EFFECT OF COMPUTER-AIDED INSTRUCTION ON RETENTION BETWEEN FIELD-DEPENDENT AND FIELD-INDEPENDENT NCE PHYSICS STUDENTS IN NORTH-WEST, NIGERIA

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ABSTRACT

This study examined the effect of Computer-Aided Instruction on Retention between Field-Dependent and Field-Independent NCE Physics students in North-West, Nigeria. The study developed two Research Objectives; answered two Research Questions and tested two Null Hypotheses. The research design for this study is Quasi-experimental group design involving pre-test, post-test and post post-test. Two groups of students were used for data collection, the experimental and control group and both were pre-tested before the treatments; post-tested to determine the effect of treatments on retention among the groups. The population of this study covered a total of 500 NCE II Physics students in five Federal Colleges of Education in North-West, Nigeria. The sample of this study covered a total number of 135 students. A validated instrument with reliability coefficient of 0.8 namely Physics Electromagnetism Performance Test (PEPT) was used for data collection. Research questions were answered using mean and standard deviations, while Null Hypotheses were tested using ANCOVA on significant difference in retention of Field-Dependent and Field-Independent at 0.05 level of significance. Findings show that the mean performance scores of Field-Dependent and Field-Independent students taught Electromagnetism concept using Computer-Aided instruction is greater than that of their counterparts taught using lecture method among others. Based on the findings of this study, the researchers recommended that the Federal Government of Nigeria through state ministries of Education should collaborate with professional bodies such as STAN and train teachers through workshops and seminars on using Computer-Aided Instruction in teaching Physics at Colleges of Education.

KEYWORDS: Computer-Aided Instruction, Retention, Field-Dependent, Field-Independent

Introduction

Science is an organised body of knowledge in the form of concepts, laws, theories, and generalizations. According to Russell (2017), science is the study of nature and natural phenomena in order to discover their principles and laws. Science has three interrelated dimensions: content, process, and attitude. Content can be separated into physical, life, and earth sciences. The process involves the 15 inquiry skills proposed by the American Association for the Advancement of Science (AAAS), which include observing, classifying, experimenting,

measuring, inferring, organising data, to mention a few (Ahmed & Artosh, 2016). An attitude is a predisposition or a tendency to respond positively or negatively towards a certain idea, object, person, or situation. It influences an individual's choice of action and responses to challenges, incentives, and rewards (all together called stimuli) (Achor, Imoko & Tyavbee 2010). Science is the intellectual and practical activity encompassing the systematic study of the structure and behaviour of the physical and natural world through observation and experimentation. It is also a systematically organised body of knowledge on any subject (Rowley & Hartley, 2017). Science as a branch of knowledge is the systematic study of things around us. Scientific knowledge is comprised of the totality of knowledge obtained from scientific studies (Berestova, 2015).

On the other hand, science education is "the total process of human learning by which knowledge is impacted, faculties trained, and skills developed" (Omorogbe & Ewansiha, 2013: 35). Science education is a field of study concerned with producing a scientifically literate society. It is a field concerned with sharing the scientific content and process with individuals not traditionally considered part of the scientific community. The target individuals may be children, secondary or college students, or even adults within the general public. The field of science education comprises science context, some social context, and some teaching pedagogy (Illeris, 2018).

The standard for science education provides expectations for the development of understanding for students through the entire course of their secondary and tertiary education. Some traditional subjects included in the standards are biology, chemistry, and physics. Physics is one such discipline that constitutes science education. Physics is a branch of science that is concerned with fundamental ideas about nature and attempts to establish relationships between different quantities as precisely as possible (Serway & Jewett, 2018). In addition, Stonier (2012) defined physics as a physical science that is concerned mainly with matter as it relates to energy as well as the study of laws that determine the structure of the universe.

Physics is a very important subject for the development of a nation. Physics and its concepts and techniques result in the understanding of all other branches of science (Willis, 2017). Based on this, the Federal Republic of Nigeria places the subject as one of the core subjects that all science students must be exposed to at the senior secondary school level (Sooter, 2013). The knowledge of physics facilitates the understanding of other science disciplines (Singer & Smith, 2013). Physics is also a cross-cutting discipline that has applications in many sectors of economic development, including health, agriculture, water, energy, and information technology (Huyer, 2015). For instance, an understanding of physics is quite necessary for developing new instrumentation and techniques in the health sector. With the help of medical physics, the right equipment for the diagnosis of diseases and the efficient communication of medical data is acquired (Heywood & Heywood, 2017).

Physics is a unique subject that promotes the acquisition of specialised science skills and knowledge and explains the natural phenomena of life in society (Mulkay, 2014). It is a subject that has grown up with civilization as man's quantitative needs have increased. It has contributed to the development of the sciences and civilization.

Physics extends and enhances the understanding of other science disciplines, such as the earth, agricultural, chemical, biological, and environmental sciences, plus astrophysics and cosmology-subjects of substantial importance to all peoples of the world, and improves our

quality of life by providing the basic understanding necessary for developing new instrumentation and techniques for medical applications, such as computer tomography, magnetic resonance imaging, positron emission tomography, ultrasonic imaging, and laser surgery (Martinas & Tremmel, 2014).

