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The Effect of Inquiry Teaching Approach in Enhancing Physics Students' Achievement in Physics in Ekiti State, Nigeria

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Abstract

This study was set to verify the effect of inquiry teaching approach and conventional teaching approach on secondary school students' learning outcomes in Physics, Ekiti State is the focus of this study. This study adopted the non-equivalent pre-test, post-test, experimental design. The population of the study comprised of all Secondary School (SSII) Physics students, the sample consisted of SSS II students in intact Physics classes in one Local Government Area (LGA). Two research instruments titled Physics Achievement Test (PAT) and Attitude to Physics Teaching and Learning Questionnaire (APTLQ) were used for the purpose of data collection. The PAT contained 20 multiple choice objective test items drawn from past WAEC questions which was used as pre-test to ascertain equivalent ability of the groups, The post-test was carried out to ascertain the effect of the treatment on their academic performance, and the retention test was administered two weeks after the post-test to determine the extent at which they retain Physics concepts. The APTLQ consisted of 20 carefully structured items requesting their attitude towards Physics. It used the 4-point Likert scale which assigns 4 – Strongly Agree (SA), 3 – Agree (A). 2 – Disagree (D) while 1 go for Strongly Disagree (SD) respectively. Three research hypotheses were formulated at 0.05 level of significance. Results of the data analysis revealed that, students taught with inquiry teaching approach performed better than those taught with conventional teaching approach in the achievement test and the inquiry teaching approach improved students' attitude towards Physics than the conventional teaching approach. It equally helps students' retention ability of Physics concepts.

Keywords: *Inquiry teaching approach, Convectional teaching approach, Learning outcome, Instructional strategy, Achievement and Equivalent ability.*

Introduction

Science is globally recognised as of a great importance both to the technological and economic development of a nation. Nations of the world are classified as developed or underdeveloped nations based majorly on their scientific strength. Scholars have explained the concept of science varyingly; Muhammad (2007) defined science as a system of knowledge, a process of acquiring and refining knowledge through the process of observation and experimentation, while Bassey (2003) viewed science as an attempt to understand and represent nature, to understand human memory and to express these understanding in some coherent way.

Science is the need of all times, its teaching is therefore indispensable in the present day world of rapid progress and development. The major contribution of science education is the inculcation of scientific attitude in the learners. Scientific attitude according to

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Muhammad (2007) means open mindedness, a desire for accurate knowledge and confidence in procedures for seeking knowledge and means of stimulating creativity among the learners.

Science education finds a large number of applications in our daily lives. The indispensable contributions of science are clearly seen in the fields of medicine, transportation and information technology. Science teaching enable learners to see that experimental evidence is a tool in making sense of the world around them. Kumar (1995) opined that the most significant aspect of modern science is the impact it has had in solving a variety of problems of practical and technological importance as well as those related to the pressing problems of mankind. Science and technology is associated with modernity which is an essential tool for rapid development.

Physics is an important science subject that is closely related to technology. It is a branch of physical science that explains the property of matter and energy and the relationship between them. Physics focuses on the general nature of the natural world. Physics has played a crucial role in the service of mankind. The principles in Physics are daily applied in our homes and the discoveries made from these principles have been of great importance to human existence. The reliance on technology reveals the importance of Physics as a subject.

Physics is a fundamental science. Its application cuts across all other science subjects. Other disciplines such as agriculture, environmental and biological sciences use the laws of Physics to better understand their studies. Physics has many applications in medicine. The discoveries in Physics are being exploited by medical communities to devise new techniques for diagnosing and treatment of a variety of illness (Mohammed, 2007).

Modern means of transportation such as auto-mobiles and aircraft are all made possible through the application of basic laws in Physics. Also in the entertainment industry, the principles of Physics are employed in the refinement of sound and colour mixing to create special effects in stage presentation, furthermore, its principles of Physics formed the basis in information technology which has helped to reduce the world into a global village. The discoveries of telephone, radio, television, fax machine, computer, satellite and internet services have literally decreased the distance between nations and provided the basis for a corporate living, coexistence and better human relations. All these lead to development of social standard in both personal and professional life.

