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EFFECT OF INQUIRY AND LABORATORY STRATEGIES ON PHYSICS STUDENTS' ACADEMIC PERFORMANCE IN SENIOR SECONDARY SCHOOLS; KATSINA STATE NIGERIA

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Abstract: This study examined the effect of inquiry and laboratory strategies on physics academic performance in senior secondary schools in Katsina State, Nigeria. The study was guided by 3 objectives, 3 research questions, and 3 hypotheses. A quasi-experimental and control group design involving three groups; two experimental and one control were used. The population of this study comprises a total of 5,389 senior secondary II students offering physics from 19 public schools in Rimi, ZEQA. The sample of students for the study comprised 205 students from three intact classes selected from three co-educational schools by Rimi Zonal Education Quality Assurance. Physics Performance Test was used for data collection. The reliability coefficient of PPT was obtained using PPMC and Cronbach alpha which was 0.917 respectively. The research questions were answered using mean scores and standard deviation, while the null hypotheses were tested using ANOVA and t-test at a $P \leq 0.05$ level of significance with the aid of SPSS. The results obtained showed a significant difference between the mean academic performance scores of students taught physics using inquiry strategy, laboratory strategy, and lecture method in favor of those taught using inquiry and laboratory strategies. The results also revealed no significant difference between the mean academic performance scores of male and female students taught physics using inquiry and laboratory strategies. The study concluded that employing inquiry and laboratory strategies can lead to improved academic performance among physics students. Moreover, Inquiry and Laboratory are gender friendly teaching strategies. Based on the findings, it was recommended that physics teachers should be encouraged to use inquiry and laboratory strategies in teaching physics concepts at the secondary school level in Katsina State.

Keys: Inquiry Strategy, Laboratory Strategy and Academic Performance

Introduction

Physics is a science that deals with the structure of matter and the interaction between the fundamental constituents of the observable universe. In the broadest sense, physics (from the Greek word physikos) is concerned with all aspects of nature on both the macroscopic and submicroscopic level. Its scope of study encompasses not only the behavior of objects under the action of given forces but also the nature and the origin of gravitational, electromagnetic

and nuclear force field. Its ultimate objective is the formulation of a few comprehensive principles that bring together and explain all such disparate phenomena. Physics is widely recognized to be the most fundamental of all sciences and also a foundation of our society (Pravica, 2015). This is because many of the advances in science and technology that we know and enjoy today have been as a result of scientific research where physics played a key role. The discovery made in physics not only broaden our view of fundamental processes, but frequently are crucial importance in the advancement of other sciences. According to Onwu (2015) Physics teachers are expected to make the subject more relevant, enjoyable, easy and meaningful to students. Teaching methods need to be improved and appropriate teaching strategies employed as the teaching- learning situation may demand. Teaching methods such as demonstration, inquiry, peer-tutoring, project, lecture-demonstration, lecture performance, problem-solving, field trips, cooperative or group learning, excursion, remedial, laboratory and guided discussion and the use of audio-visual materials have been recommended for the teaching of Physics.

Method is very vital in any teaching and learning situation. The method adopted by the teacher may promote or hinder learning. It may sharpen mental activities which are the bases of social power or may discourage initiatives and curiosity thus making self-reliance and survival difficult (Dantai & Paul, 2017). What constitutes good/effective teaching and learning of school subject is the use of appropriate method of teaching. Sola (2017) asserted that one of the most persistent and compelling problems besetting academic achievement in Nigeria is poor quality of teaching. There exists a number of teaching methods for physics teachers to use. They include: lecture, discussion, demonstration, laboratory, inquiry, individualized instruction, field–trip, peer- group teaching methods and so on. According to Obeka (2015), Physics as a subject is bulky in nature in terms of content, subject teachers usually adopt lecture method of teaching in order to cover the syllabus within the stipulated time and thus does not give room for proper understanding of the subject. This study intends to find out the effect of Inquiry and Laboratory strategies on Academic Performance in Physics.

Inquiry strategy of teaching can be defined as a Pseudo experiment, where the teacher has the students ratified already taught concepts (Obeka, 2017). The parts of lessons taught must match the different components and are revised. Furthermore, inquiry method of teaching is a teaching method where the learner with minimum guidance from the teacher seeks to recognize problem through procedure of making a diligent search. Inquiry is a term used in Physics teaching to mean a way of questioning, seeking knowledge or information or finding out about Phenomenon (Akinsete, 2016). It involves investigation, searching, defining a problem, formulating hypotheses, gathering and interpreting data and arriving at a

conclusion. It also permits student to assimilate and accommodate information (Nwachukwau & Nwosu, 2017).

