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ENHANCING THE ACADEMIC ACHIEVEMENT OF PHYSICS STUDENTS IN ELECTRICITY THROUGH GUIDED DISCOVERY METHOD

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Abstract
The study examined the effectiveness of Guided discovery method on secondary school students' academic achievement in electricity in Anyigba, Kogi state, Nigeria. The study adopted a quasi-experimental research design. The study population consisted of all the SSII students studying Physics in all public co-educational secondary schools in Anyigba, Kogi State during the 2024/2025 academic session. The study was guided by four research questions and three hypotheses, which were tested at 0.05 level of significance. The sample comprised 122 SSII students in two intact classes from two co-educational public secondary schools, selected using the probability proportional size (PPS) sampling technique. The instrument used for the collection of data was Electricity Achievement Test (EAT), which was developed by the researcher and validated by experts in Test and Measurement and Physics education. The internal consistency of EAT using Kuder Richardson 20 (KR20) formula stood at 0.87. The obtained data were analyzed using descriptive and inferential statistics. The findings from the study revealed that students exposed to the guided discovery method achieved higher in electricity than their counterparts who were exposed to the conventional method. On the basis of this, it was recommended that Physics teachers should be encouraged to adopt the use of guided discovery method as a mode of teaching electricity concepts and that it should be also incorporated into the teacher education program.

Introduction

Science is a great enterprise that brought advance technology because of its significance and relevance to life, society, and the nations. Science is both a process (scientific method) and a product (knowledge, fact and principles). Both the process and product of science are acquired through education which is a specialized type of education such as science education. Science plays an important role in the society because it relates to our

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daily life and career (Abdulwaheed, 2022). The importance of science in our society led the Federal Government of Nigeria, through the Federal Ministry of Education to introduce science subjects in the nation's secondary school curriculum. Physics is one of the major of such subject introduced.

Physics can be describe as the backbone of science and technology because many of the tools on which scientific and technological advancement depends are direct products of physics. Knowledge of physics is one of the key factors that led to the guided discovery of light, vehicles, solar panels, and electrical appliances and farm machines such as tractors, bulldozers and plow. Bello (2019) saw physics as the core subject in science and technology because it studies the essence of natural phenomena and helps people understand the rapidly technological changing society. Physics therefore is an intentional enterprise that plays a key role in the future progress of mankind.

Despite the importance of physics as a subject and electricity as a topics in physics, the achievement of students in external examinations has remained unsatisfactorily poor especially in the Anyigba education zone. Evidence from the WAEC Chief Examiner's Report across the years shows that from 2019 to 2023 shows that the percentage number of students who passed the subject at a credit grade and above kept fluctuating. In some of the years, a high number of students passed at the credit level such as 68.74% in 2019, whereas a significant decrease was noted in 2020, with the number of students who passed at the credit level and above reduced to 46.77 percent. A similar trend was observed in 2022 where 60.01 percent passed at the credit level and above. This trend decreased in 2023, where 58.95 percent of students passed at credit level and above. A comparison of students' performance is often given by the WAEC Chief examine inform of a raw mean score indicating the average achievement of students in the subject, followed by a standard deviation score which further shows the variance in the performance of students for the years.

Factors such as lack of well-equipped and functional physics laboratory, method of teaching, Lack of qualified teachers, shortage of experienced and committed physics teachers, teaching methodology such as Traditional method among others. The teaching methods adopted by physics teachers hold common place. Based on the deplorable trend of physics students' low achievement, some researchers have recommended some instructional strategies to help in salvage the problem of low achievement in physics. For instance, Kapur (2010) suggested problem-based learning for better performance, problem-solving, and line graphing skills in physics Orji (2013), cooperative learning strategy (Abdulwaheed, 2023) among others, but the problem is yet to solve.

Science teachers have always recognized the importance teaching of teaching methods as a means of introducing learners to the scientific process of experimentation. To this end, the United Nations Educational Scientific and Cultural Organization (UNESCO) and the International Union of pure and Applied Physics (IUPAC) have participated in numerous international meetings to promote inexpensive experimental teaching in Physics. Guided discovery teaching method is a style or method of teaching where the learner is seeks to discover and create answers to recognized problems through procedure of making a diligent search, some time with minimum guidance from the teacher (Callahan, et al., 2015).