The knowledge of Physics is applied in various ways of human life considering the very large number of electrical and electronic devices utilizes one or the other principles or laws of Physics. Discoveries made by physicists such as magnetism, electricity and conductors helps in the formation of modern conveniences like television, radio and other electrical and household equipment. A wide range of application of Physics is used in industrial development of materials necessary for the wellbeing of human race.

Physics education is therefore essential to enable the learner acquire problem-solving and decision-making skills that provide ways of thinking and inquiry which help to respond to wide spread and radical changes in industry, health, climate, information technology and economic development. The purpose of teaching Physics in the secondary schools is to enable student to systematically grasp the creative knowledge of Physics needed for further study of modern science and technology and to understand its applications.

Another important factor is the instructional technique adopted by the teacher in Physics classroom and laboratory. According to Duyilemi (2000), how to learn is as important as what to learn, but how to teach (teaching strategy) is more important than what

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to teach. Physic teachers still frequently apply the old and conservative method of teaching which is the unilateral transmission of information from the teacher who serves as the source, to the student who is the receiver, for this to change there is need to carry out a study on teaching strategies.

Various teaching methods have been suggested by researchers in science based subjects which are: inquiry teaching approach, demonstration, interactive, learning cycle model, team teaching, project and assignment, others are program instruction, blended learning, mastery learning, mind mapping, concept mapping, individualized instruction, and problem solving (Llewellyn, 2007; Susanne, 2011; Bello, 2011). Despite the development of these lofty instructional strategies in theory, one would wonder why Nigeria Physics teachers particularly Ekiti State, Gbonyin Local Government science teachers are convenient with the traditional lecture method regardless of its attendant effect on level of achievement of students in subject. The transmission is said to be effective but the reception is negligible. The teachers' methods of teaching may go a long way in enhancing effective learning by the students. The traditional teaching method of Physics in schools is the one that involves "chalk and talk" activities which is teacher centered, where the students becomes passive 'robots' in the classroom and regards the teacher as the repertoire of knowledge. Studies have also advocated for the 21st century approaches to science teaching in Nigeria. These approaches include inquiry, collaborative teaching and discovery among others.

This study compared the influence of the inquiry teaching approach with the conventional approach of teaching Physics in other to determine which of these approaches is most effective in enhancing students' attitude, improve their academic performance and retention of Physics.

Therefore, the specific objectives of the study are to:

i. examine the influence of Inquiry Teaching Approach (ITA) on improving students' academic performance in Physics;
ii. establish the influence of ITA on enhancing students' attitude towards learning Physics;
iii. determine the influence of ITA on enhancing students' retention of Physics concepts.

Research Hypotheses

The following research hypotheses were generated to guide the study.

i. There is no significant difference in the academic performance of students taught with ITA and conventional teaching approach (CTA).
ii. There is no significant difference in the attitude of students taught with ITA and CTA towards physics.
iii. There is no significant difference in the retention of students taught with ITA and CTA.

Methodology

The Study adopted the pre-test, post-test, control group research design. The target population for the study comprised all the senior secondary schools two (sss2) students offering Physics in Gbonyin Local Government Area of Ekiti State.

The Sample for the study consisted of forty three (43) senior secondary schools two (sss2) Physics students. Stratified random sampling technique was used to select two schools from

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the local Government. Students from the schools selected were randomly assigned to experimental group and control group.

Two instruments were tittle Physics Achievement Test (PAT) and, Attitude to Physics Teaching and Learning Questionnaire (APTLQ) were used for the purpose of data collection. The PAT consists of 26 multiple choice questions drawn from (sss2) syllabus. The PAT was used as pre-test to ascertain equivalent ability of the groups and for the post-test to ascertain the effect of the treatment in their performance. The retention test was administer was administered two weeks after the post-test to determine their retention ability in Physics concept taught.

