovery, and Expository instructional methods. Male students significantly achieved more than their female counterparts. Based on the findings, it recommends guided discovery in teaching waves followed by demonstration and expository instructional techniques to Physics students.

Keywords: *Physics, Demonstration, Guided-discovery and Expository instructional methods, students' achievement*

INTRODUCTION

Physics as a branch of science has a great impact on which nations depend to advance technologically. Omiwale (2011) described Physics as a branch of science that deals with the measurement and the fundamental constituents of the universe, the forces they exert on one another, and the relationship between matter and energy. Physics is one of the important

branches of science which enables learners to understand what happens around them, helping them to solve simple problems they encounter in daily life. Physics is a science subject that involves both theoretical and practical experiences. Physics provides students with analytical problem-solving tools, which are important to many sciences. Mkpanang and Inyang (2019) define Physics as a natural science that involves the study of physical properties of matter, its measurement, and motion through space and time with related concepts as waves and energy, to help students understand how the universe behaves and the laws applied to it. Physics as a branch of science and the pre-requisite subject for Science and Engineering prepares students to synthesize, analyze data, and present findings in an understandable format. This implies that Physics requires effective and efficient teaching for meaningful learning.

The study of Physics equips students with concepts, principles, and theories necessary for controlling and preserving the environment. The knowledge of Physics is essential in understanding modern technology and the myriads of scientific developments (Damar, Hulda & Jonah, 2016). Physics generates fundamental knowledge needed for future technological advances that will continue to drive and contribute to the infrastructures and the skills to take advantage of scientific advances and discoveries. Through the application of Physics principles, transportation has been made more luxurious through the production of motorcycles, cars, trains, airplanes, and ships. Job opportunities are available for people with knowledge of Physics in the ministry of science and technology, oil companies, and refineries. Construction and engineering industries require a high level of Physics knowledge (Omotayo, 2009 and Adedayo, 2010). As laudable as the objectives of physics are, achieving them seems difficult over time. Iji, Ogbole and Uka (2016) pointed out that the achievement of students in some physics concepts is poor; this fact calls for attention. Some factors for undesirable students' achievement and low enrolment in senior secondary school physics are poor supply of instructional materials, the inadequacy of Physics teachers, and the teaching method used.

The teaching of Physics in senior secondary schools has not been encouraging due to the abstract nature of the subject, and there is a need for instructional methods to facilitate students' learning (Ayaji, 2008). The performance of candidates in the Physics examination conducted by the West Africa Examinations Council (WAEC) has been experiencing a decline as shown in the summary of WAEC results for 2011 – 2016. The poor achievement of Physics students may be attributed to the methods adopted by teachers (Onwioduokit, 2013; Utibe & Agah, 2016). Since waves involve a lot of applications to real-life situations and proofs, different methods are suggested for their teaching. They include demonstration, guided discovery, and expository instructional methods.

The demonstration instructional method as described by Ikitde and Edet (2013), involved the teacher or students doing activities in front of the class and explaining as the activity progresses. The instructional method covers all the necessary steps in effective teaching. It allows learners to see and hear the details related to the skill. Guided-discovery instructional method, according to Akanmu and Fajemidegba (2013), is a process of allowing the students to take the leading role in their own learning experience under the guidance of a teacher. It is an instructional method whereby the student is featured as the active participant, where the teacher assumes the roles of a facilitator, mediator, and assessor of learning. It

helps to develop students' abilities in applying concepts and personal growth, developing positive attitudes, and fostering motivation. Herviana (2015) described the expository instructional method as a method in which the teacher is the source of all knowledge; it makes generalizations and principles and answers questions. In teaching through an expository method, more information is covered in less time than through other teaching methods. In the expository method, teachers explain the lesson material while the students listen (Mhiliwa, 2015). The expository instructional method depends on the teacher's preparation, knowledge, confidence, passion, enthusiasm, motivation, and capabilities, such as the ability to manage the classroom (Maheswari, 2013).