Guided Discovery Method is a powerful instructional approach that guides and motivates learners to explore information and concepts in order to construct new ideas, identify new relationships, and create new models of thinking and behavior, Adams & Freeman (2016); O'Neil& Pegrum (2018). Guided Discovery Method is a method that encourages learners to explore the content by using of concrete experience, Uwameiyi and Ogunbemeru (2015). Therefore, guided discovery method is characterized by convergent thinking and enables students to make references with limited guidance from the teacher with the opportunity to discover principles or explanations (Nguyen, 2018).

Gender as a factor in science subjects has generated some concern for science educators. Ocho (2017) observed that female students achieve better than male students in science. Ezeudu (2015) observed that sex has significant effect in favor of females in cognitive performance. This shows that there is controversy on science performance by gender. Gender refers to the socially/culturally constructed characteristics and associated with males and females in any society (Okeke 2017). Gender is the outcome of cultural learning and socialization that continues throughout life because undue attention is paid to socialization during childhood. It is socially constructed and not biologically determined. In response to this challenge, the researcher finds it necessary to empirically verify empirically the effectiveness of guided discovery method in enhancing physics students' achievement in electricity and whether the method is gender biased.

The study was anchored on constructivist's theory such as Ausubel (1969) theory of meaningful verbal learning. This theory is based on anchored on the principles of meaningful learning, prior knowledge, and advanced organizer. The theory emphasizes that meaningful learning occur when new information is linked or associated with existing concepts in the learner's current knowledge. The implication of the theory for the present study is that the teacher who acts as a facilitator motivates learners to discover facts and principles for themselves, and also provides a preview of the concept to be learnt with the use of advance organizer. The theory is relevant to the present study because learning is a process through which the learner actively constructs new ideas based on his/her previous knowledge. This is applicable to the guided discovery method.

Statement of the Problem

The persistent poor achievement in Physics has been partly ascribed to inadequate teaching and instructional methods adopted by teachers. In support of this view, Derek (2017) reported the seriousness of the deplorable performance of secondary school students in Physics and identified the persistent use of traditional methods of instruction as one of the major shortcoming affecting learning and higher performance in Physics. Many students find Physics to be a hindrance in attaining their objectives. Therefore, it is necessary to properly groom the students' right from the secondary level to enable them to improve their academic achievement in Physics. The low achievement of students in science subjects, particularly Physics, has assumed a serious dimension as reported by the West African Examination Council (2021). Considering this, the study intent to investigate in enhancing physics students' achievement in electricity through the guided discovery method.

Purpose of the study

The main purpose of this study is to investigate in the enhancing physics students' achievement in electricity through guided discovery method in Anyigba, Kogi State. The specific objectives are as follows:

i. Determine the achievement levels in electricity before and after exposure to the guided discovery method

ii. Determine the mean scores of the SSII students' pretest and posttest achievement in the experimental and control groups?

iii. Determine the mean pretest and posttest achievement scores of male and female SSII students in the experimental and control group?

iv. Determine the interaction effect of methods and gender on the mean scores of students' achievement in electricity?

Research Questions

The study was guided by the following research questions:

i. What are the SSII levels of achievement in electricity before and after guided discovery method exposure?

ii. What are the mean pretest and posttest achievement scores of the SSII students in the experimental and control groups?

iii. What are the mean pretest and posttest achievement scores of male and female SSII students in the experimental and control group?

iv. What is the interaction effects of methods and gender on the mean scores of students achievement in in electricity?

Hypotheses

The following hypotheses were used to guide the study

HO_1: There is no significant difference between the mean posttest achievement scores of the SSII students in the experimental and control groups

$HO_{2:}$ There is no significant difference between the mean posttest achievement scores of male and female SS II students in the experimental group.

HO_3: There is no significant interaction effect of methods and gender on the mean scores of students' achievement mean scores in electricity.