The APTLQ also consists of 20 carefully structured items requesting their attitude towards Physics. It used 4-point likert scale. The instruments were validated by giving PAT to two experienced secondary school physics teachers who have been NECO and WAEC examiners for more than ten years and also an expert in test and measurements department. Furthermore, a copy of APTLQ was given to expert in test and measurements. The items in the PAT and APTLQ were modified based on the suggestions raised by the experts.

The reliability of the instruments were ascertained through test-re-test method, copies of APTLQ were administered on 20 physics teachers outside the target population two times within an interval of two weeks while copies of PAT were equally administered on 20 physics students outside the target population twice within an interval of two weeks and their responses were collected and analyzed using Pearson Product Moment Correlation Analysis and a reliability co-efficient of 0.86 and 0.76 were obtained for APTLQ and PAT respectively.

The instruments were administered to the respondents by the researchers and were collected back. Data collected were analyzed using inferential statistics of means, standard deviation and one-way analysis of variance (ANOVA).

Results of Findings

Hypothesis One: There is no significant difference in the academic performance of students taught with ITA and CTA in Physics.

In testing this hypothesis, the pre-test and post-test scores of the ITA and CTA groups were compared and analyzed using descriptive statistics and one-way analysis of variance (ANOVA) at 0.05 level of significance. The results are presented in tables 1 and 2.

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Table 1: Descriptive Statistics of Students' Pre-test and Post-test Scores

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Mini	Maxi
					Lower Bound	Upper Bound		
Pre-test ITA	28	6.3425	3.01667	.33144	7.4629	8.8073	4.00	14.00
Post-test ITA	15	15.546	3.12564	.34418	10.9605	18.3553	8.00	18.00
Pre-test CTA	28	3	3.00200	.34334	7.1544	8.5515	4.00	12.00
Post-test CTA	15	7.8529	3.46472	.42270	7.6694	9.3894	4.00	16.00
Total	86	8.5294	3.16547	.22110	9.3845	10.2563	4.00	19.00

Table 1 shows the pre-test mean scores of students in ITA and CTA as 6.3425 and 7.8529 while their respective post-test means scores are 15.5463 and 8.5294. Since the post-test mean score for ITA is greater than the post-test mean score for CTA it is evident that the ITA group performed better than the CTA group which implies that the least effective in terms enhancing performance is CTA.

Table 2: One-way ANOVA for the Performance of Students taught using ITA and CTA.

	Sum of Squares	**d f**	**Mean Square**	**F**	**Sig.**
Between Groups	2261.000	5	124.200	81.438	.000
Within Groups	603.354	300	4.517		
Total	2864.354	305			

P>0.05

Table 2 shows the ANOVA analysis of the students' pre-test and post-test scores in the experimental and control group. The F = 81.438 at 0.000 level of significance clearly depicts significant effect of the intervention/treatment on the students.

These points to the fact that ITA has the highest effectiveness in enhancing students' performance while CTA is the least effective, based on the results, the hypothesis stating that there is no significant difference in the academic performance of students taught with ITA and CTA is hereby rejected.

Hypothesis Two: There is no significant difference in the attitude of students taught with ITA and CTA towards Physics.

In testing this hypothesis, the pre-test and post-test mean score of students from the Attitude to Physics Teaching and Learning Questionnaire (APTLQ) in the two groups were compared using the descriptive statistics and one-way ANOVA The results are presented in tables 3 and 4.