Laboratory method is an activity based; student-centered teaching method where students learn by carrying out activities in the laboratory. These activities include; touching, seeing, feeling, weighing, measuring, demonstrating, carrying out tests/experiments and any other practical activities in the laboratory. A deeper understanding of the science and technological processes can be achieved through laboratory activities which encourage active participation and serve to develop critical thinking and also provide concrete experiences to substantiate the theoretical aspect that might have been taught. Sola (2017) asserted that laboratory work promotes competence in skill of gathering information, organizing, communication, interpreting, observing, drawing conclusions and making inferences. Sola, (2017) viewed laboratory as providing conceptual understanding, procedural knowledge and hence investigative enterprise.

Many studies were conducted in Nigeria (for example, studies conducted by Olorukooba & Lawal 2015; Ojediran, Oludipe & Ehindero 2017; Anchor & Agamber, 2019 among others) to ensure adoption of the most effective strategy for teaching and learning of Physics, yet poor Physics performance is being recorded always in examinations (Eyenaka, Patrick & John, 2016).

Academic Performance is an expression used to present students' scholastic standing. It is a function of various factors such as method of teaching, teachers' qualifications, home background, school environment, attitude, interest among others (Popoola, 2015). Academic Performance in Physics could be attributed to many factors among which teachers' strategy of teaching itself may be considered as an important factor. The teaching and learning of Physics in Nigeria has suffered due to the use of the traditional chalk-talk approach, lack of qualified teachers and inadequate facilities for conducting experiments and research among others (Jegede & Adedayo, 2017). Shakir (2018) defined Academic Performance as what a student does or achieves at the school which is the bases of promotion and placement in our Performance system.

Gender as a factor in Students' Performance has being receiving research attention for some years. Ibe (2016) found that gender is not a significant factor in students' performance in Physics. However, he identified sex-role stereotype and masculine image of science as factors influencing students' choice and achievement in science subjects generally. He further stated that this sex-role stereotype and masculine image of science tend to place female students at a disadvantage in their choice relative to their male counterparts. Many studies on gender have suggested that male achieved better results in science than their female counterparts while other studies showed that there is no significant difference in

academic achievement between male and female.

Therefore, there is need to search for more effective instructional strategies that are likely to improve students' academic achievement in secondary school Physics. Hence, this study seeks investigate the effect of Inquiry and Laboratory strategies on academic performance in senior secondary schools; Katsina State Nigeria.

Statement of the Problem

The continuous reports of students' poor Academic in physics examinations has been an issue of great concern among educationists (Stephen, 2018). The West African Examination Council (WAEC) chief examiner's report attributed the failure in Physics examinations by students to inadequate preparation for practical wok, poor calculation and descriptive skills (WAEC, 2022). Similarly, there has been a poor Physics academic achievement in National Examination Council (NECO) examination scored credit and above (NECO, 2020). However, studies have shown that appropriate usage of instructional strategy can improve students' academic performance (Shafiu, 2018). In this regard, many studies (Ibrahim 2016; Shafiu 2018; Anchor & Agamber 2020) in Nigeria regarding the effects of instructional strategies on students' academic performance were conducted yet students perform poorly in physics examination (Awodun & Ojo 2017; Ojediran, Oludipe & Ehindero, 2018; Eyenaka, Partric & John, 2020). Nevertheless, secondary school students have been taught Physics through predominant use of traditional teaching method despite the continuous poor students' academic performance being recorded over the years (Tambawa, Lawal & Usman, 2017). Enyenaka, Partric & John (2016) recommended that traditional method of teaching and learning are being revised for maximum outputs by embracing students-centered approaches to teaching and learning Physics.

In view of the aforementioned, something must be done to address this problem otherwise the Nigeria's dream of technological buoyancy and subsequent development would be a mirage. Hence this study attempts to investigate the effect of Inquiry and Laboratory Strategies on Academic Performance among Senior Secondary Physics Students in Rimi Zonal Education Quality Assurance of Katsina State.

Objectives of the Study

The main objective of the study is to examine the effect of inquiry and laboratory strategies on Physics students' academic performance in senior secondary schools; Katsina State Nigeria. Thus, this study addressed the following objectives; to:

1. Determine the effect of Inquiry and Laboratory Strategies on Students' Academic Performance in Physics.
2. Find out the effect of Inquiry Strategy on gender academic performance among Physics Senior Secondary Schools Students in Katsina State.