Method

The study adopted quasi experimental, specifically pretest-posttest nonequivalent control group research design. The study population for the study comprised all SSII students studying Physics in all public secondary schools in Anyigba, Kogi State during the 2024/2025 academic session. A total of 122 SSII Physics students in two intact classes from two co-educational public schools were used as the sample for the study. In selecting the two schools used in the study, the Probability Proportionate to Size (PPS) sampling technique was adopted. The choice of using only the public co-educational schools was based on the fact that the students have a similar learning environment.

The instrument used for data collection was Electricity Achievement Test (EAT), which was developed by the researcher and validated by experts in the fields of Measurement and Evaluation and Physics education. A pilot study was conducted on 34 SSII intact class physics students from a public secondary school that was not part of the selected schools but had a similar learning environment. Data obtained from the pilot study was used to establish the reliability of the instrument. The internal consistency of EAT using Kuder Richardson 20 formula (KR20) stood at 0.87.

The items for EAT was developed based on the secondary school physics curriculum on the concepts of electricity in the secondary school physics curriculum and structured based on the table of specifications. The EAT comprised of 20 multiple-choice questions on the principle of electromagnetism. The 20 items have four options, A to D, with only one correct option in line with Senior School Certificate Examination standard. Each correct option attracted 5 marks, while wrong option attracted 0 mark. Therefore, the maximum and minimum mark obtainable were 100% and 0% respectively. For EAT, the students' scores were categorized into high, average, and low achievement levels. High achievement level indicates the range of scores from 60% and above. The average achievement level indicates the range of score from 50 to 59%, while a low achievement level indicates a score range from 0 to 49%.

The two intact classes were randomly assigned to the experimental and control groups. There were 63 students in the experimental group (33 males and 30 females) and 59 in the control group (34 males and 25 females). Both the experimental and control groups were pretested before the start of the treatment. Treatment started one week after the administration of the pretest for each groups. The students in the experimental group were taught electricity by a Physics teacher who served as research assistant using guided discovery method, while the students in the control group were taught the same concept by the Physics teacher who was also the research assistant, using the conventional teaching method. The lesson plans prepared by the researcher were used by the

research assistant teachers for four weeks to teach electricity in the experimental and control groups using the normal school schedule for Physics lesson.

After the four (4) weeks' treatment, both the experimental and control groups were post -tested. The students' scores of the students for the pretest and posttest were sorted out and analyzed. Descriptive and inferential statistics were used in analyze the obtained data. The four research questions were answered using simple percentages, means and standard deviations, and the three hypotheses were tested at a significance level of 0.05 using analysis of covariance (ANCOVA).

Results

Research Question One: What are the SSII students' levels of achievement in electricity before and after exposure to guided discovery method?

To answer this research question, the Electricity achievement test (EAT) was administered to the students in the experimental group. The analysis results are presented in Table 1. The analysis in Table 1 shows a total number of 63 students in the experimental group. The analysis revealed that before the students were exposed to guided discovery method, no student was found at high achievement level (60-100%). This indicates 0%. 15(23.81%) students were found at average achievement level (50-59%), while 48 (76.19%) students were at low achievement level (0-49%). However, after the exposure of the students to the intervention, 20(31.75%) students were found at high achievement level (60-100%). 24(38.09%) students were found at average achievement level (50-59%), while 19(30.16%) students were at low achievement level (0-49%). The analysis showed that guided discovery method was effective in enhancing students' achievement in electricity.

Table 1: Levels of Achievement of SSII Physics Students before and After Exposure to Generative Instructional Method

Achievement Levels	Range of the Scores in Percentage	Before N	Before %	After N	After %
High	60-100	0	0	20	31.75
Average	50-59	15	23.81	24	38.09
Low	0-49	48	76.19	19	30.16
Total		**63**	**100**	**63**	**100**

Research Question Two: What are the mean pretest and posttest achievement scores of the SSII students in the experimental and control groups?