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Table 3: Descriptive Statistics of Students' Pre-test and Post-test Attitudinal Test

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-test ITA	28	48.1351	7.21943	1.18687	52.7281	57.5422	40.00	68.00
Post-test ITA	28	69.5526	6.29756	1.02160	58.4827	62.6226	50.00	72.00
Pre-test CTA	15	47.5294	6.52842	1.11962	57.2515	61.8073	47.00	72.00
Post-test CTA	15	58.9118	6.34545	1.08824	56.6977	61.1258	45.00	72.00
Total	86	58.3641	8.23961	.57408	57.2322	59.4959	34.00	76.00

Table 3 shows that the pre-test attitudinal mean scores of the students in ITA is 48.1351 and CTA is 47.5294 respectively. While the post-test attitudinal mean scores of the students accordingly for each of the groups are ITA (69.5526) and CTA (58.9118). This is an indication that students taught using ITA developed a more positive attitude to Physics compared to CTA.

Table 4: One-way ANOVA for the Students' Attitude to Teaching and Learning of Physics Questionnaire in the ITA and CTA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5342.495	8	2367.675	39.698	.000
Within Groups	7657.199	300	57.536		
Total	13998.694	308			

P>0.05

Table 4 shows that the results of the ANOVA for the Attitude to the Teaching and Learning of Physics Questionnaire among the two groups. The result indicates that, there is a statistical significant difference between the mean scores. The F = 69.5526 at P >0.05 significant level and between mean square is greater than within means squares. This implies that, there is significance difference in the attitude of students exposed to and ITA and CTA. Based on results above, the hypothesis stating that there is no significant difference in the attitude of students taught with ITA and CTA towards Physics is hereby rejected.

Hypothesis Three: There is no significant difference in the retention of students taught with ITA and CTA in Physics.

To test this hypothesis, the retention tests of the two groups were compared using the descriptive analysis and the ANOVA. The results are presented in tables 7 and 8.

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Table 5: Descriptive statistical analysis of Retention Test Scores of Physics taught using LCA, and CTA

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
ITA	28	11.6216	2.05955	.33859	10.9349	12.3083	8.00	17.00
CTA	15	7.1471	1.98681	.34074	6.4538	7.8403	3.00	11.00
Total	43	10.9515	3.57929	.35268	10.2519	11.6510	3.00	19.00

The table shows the mean scores of the retention test which indicates that the ITA (11.6216) is greater than CTA with (7.1471). This clearly depict that the students taught using ITA retains the Physics concepts better than the students taught using the CTA.

Table 6: One-way ANOVA analysis of Retention Test Mean Scores of Students taught using ITA and CTA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	850.321	2	425.161	63.148	.000
Within Groups	1456.436	100	4.564		
Total	2306.757	102			

$p>0.05$

The results from table 6 indicates that, at probability level of 0.05 and F = 63.148, depicts that significance exists in retention of Physics concepts among the students taught using ITA and CTA. The hypothesis stating that, there is no significant difference in the retention of students taught using ITA and CTA in Physics is hereby rejected.

Discussion of findings

The findings of the study indicated that there was no significant difference in the performance of Physics students prior to the treatment using inquiry-teaching and the conventional teaching approaches. This indicated that the students have equivalent entry behavior at the beginning of the study. It is also an indication that the students were homogenous in terms of prior knowledge of Physics.

The result of hypothesis one which states that, there is no significant difference in the academic performance of students taught with ITA and conventional teaching approach (CTA) revealed that, students in the experimental groups ITA gained higher scores when their post-test mean scores were compared to their pre-test scores than those in the control group. This is an indication that the interventions given have improved their performances in Physics.