3. Find out the effect of Laboratory Strategy on gender academic performance among Physics Senior Secondary Schools Students in Katsina State.

Research Questions

The following research questions are formulated to guide the study:

1. What is the difference in the mean Academic Performance scores of students taught using Inquiry, Laboratory and those taught using Lecture Method in Senior Secondary Schools of Rimi ZEQA?
2. What is the difference in the mean Academic Performance score of male and female students taught Physics using Inquiry Strategy in Senior Secondary Schools of Rimi ZEQA?
3. What is the difference in the mean Academic Performance score of male and female students taught Physics using Laboratory Strategy in Senior Secondary Schools of Rimi ZEQA?

Research Hypotheses

The following null hypotheses are postulated for the study and will be tested at 0.05 level of significance.

H_{01}: There is no significant difference between the mean Academic Performance scores of Students taught physics using Inquiry strategy, Laboratory strategy and those taught using lecture method.

H_{01}: There is no significance difference between mean Academic Performance scores of male and female Students' taught Physics using Inquiry Strategy.

H_{01}: There is no significance difference between mean Academic Performance scores of male and female Students' taught Physics using Laboratory Strategy.

Methodology

The research design for this study is a quasi-experimental and control group design. There are three groups in this study; the first group is the experimental group one (EG_1), which was exposed to Inquiry strategy (X_1); the second is the experimental group two (EG_2), which was exposed to Laboratory strategy (X_2); and the last group is the control group (CG), which was exposed to Lecture method. All the three groups were pre-tested (O_1) to ensure that the selected participants were not significantly different in terms of Academic Performance. The treatment and teaching periods lasted for six (6) weeks. Immediately after the treatment, a post-test (O_2) was administered to the three groups to determine the effect of the treatment on the students' Performance. Gender is considered a moderating variable in this study, which involves male and female students.

EG_1 → O_1 → X_1 → O_2

$EG_2 \rightarrow O_1 \rightarrow X_2 \rightarrow O_2$

$CG \rightarrow O_1 \rightarrow X_0 \rightarrow O_2$

Fig. 3.1: Research Design is illustrations

Where

EG_1	Experimental Group One	X_1	Treatment one (Inquiry strategy)
EG_2	Experimental Group two	X_2	Treatment two (Laboratory Strategy)
CG	Control Group	X_0	No treatment (Lecture method)
O_1	Pre-test		
O_2	Post-test		

A total of 205 SS Il Physics students were used for the study from the population of 5,389 Physics students in all 19 public Senior Secondary Schools in Rimi Zonal Education Quality Assurance using intact class. Physics Performance Test (PPT) was used for data collection. The reliability coefficient of the PPT was obtained using Pearson Product Moment Correlation (PPMC) and Cronbach alpha which was found to be 0.917 respectively. The research questions were answered using mean scores scores and standard deviation, while the null hypotheses were tested at $P \leq 0.05$ level of significance using ANOVA and t-test independent sample by the aid of SPSS version 23.

Results and Discussion.

In order to be able to answer the research questions, the researcher made use of descriptive statistics (mean scores and standard deviation).

Research Question One: What is the difference in the mean Academic Performance scores of students taught using Inquiry, Laboratory and those taught using Lecture Method in Senior Secondary Schools of Rimi ZEQA?

Table 1: Differences in the Mean performance score of Experimental group I, Experimental group II and Control group.

Groups	N	Mean	Std. Dev.	Mean difference
Experimental Group I	65	46.98	3.92	0.00
Experimental Group II	55	47.93	2.24	0.95
Control Group	85	32.31	3.75	14.67 & 15.62

Table 1, presents the post-test mean Academic Performance scores of students in experimental and control groups. From the result, the post-tests mean score of students in experimental group I was 46.98 while that of Experimental group II was 47.93, a mean difference of 0.95 was recorded against experimental group I. For the control group, the post-tests mean score of students was 32.31 with a mean difference of 14.67 & 15.62 when compared to experimental group I & II respectively, all against the control group. This indicates that the difference is in favour of Experimental group I and II.

Research Question Two: What is the difference in the mean Academic Performance score of male and female students taught Physics using Inquiry Strategy in Senior Secondary Schools of Rimi ZEQA?