To answer the second research, the analysis is presented in Table 2. The analysis in Table 2 indicated a pretest and posttest achievement mean scores of 28.36 and 50.63 with standard deviations of 3.87 and 2.75, respectively, for the students exposed to the guided discovery method (Experimental), while those exposed to conventional method (control) had a pretest and posttest achievement mean scores of 24.65 and 28.58 with standard deviations of 3.11 and 3.55, respectively, the mean differences between the two groups were 22.27 and 3.93. This implies that students exposed to guided discovery method had higher achievement than their peers exposed to the conventional method.

Table 2: Mean Pretest and Posttest Achievement Scores of SSII Students in the Experimental and Control Groups

Variable	N	Pretest Mean	Std. Dev	Posttest Mean	Std. Dev	Mean Difference
Experimental	63	28.36	3.32	50.63	2.75	22.27
Control	59	24.65	3.41	28.58	3.30	3.93

Research Question Three: What are the mean pretest and posttest achievement mean scores of male and female SSII students in the experimental and control groups respectively?

To answer third research question, Table 3 presents the mean achievement scores with the standard deviations of male and female students in the experimental and control group. The analysis in Table 3 revealed that in the experimental group, the mean score of the pretest and posttest achievement of 28.23 and 36.33, respectively, with standard deviations of 3.42 and 2.38 were recorded for male students, whereas those of 25.14 and 32.33, respectively, with standard deviations of 3.15 and 2.24 were recorded for female students. Similarly, in the control group, the pretest and posttest achievement mean scores of 23.35 and 24.69 with standard deviations of 3.10 and 3.90 were recorded for male students, while those of 24.76 and 23.58 with standard deviations of 3.11 and 2.73 were recorded for female students. The mean differences for male and female students in the experimental group were 8.34 and 7.13, respectively, whereas those of the control group were at 1.35 and 1.18 respectively.

Table 3: Mean Pretest and Posttest Achievement Mean Scores of Male and Female SSII Students in the Experimental and Control Groups.

			Pretest		Posttest		Mean
Variable	**Gender**	**N**	**Mean Dev**	**Std.**	**Mean Dev**	**Std.**	**Difference**
	Male	33	28.23	3.42	36.33	2.38	8.10
Experimental	Female	30	25.14	3.15	32.33	2.24	7.19
	Male	34	25.13	3.15	28.69	3.85	3.56
Control	Female	25	24.32	3.10	26.42	2.69	2.10

Research Question Four: What are the interaction effects of method and gender on the mean score of students' achievement mean scores in electricity?

To answer the forth research question, Table 4 presents the mean differences of male and female students in the experimental and control groups. The analysis in Table 4 showed that the mean achievement (8.10 and 7.19) were higher at the two gender levels (male and female) in the experimental group than that of their peers in the control group. This implies that there was no interaction effect of the methods on the students' mean achievement in electricity. This implies that guided discovery method was superior to the conventional method in enhancing students' achievement in electricity in Anyigba.

Table 4: Interaction effects of Methods and Gender on the Achievement Mean Scores of SSII Students in Electricity

Gender Category	**The experimental Group (GDM) (Mean Difference)**	**Control Group (CONV) (Mean Difference)**
Male	8.10	3.56
Female	7.19	2.10

Hypotheses

The data collected from both the experimental and control groups were subjected to analysis of covariance (ANCOVA) in order to test hypotheses 1, 2 and 3. The summary of the analysis is presented in Table 5.

Table 5: Summary of ANCOVA test of Significance on the Effects of Treatment, Gender and Methods on the Achievement Mean Scores of SSII Students in Electricity

Sources of Variation	Type III Sum of Squares	Df	Mean square	Fcal.	P	Decision
Corrected Model	232.738	4	79.312	9.421	0.000	
Intercept	4837.142	1	4837.142	57.823	0.000	
Treatment	2440.380	2	334.281	37.821	0.000	S
Gender	38.832	2	6.784	0.783	0.512	NS
Treatment*Gender	232.540	2	9.214	1.234	0.063	NS
Error	46372.832	115	8.356			
Total	249342.421	122				
Corrected Total	3461.632	121				

* Significant at p<0.05 level

Note: Hypotheses 1, 2, and 3 were tested in Table 5.