Ameh and Dautani (2012) studied the effect of lecture and demonstration methods on the academic achievement of students in chemistry in the Nassarawa local government Area of Kano State. The sample was 58 chemistry students in senior secondary one (SS1). The study revealed that students performed better in chemistry when taught using the demonstration method compared to the lecture method group. Male students were better in academic achievement when taught with the demonstration method than when taught using the lecture method and female students achieve equally when taught with the demonstration method. Abdulhamid (2010) conducted a study to examine the effects of demonstration and discussion approaches on secondary school students' achievement in Agricultural Science. He observed that the demonstration approach developed and sustained students' learning interests, which led to their better achievement in Agricultural Science. Utibe and Onwioduokit (2019) examined the effect of guided discovery, demonstration methods, and Senior Secondary Physics Students' Acquisitions of Entrepreneurial Skills in household electrical circuit sketch and wiring skills in Akwa Ibom State. This study adopts a quasi-experimental multi-stage design using students from two purposely selected schools to form the two experimental groups in the Abak Local Government Area of Akwa Ibom State. The population for the study was all the Senior Secondary one (SS1) physics students for the 2017/2018 session in the 19 public secondary schools in the Abak Local Government Area of Akwa Ibom State. The household electrical circuit sketch and wiring skills test lessons on electrical circuit sketch and wiring skills were used for the collection of data. It was recommended that guided discovery and demonstration methods should be used in teaching entrepreneurial skills in household electrical circuit sketch and wiring skills.

Daluba (2013) experimented with the effect of the demonstration method on students' achievement in Agricultural science using 195 senior secondary three (SS3) students in Kogi State. At the end of the study, the students taught with the demonstration method had high achievement scores in the agricultural students' Achievement Test (ASAT) than their counterparts in the control group that was taught with the conventional lecture method. Allahoki (2012) studied the effectiveness of the guided-discovery teaching method on academic achievement in ecological concepts among secondary school students in Sabon Gari Educational Zone, Kaduna State. A sample of 100 students was randomly selected and assigned to experimental and control groups using a quasi-experimental pretest and posttest design. At the end of treatment, the result shows no significant difference between the achievement of males and females. It also showed a significant difference between students taught using the guided-discovery method and those exposed to the lecture method. It

recommended that conferences, seminars, and workshops should use appropriate experimental techniques in teaching. The difference between the study and the present study is that their study was conducted on ecological concepts while the present research is conducted on wave motion concepts. Odutuji (2019) investigates the effects of an activity-based approach and expository method on students' achievement in Basic Science. It also examined the influence of gender on students' achievement when taught using an activity-based approach. Eighty-seven Junior Secondary Two Basic Science students in their intact classes from two purposively selected co-educational schools in Ondo West Local Government Area of Ondo State, Nigeria constituted the sample. The instrument used was the Achievement Test in Basic Science (ATBS). The coefficient of reliability of ATBS was 0.76 using a test-re-test technique. The findings showed that a significant difference existed between the achievement of students exposed to activity-based approaches and those taught using the expository method. Learners in the activity-based approach group demonstrated better achievement than their counterparts in the expository method group. The results also revealed that gender had no significant effect on the students' achievement in Basic Science.

Nnorom (2016) examined the effect of the investigative laboratory approach and expository method on the acquisition of science process skills by biology students of different levels of scientific literacy in Nnewi North Local Government Area of Anambra state Nigeria. Two instruments, Test of Science Process Skills Acquisition (TOSPSA) and the Scientific Literary Test (SLT) were used for data collection. Results revealed that students taught using the investigative laboratory approach performed better than those taught using the expository method. Also, there was no interaction between the methods and scientific literacy level of biology students on science process skills acquisition. Another concern of this study is the relationship between gender issues among students among researchers. In the process of learning science-based subjects, some researchers show the superiority of male over female students and others show the superiority of females over males. Arigbabu and Mji (2004) opined that gender is not a significant factor associated with student achievement if given equal opportunity. With the right teaching process, male and female students will achieve equally. The observations showed no significant difference in gender and students' achievement in Biology when taught nervous coordination using computer simulation and charts.

Abubakar and Dokubo (2011) investigated the effect of gender as a predictor of academic achievement among Mathematics students. The primary concern on gender results is the cause of inconsistent achievement of Nigerian secondary school students in the three senatorial districts of Akwa Ibom State. There is a need to find out if demonstration, guided discovery, and expository instructional methods can eradicate gender-related differences in achievement among students. Oba and Lawrence (2014) examined the effects of gender on attitudes toward Physics among Senior Secondary School students studying Physics in Oyo State, Nigeria. The Multiple classification analysis was used to explain the magnitude of the post Attitude of the different categories of the students. Gender was found not to affect students' attitudes, but there was a slight difference in the attitude of the students in favour of females. Stakeholders should put differences in the attitude of males and females in the development and implementation of the curriculum.