Table 4.6: Differences in the Mean Performance scores between male and female students in Experimental Group I

Groups	N	Mean	Std. Dev.	Mean difference
Male	37	47.19	4.48	0.00
Female	28	46.71	3.08	0.48

From Table 2, the difference between the mean academic performance scores of male and female students taught physics using Inquiry strategy is 0.48, with the male students recording a mean of 47.19 and standard deviation of 4.48 and the female students recorded a mean of 46.71 and standard deviation of 3.08. This indicates difference is in favor of the male students.

Research Question Three: What is the difference in the mean Academic Performance score of male and female students taught Physics using Laboratory Strategies in Senior Secondary Schools of Rimi ZEQA?

Table 3: Differences in the Mean performance scores of male and female students in Experimental Group II

Groups	N	Mean	Std. Dev.	Mean difference
Male	37	47.68	2.38	0.00
Female	18	48.44	1.88	0.76

From Table 3, the difference between the mean academic performance scores of male and female students taught physics using Laboratory strategy was 0.76 (the female recorded the mean of 48.44 and standard deviation of 1.88 while the male recorded a mean of 47.68 and standard deviation of 2.38). The difference is in favor of the female students; however, the difference is not much.

Hypotheses Testing

In order to be able to test the stated hypotheses, the researcher used inferential statistics, ANOVA and Independent samples t-test statistics to be specific. The use of this statistics was based on the nature of the data collected. Moreover, and all the hypotheses were tested at 5% level of significance.

H_{01}: There is no significant difference between the mean Academic Performance scores of Students taught physics using Inquiry strategy, Laboratory Strategies and those taught using lecture method. This hypothesis was tested using analysis of Variance (ANOVA) at a 0.05 level of significance.

Table 4: Summary of ANOVA on significant difference in performance scores of students taught physics using Inquiry strategy, Laboratory strategy and lecture method.

Source	Sum of Squares	Df	Mean Square	F	Sig.	Remark
Between groups	11387.57	2	5693.79	472.00	0.00	Significant
Within groups	2436.74	202	12.06			
Total	13824.31	204				

Significant at $P \leq 0.05$

Table 4 presented the Summary of ANOVA on significant difference in Performance scores of students taught physics using Inquiry strategy, Laboratory strategy and lecture method. Results show that Sum of Squares observed between groups is 11387.57, within groups is 2436.74. The f-value observed is 472.00 and the p-value observed is 0.00. The p-value recorded is less than alpha value (0.05). The hypothesis is therefore rejected. There is significant difference between the mean Academic Performance scores of Students taught physics using Inquiry strategy, Laboratory strategy and those taught using lecture method. To determine the location of difference, the researcher further analyzed the result using Post-hoc test and result is presented in Table 4.12.

Table 5: Post hoc Tukey comparisons of students Performance by groups.

(I) grouping	(J) grouping	Mean Difference (I-J)	Std. Error	P-Value	Remark
Exp. Grp. I	Exp. Grp. II	0.94	0.64	0.302	Not
	Control Grp	14.68	0.57	0.00	Sig.
Exp. Grp II.	Exp. Grp I	0.94	0.64	0.302	Not Sig.
	Control Grp	15.62	0.60	0.00	Sig.
Control Grp.	Exp. Grp I	-14.68	0.57	0.00	Sig.
	Exp. Grp II	-15.62	0.60	0.00	Sig.

Significant at $P \leq 0.05$

Table 5 presents Post hoc Tukey Comparisons of students' performance by groups. Results shows that there is no significant difference in the performance of students in experimental group I and II (P=0.302), but significant difference exist between Experimental group I when compared to control group (P=0.00). Similarly, there is significant difference in the performance of experimental group II and control group (P=0.00). This indicate that students exposed to Inquiry and Laboratory strategy performed better than their counter parts exposed to lecture method.

H_{02}: There is no significance difference between mean Academic Performance scores of male and female Students' taught Physics using Inquiry Strategy. This hypothesis was tested using t-test at a 0.05 level of significance.

Table 6: t-test Analysis of male and female students' Academic Performance in Experimental Group I

Groups	N	Mean	Std. Dev.	df	t value	P value	Remark
Male	37	47.18	4.48	63	0.480	0.633	Not Significant
Female	28	46.71	3.09				

Significant at $P \leq 0.05$

Table 6 shows that the t-value obtained for the difference between mean Academic Performance scores of male and female Students' taught Physics using Inquiry Strategy is 0.480, the P value is 0.633 at degree of freedom 63. Since the p-value of 0.633 is greater than the alpha value 0.05, the null hypothesis which states that there is no significant difference between mean Academic Performance scores of male and female Students' taught Physics using Inquiry Strategy is hereby retained. Consequently, there is no significant difference between mean Academic Performance scores of male and female Students' taught Physics using Inquiry Strategy among senior secondary schools of Rimi ZEQA.