HO_1: There is no significant difference between the mean posttest achievement scores of the SSII students in the Experimental and control groups.

Table 5 reveals the two-way ANCOVA test on the main effect of the method on the mean scores of students' achievement in electricity. The analysis showed a significant outcome F(2, 115, = 37.821, P = 0.000 < 0.05). Since the P-value of 0.000 is less than the significant level set at 0.05, the null hypothesis was rejected. This means that there was a significant difference between the mean scores of the posttest achievements score of the SSII students taught electricity using guided discovery method and those taught the same concept using conventional method.

HO_2: There was no significant difference between the mean posttest achievement scores of male and female SSII students in the experimental group.

Table 5 presents the analysis of the ANCOVA test on the interaction effects of method and gender on the students' achievement mean scores in electricity. The analysis indicated F(2, 115 = 0.783, P = 0.512> 0.05). Since the P-value of 0.512 is greater than the significant level set at 0.05, the null hypothesis was retained. This means that there was no significant difference between the mean scores of posttest achievement of male and female SSII students taught electricity using guided discovery method. The method is not gender biased.

Ho3: There are no significant interaction effects of methods and gender on the mean score of students' achievement in electricity.

Table 5 presents the analysis of the ANCOVA test on the interaction effects of method and gender on the students' achievement mean scores in electricity. The analysis revealed no significant interaction effects F(2, 115 = 1.090, P = 0.063 > 0.05). Since the P-value of 0.061 is greater than the significant level set at 0.05, the the null hypothesis was upheld. This means that there was no significant interaction effect of methods and gender on the mean achievement mean scores of students in electricity. The implication of this is that guided discovery method did not discriminate across gender.

Discussion of the Findings

The overall result of the study revealed that the students taught electricity using guided discovery method achieved higher than their peers taught the same concept using the conventional strategy. This finding is in consonant with the studies of Ogunleye and Babajide (2011); Nwafor and Aja (2017); Olagbaju (2019) found that students exposed to guided discovery method had higher achievement in Physics. This implies that if physics and science

teachers alike could adopt the guided discovery method in teaching-learning processes, there will be an improvement in students' mastery and achievement in electricity will improve.

The study also showed that there was no significant difference between the mean score of posttest achievement of male and female students taught electricity using guided discovery method. The study further revealed that there was no significant interaction effect of methods on the mean scores of the students' achievement in electricity. This finding is in agreement with those of Oludipe and Oludipe (2010) and Okoli and Ofodum (2017), who reported that the guided discovery method reduce gender differences. This implies that guided discovery method does not discriminate across gender and was more effective than the conventional method in enhancing students' achievement in electricity.

Conclusion

This study examined the effectiveness of the guided discovery method on the achievement of secondary school Physics students in electricity and found that the strategy was effective in improving the learning outcomes of students in electricity. This could be attributed to the basic feature of the metod as a learner-centred approach where students carry out activities themselves. That is, they build their own ideas, identify their conceptions and misconceptions, and correcting such identified misconceptions. Gender has no effect on the mean academic achievement score students in electricity. Treatment and gender have no significant interaction effects on the mean academic scores of the students in electricity. Based on the findings of this study, it was concluded that guided discovery method has great potential in enhancing students' achievement in electricity and the method built better teacher-student and student-student interaction during lessons and developed greater confidence in the students.

Recommendations

Based on the findings of this study, the following recommendations were provided.

1. Physics Teachers should be encouraged to adopt the use of guided discovery method in the teaching-learning processes to improve students' achievement in electricity.
2. Governments at all levels, in collaboration with professional bodies such as the Science Teachers Association of Nigeria (STAN), Nigerian Educational and Research Development Council (NERDC), should organize capacity building programs for secondary school Physics teachers and science teachers alike, through seminars, workshops, symposia and conferences among others, on the effective use of guided discovery method.
3. Guided discovery method should be incorporated into the science teacher program for equipping the trainee teachers with the skills on the effective use of the method. In addition to this, the strategy should be incorporated into the science curriculum of secondary schools and advocate that learners should be part of the knowledge creation process.

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