The researchers, who teach under Akwa Ibom State schools and participate in the coordination and marking of the West African Senior School Certificate Examination and National Examinations Council Senior School Certificate Examination for over ten years have observed a decline in students' achievement in physics. The poor achievement among Physics students calls for serious concern and poses a threat to knowledge input among students for future achievement. Effective teaching methods could improve learners' achievement in Physics. Based on this note, the researchers examine demonstration, guided discovery, and expository instructional methods on students' achievement in Physics.

This study investigates the effect of demonstration, guided-discovery, expository instructional methods on students' achievement in physics. The study was designed to achieve the following specific objectives:

1. Compare the mean achievement scores of Physics students in waves when taught using demonstration, guided-discovery, and expository instructional methods.
2. Determine the difference between the mean achievement scores of male and female Physics students in waves.
3. Determine the interaction effect of instructional methods and gender (male and female) on the mean achievement scores of Physics students in waves.

The following research hypotheses were presented to guide the researchers in the course of this study:

H₀₁: There will be no significant difference among the mean achievement scores of Physics students in waves when taught using demonstration, guided-discovery and expository instructional methods.

H₀₂: There will be no significant difference among the mean achievement scores of male and female Physics students in waves.

H₀₃: There will be no significant interaction effect of instructional methods and gender (male and female) on the mean achievement scores of Physics students in waves.

The findings of this study will benefit Physics teachers and students as the knowledge acquired through demonstration, guided discovery, and expository instructional methods will provide a lifelong opportunity for self-development and improve academic achievement and retention in the concept of waves. Physics teachers, curriculum developers, parents, the Ministry of education, Physics textbooks publishers, and researchers will also benefit from the findings of this study as the results will reveal areas of improvement in instruction that may give rise to the use of demonstration, guided discovery and expository instructional methods in teaching Physics in the senior secondary school.

METHOD

This study adopted a quasi-experimental research design using students from six purposely selected schools to form the three experimental groups. According to Nworgu (2014), this type of design contains different levels and can be used in an investigation to establish the combined effects of more independent variables.

Groups –	Pre-test	Treatment	Post-test	Retention test
Experimental group 1(E ₁)	O ₁	X ₁	O ₁	O ₁
Experimental group 2(E ₂)	O ₁	X ₂	O ₁	O ₁
Experimental group 3(E ₃)	O ₁	X ₃	O ₁	O ₁

The study was conducted in coeducational secondary schools in Ikot Abasi Local Government Area of Akwa Ibom State, Nigeria. The population comprised all the senior secondary two physics students in the area. It has 12838 students (male, 5614 and female, 7224) in 2021/2022 academic session. The sample is 172 SS2 Physics Students (60 in the first, 58 in the second and 54 in the third experimental group). Simple random sampling technique was used in selecting six secondary schools out of eight from the area. Purposive sampling technique was used in selecting coeducational schools because gender was a variable in the study. A class was assigned to a particular teaching method of demonstration, guided-discovery or expository.

The instrument for data collection was a researcher-made Physics Achievement Test on Waves, with multiple choice items having four options lettered A – D with only one correct option and three distracters. The PATW was used for pre and post-tests. The instrument was faced validated by two lecturers from Akwa Ibom State University and a lecturer from University of Nigeria, Nsukka, while the content validity was done by the researcher using the table of specification for the test. Three lesson packages based on demonstration, guided-discovery and expository instructional methods were prepared by the researchers and used with the trained research assistants in teaching the students the concept of waves. To establish the reliability index of the instrument, it was administered to a trial testing group of 60 students who were not part of the main subjects for the study but were found to be equivalent in all aspects of the subject in the study. The result obtained during this administration using a test-retest method was subjected to KR21. The analyses give a reliability index of 0.87. On the basis of the reliability index, the instrument was suitable for used in conducting the study. The data were analyzed using descriptive statistics and ANCOVA for the hypotheses at a 0.05 level of significance.