H_{03}: There is no significance difference between mean Academic Performance scores of male and female Students' taught Physics using Laboratory Strategy.

This hypothesis was tested using t-test at a 0.05 level of significance.

Table 7: t-test Analysis of male and female students' Academic Performance in Experimental Group II

Groups	N	Mean	Std. Dev.	Df	t value	P value	Remark
Male	37	47.68	2.38	53	-1.197	0.236	Not Significant
Female	18	48.44	1.89				

Significant at $P \leq 0.05$

Table 7 shows that the t-value obtained for the difference between mean Academic Performance scores of male and female Students' taught Physics using Laboratory Strategy is -1.197, the P value is 0.236 at degree of freedom 53. Since the p-value of 0.236 is greater than the alpha value (0.05), the null hypothesis which states that there is no significant difference between mean Academic Performance scores of male and female Students' taught Physics using Laboratory Strategy is hereby retained. Consequently, there is no significant difference

between mean Academic Performance scores of male and female Students' taught Physics using Laboratory Strategy among senior secondary schools of Rimi ZEQA.

Discussion

Finding number one revealed significant difference between the mean Academic Performance scores of Students taught physics using Inquiry strategy, Laboratory strategy and lecture method, also in favor of those taught using Inquiry and Laboratory strategies. This shows that Physics students taught using Inquiry strategy and Laboratory strategy performed better than their counterpart taught using Lecture Method. The finding agreed with that of Dalhat and Olalaro (2022) which revealed a significant difference in the performance of students in favour of the inquiry strategy group and concludes that inquiry strategy be adopted by teachers of Physics to improve students' performance to bridge the gap among high, medium and low achiever. The finding also contradicts that of Agboola and Oloyede (2019) who reported that the project method brings about a significant difference in the achievement of the experiments of subjects in the experimental group compared with those exposed to inquiry and lecture-demonstration methods of teaching Separation of Mixtures as a Model of Experimental Aspect of Chemistry. The finding is in congruence with that of previous researches researchers like Ayama (2019), Pandey, Nanda and Ranjan, (2017), Saeed, (2017), whose observation revealed supremacy of inquiry approach when compared to other approaches. Other studies that shares similar view include that of Hussaini, Azeem and shakoor (2017) whose work explored that there is significant effect of guided, unguided and combination scientific inquiry on students' achievement than traditional physics teaching method and their proficiency to apply the concepts of physics in real situations.

Finding to research hypothesis two revealed that there is no significant difference between mean Academic Performance scores of male and female Students' taught Physics using Inquiry Strategy. This finding is similar to that of Akanmu and Fajemidagba (2014) who investigated the effect of guided discovery learning strategy on students‟ performance in Math alongside influence of gender and scoring levels ability of the students. The finding to their study revealed that both male and female students performed equally well when taught using Guided-Discovery strategy. Similarly, John (2014) reported that that the peer tutoring is gender friendly and effective in the teaching and learning of geometry.

Finding number three revealed no significant difference between mean Academic Performance scores of male and female Students' taught Physics using Laboratory Strategy. Tran (2014) carried out a study on laboratory on the academic achievement and knowledge among students, finding shows that that Laboratory Strategy, despite being gender friendly also promotes higher level of achievement and knowledge.

Conclusion

The study on the effect of inquiry and laboratory strategies on physics academic performance in senior secondary schools in Katsina State, Nigeria, has provided valuable insights into the impact of these teaching approaches on students' learning outcomes. The following conclusions can be drawn from the study

i. The study suggests that employing inquiry and laboratory strategies can lead to improved academic performance among physics students.

ii. No significant difference in the students' academic performance of male and female students taught Physics concepts using inquiry and laboratory strategies were observed. This means that inquiry and laboratory teaching strategy is gender friendly.

Recommendations

In view of the research findings the following recommendations are put forward:

i. Physics teachers should be encouraged to use inquiry and Laboratory strategies in teaching Physics concepts at secondary schools of level as it is empirically established that it enhances students' academic performance.

ii. Curriculum planners and book publishers should incorporate student centered activities and constructivist approaches such as inquiry and laboratory strategies in designing and implementing the curriculum.

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