The result of the findings agrees with the work of earlier researchers such as Liewellyn (2007), Susanna (2011) and Jill (2007) where they also recorded a significant effect of inquiry teaching approach in enhancing students' performance in Chemistry and other science subjects. Abdul, Muhammed and Monzoor (2011) also corroborated the result

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where they described the inquiry teaching as an approach that ensures students' positive participation, on-task behaviour, and rich collaboration as well as empowering students' ownership and self-directed learning by increasing their involvement and responsibility for their own learning. In the view of Hasret and Necati (2006) in a study on relative effect of inquiry teaching to increase the students' achievement in Physics, revealed that, inquiry teaching approach is an educational model that helps to resolve the main problems in teaching the scientific knowledge. It facilitates students to learn effectively and organize the knowledge in a meaningful way. It also corroborated the submission of Madu and Amaechi (2012) in an investigation into the effect of five-step learning-cycle model a form of inquiry teaching approach on students' understanding of concepts related to elasticity found that, the implementation of the inquiry teaching enhances students' understanding of key concepts involved in elasticity. The reason for this observation may be attributed to value associated with alternative ways of acquiring knowledge in science and confirmation of value of hands-on activities which are characteristics of an inquiry model models. The result here seemed not to be in consonance with the result of studies conducted by Mayer (2008) and Iroegbu (2000) where they discovered that pure inquiry in form of discovery learning makes the students lost, frustrated and confusion leads to misconception and affects performance.

Hypothesis two which states that, there is no significant difference in the attitude of students taught with ITA and CTA towards physics was set out to determine the effectiveness of inquiry-teaching approach on the students' attitude to Physics indicated that, the inquiry-teaching approach shows effectiveness in improving the students' attitude to Physics. The result of this hypothesis elucidated the results of the study conducted by Susanne (2011) where it was discovered that inquiry teaching demonstrated modest improvement in overall students' achievement and self-expressed interest, attitude and confidence in Physics. The result is also in line with the study of Barrow (2007) where he described the effect of using inquiry as leading the students to the acquisition of skills and the development of positive attitude that permits the students to seek resolutions to questions of meaningful and logical answers.

Hypothesis two which states that, there is no significant difference in the retention of students taught with ITA and CTA. The results from this hypothesis showed that inquiry teaching approach enhances students' retention of Physics concepts with the retention test mean score of students taught using ITA and CTA. The findings of this hypothesis corroborated the results of study conducted by Burke (2007) where it was discovered that inquiry teaching was being able to form a connection between classroom science and students' daily experiences of living which makes learning long lasting. The result also corroborated the finding of Hasret and Necati (2006) which showed that inquiry teaching makes scientific knowledge to be long-lasting (retention). The findings also corroborated Madu and Amaechi (2012) in an investigation into the effect of five-step learning-cycle model on students' understanding of concepts related to elasticity found that, the implementation of the inquiry teaching model enhances students' understanding of key concepts involved in elasticity. The reason for this observation may be attributed to value associated with alternative ways of acquiring knowledge in science and confirmation of value of hands-on activities which are characteristics of the learning models.

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Conclusions

The concern of Physics teachers, researchers and educators is the search for efficient and effective ways of communicating Physics concepts to students. Based on the analysis of data and the interpretation of the results of this study, it can be deduced that the inquiry teaching approach produce significantly better performance and retention in Physics achievement and retention test than conventional teaching approach, therefore inquiry teaching approach is an effective mode of instruction for Physics students in secondary schools. The findings revealed that the ITA can be used for teaching and learning of Physics in secondary schools. ITA was found to be effective because it improves the performance of students, enhances retention of concepts and brings about the students' development of positive attitude to Physics.

Recommendations

Based on the submissions above in this study the following recommendations are hereby offered:

1. All Physics teachers must have a comprehensive understanding of the hierarchical nature and relationship of various pedagogical practices and inquiry process if they are to teach Physics effectively.
2. Teacher education programs should emphasize inquiry-teaching approach and in-service teachers should be provided training or refresher course to enable them to use inquiry-teaching approach in Physics classroom.
3. Government should increase the grants going to schools, so that the Physics laboratories could well equipped to the required standard. This will ease the stress of teachers in their bid to designing the instructional packages for teaching and learning Physics.
4. Physics curriculum should be designed using the inquiry teaching approach, and textbooks should be written using the features and hierarchical nature of inquiry-approach to compliment the teachers work in the classroom.

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