RESULTS

Table 1: Mean Pre-test/Post-test Scores of the Students taught with demonstration, guided-discovery and expository instructional methods

Instructional Methods	N	Pretest		Posttest		Mean Difference
		\bar{x}	SD	\bar{x}	SD	
Demonstration	60	12.50	3.67	63.20	11.46	50.70
Guided-discovery	58	14.44	4.29	66.92	10.71	52.48
Expository	54	12.56	3.27	60.72	9.92	48.16

The result in Table 1 shows that students taught waves using the demonstration method had a pre-test mean score of $\bar{x} = 12.50$ (SD = 3.67) and a post-test mean score of $\bar{x} = 63.20$ (SD = 11.46) with a mean difference of 50.70. The guided-discovery group had a pre-test mean score of $\bar{x} = 14.44$ (SD = 4.29) and a post-test mean score of $\bar{x} = 66.92$ (SD = 10.71) with a mean difference of 52.48. While the expository method had a mean score of $\bar{x} = 12.56$ (SD = 3.27) for the pre-test and $\bar{x} = 60.72$ (SD = 9.92) for the post-test with a mean difference of 48.16. The result shows that guided discovery was more potent in improving the mean achievement scores of students in waves followed by demonstration and lastly, the expository method.

Table 2: Influence of Gender on the mean achievement scores of Physics students in waves

Gender	N	Pretest		Posttest		Mean Difference
		\bar{x}	SD	\bar{x}	SD	
Male	77	13.65	3.73	66.91	8.46	53.26
Female	95	12.68	3.93	60.32	12.15	47.64

The result in Table 2 shows that the male students had a pre-test mean score of $\bar{x} = 13.65$ (SD = 3.73) and a post-test mean score of $\bar{x} = 66.91$ (SD = 8.46). The mean difference was 53.26. The female students had a pre-test mean score of $\bar{x} = 12.68$ (SD = 3.93) and a post-test mean score of $\bar{x} = 60.32$ (SD = 12.15) with a mean difference of 47.64. The result reveals a difference in the mean achievement scores of male and female students in favour of male students taught waves in Physics.

Table 3: Interaction effect of treatment and gender on the mean achievement scores of Physics students in waves

Instructional Methods	Gender	N	Pretest		Posttest		Mean Difference
			\bar{x}	SD	\bar{x}	SD	
Demonstration	Male	27	12.68	3.99	62.88	10.03	50.20
	Female	33	12.32	3.39	63.52	12.93	51.20
Guided-discovery	Male	26	14.24	4.23	69.84	8.28	55.60
	Female	32	14.64	4.42	64.00	12.15	49.36
Expository	Male	24	14.04	2.78	68.00	4.90	53.96
	Female	30	11.08	3.11	53.44	8.16	42.36

Table 3 shows a mean difference between the female and male students exposed to demonstration method in favour of female Physics students in waves. There exists a mean difference between the female and male students exposed to guided discovery method for male Physics students in waves. Finally, there exists a mean difference between the female and male students exposed to expository method in favour of male Physics students in waves.

Table 4: Analysis of Covariance (ANCOVA) of the Effect of instructional methods on Physics students' achievement in waves

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6362.981 ^a	12	530.248	6.326	.000	.357
Intercept	28162.427	1	28162.427	336.009	.000	.710
Pretest	1191.971	1	1191.971	14.222	.000	.094
Instructional Method	539.128	2	269.564	3.216	.043	.045
Gender	1180.668	1	1180.668	14.087	.000	.093
Instructional Method * Gender	1104.950	2	552.475	6.592	.002	.088
Error	11482.593	137	83.815			
Total	624844.000	150				
Corrected Total	17845.573	149				

a. R Squared = .357 (Adjusted R Squared = .300)

Table 4 shows that an F-ratio $F(2,149) = 3.216$ ($p < 0.05$, $\eta^2_p = 0.045$) was obtained. Since the associated probability value of 0.043 is less than 0.05 set for the study, the null hypothesis that there is no significant difference among the mean achievement scores of Physics students in waves when using demonstration, guided discovery and expository instructional methods was rejected. There was a significant difference among mean achievement scores of Physics students in waves when taught using demonstration, guided discovery and expository instructional methods. The result further showed an effect size of $\eta^2_p = 0.045$, indicating that 4.5% of the variance on Physics students' achievement scores in waves was due to the treatment. Table 4 also shows that the F-ratio $F(1,149) = 14.087$ ($p < 0.05$, $\eta^2_p = 0.093$) was obtained. Since the associated probability value of 0.00 obtained is less than 0.05 level of significance set for the study, the null hypothesis that there is no significant difference between the mean achievement scores of male and female Physics students in waves was rejected.

There was a significant difference between the mean achievement scores of male and female Physics students in waves. The result further showed an effect size of $\eta^2_p = 0.093$, which means that only 9.3% of the variance in the mean achievement scores of Physics students in waves was due to the influence of gender. Table 4 further shows that an f-ratio $F(2,149) = 6.592$ ($p < 0.05$, $\eta^2_p = 0.088$) was obtained. Since the associated probability value of 0.002 is less than 0.05 set for the study, the null hypothesis that there is no significant interaction effect of instructional methods and gender (male and female) on the mean achievement scores of Physics students taught waves was rejected. Table 4 also shows a significant difference due to instructional methods in favour of guided discovery instructional method. The reason for this result might be that when students are allowed to think on their own they gain more which reflects in the high mean achievement scores. The finding was in line with the work of Utibe and Onwioduokit (2019) that carried out a study to examine the effect of Guided-Discovery, Demonstration Methods and Senior Secondary Physics Students' Acquisitions of Entrepreneurial Skills in household electrical circuit sketch and wiring skills in Akwa Ibom State.

The findings further show a significant difference between the mean achievement scores of male and female students in the concept of waves in favour of male students. The reason might be that male students spend more time studying the subject than female students. The findings confirmed males' achievement in physics more than females in Khwaileh and Zaza (2011), who submitted that male students achieved better than their female counterparts in science subjects at the ordinary level. The gap in Physics achievement between the genders widens in favour of males in coeducational schools but not in single-gender schools. The gender gap in students' achievement in Physics in coeducational schools has been attributed to an un-conducive classroom environment for females due to intense gender role stereotyping and apparent male domination of Physics activities.

Table 5: Post-hoc result of the difference in the mean achievement scores of Physics students in waves based on instructional methods

(I) Instructional Method	(J) Instructional Method	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
Demonstration	Discovery	-2.247	1.880	.702	-6.803	2.309
	Expository	2.503	1.833	.523	-1.939	6.944
Guided Discovery	Demonstration	2.247	1.880	.702	-2.309	6.803
	Expository	4.750*	1.876	.037	.202	9.297
Expository	Demonstration	-2.503	1.833	.523	-6.944	1.939
	Discovery	-4.750*	1.876	.037	-9.297	-.202

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

To further reveal where the difference lies among the instructional methods, a post-hoc test is presented in Table 5. Table 5 shows that the mean achievement score of students exposed to guided discovery is significantly higher than those taught using expository method. However, the difference between the mean achievement scores in waves of Physics students exposed to guided discovery and demonstration as well as demonstration and expository methods was not significant.

CONCLUSION AND RECOMMENDATIONS

This study examines the effect of demonstration, guided discovery, and expository instructional methods on senior secondary students' achievement in Physics in Ikot Abasi Local Government of Akwa Ibom State, Nigeria. Based on the findings, the effectiveness of the guided-discovery instructional method over the demonstration and expository instructional method on Physics students' achievement in waves was significant. The male students significantly achieve more than the female students on waves in Physics. There was no significant interaction between teaching methods and gender based on the achievement scores of students on waves in Physics. Based on the findings, it has shown that with appropriate teaching methods, the outcome of interacting with the teaching materials by the teachers would be such that their teaching gain will be maximum. Therefore,

1. A teacher should select appropriate methods that will meet the teaching needs of the learners irrespective of their gender and location.
2. The curricula of Teacher Training Institutions should encompass the different teaching methods that would promote effective teaching.
3. The secondary school Physics curriculum should be such that it would enable the teachers to identify problems, stimulate students thinking ability, and allow them in a group to approach solving problems in map work.
4. The school authority and the Physics teachers should work together to ensure that teaching materials are provided for the teachers to enhance their teaching.

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