Retention is the ability to remember things, tasks, or material learned (for example, weather concepts) previously learnt. It is the endurance of behaviors that have been learned or acquired when the behaviour is not being utilized. Sluckin (2018) maintains that retention has to do with the ability of human beings to reproduce past learning. Every individual demonstrates some level of mastery in reproducing previous learning or experience. For this to happen, Spencer (2017) stated that three stages of human behaviour have to be considered, viz., (a). There must be some initial learning experience, (b) an interstitial period during which the individual stores the learned materials and experience, and (c) a final stage of reproduction of the initially learned materials or experience.

Akpan (2006) studied in chemistry, Bello (2015) studied in Physics, and Yusuf and Adekanmbi (2018) studied in Agriculture. Although these studies were conducted in several disciplines, it is shown that FI/FD cognitive styles are one of the important predictors of students' Academic Achievement. The first studies in science and agriculture were conducted by Witkin, Oltman, Raskin, and Karp (1977). As a result of this study, Witkin in Yusuf and Adekanmbi (2018) indicated that there was a significant correlation between FI/FD cognitive styles and science and agriculture academic achievement, and FI students were more successful than their FD peers in both courses. Similarly, results were asserted by VanEck (2015) when he studied force and motion subjects. Witkin et al. (1977) emphasised differences between FD and FI students' cognitive abilities to explain variation between FI and FD students' science Academic Achievements. According to Witkin et. al. (1977) and VanEck (2015), FI students are more successful than FD counterparts in science and mathematics since FI students are better than FD students about distinguishing relevant clues. But Ateş and Çataloğlu (2011) found that there is no statistically significant difference between FI/FD students' scores on Force Concept Inventory (FCI). According to Ateş and Çataloğlu, one reason of this result is that FCI doesn't require some skills that favoured FI. Hence, Ateş and Çataloğlu asserted that FCI is not appropriate assessment tool in order to determine the Impact of FI/FD cognitive styles due to its structure and style.

By the end of the 1990's, researchers began to examine the impact of FI/FD cognitive styles on science academic achievement. The result showed that there was a statistically significant mean difference between FD and FI students' conceptual understanding levels of force and motion when they were assessed using a multiple choice test. On the other hand, there was no statistically significant mean difference between FD and FI students' conceptual understanding levels when they were assessed through an open-ended test and structural communication grids.

Ates and Çataloğlu (2011) examined the impact of FI/FD cognitive styles on freshman students' academic performances related to applications of degrees of naïve impetus theory. Two-tier and multiple-choice tests were used to determine students' application degrees of naïve impetus theory. When the data was analyzed, it was found that there were statistically significant correlations between FI/FD cognitive styles and students' application degrees of naïve impetus theory, and that FI students' application degrees were higher than FD students'

in both tests. From these findings, Ateş and Çataloğlu (2011) asserted that some of the factors that affect students' academic performance are: (a) the content and presentation of the test; (b) the format of the test; and (c) the cognitive difference of the individual, like FI/FD. It is along these lines that this study sought to investigate the impact of field-dependent and field-dependent cognitive styles in Colleges of education in North-West of Nigeria.

The research is set to investigate the retention of field-dependent and field-independent NCE Physics students exposed to computer-aided instruction in Federal Colleges of Education North-West, Nigeria. States such as Kaduna, Kano, Katsina, Jigawa, Zamfara, Kebbi, and Sokoto were involved. NCE (II) students were used for this purpose. The justification behind the use of NCE (II) students rests on the fact that the NCE Curriculum outlines Electromagnetism II as a concept taught at this level. In addition, students at this level are perceived as the most suitable for research of this nature because they are neither finalists nor introductory students. The study is also delimited to the electromagnetism II concept of physics. It is a 200-level course, and many scholars, such as Atadoga & Lakpini (2013), attribute that students are failing the course over the years. The findings and conclusions were delimited to the population from which the sample was drawn.

Statement of the Problem

Research reports and available literature over the years (Atadoga & Lakpini, 2013) revealed that poor Academic Performance among NCE students in Electromagnetism Examination still persists. For instance, released result for 2011/2012 Physics first semester result in the Department of Physics, Federal College of Education Zaria, has recorded mass failure. Only 20 percent of the candidates that sat for the examination scored average. Examination officer's report from 2011 to 2016 revealed that students' Academic Performance in Electromagnetism concept is not encouraging. The outcomes of analysis indicated that in 2011, only 26% were able to score a grade from A to C; the same situation in 2015. Although in 2016, the situation improves a little bit, still the Academic Performance is not encouraging which calls for the need of research of this nature. The justification behind choice of A to C as pass mark in this study is the emphasis by JAMB as admission regulating body in tertiary institutions of Nigeria that restrict a minimum of credit (C) across subject in the final year NCE result before consideration for Direct Entry admission into 200 level of any of the Nigerian Universities for NCE graduates.

Table 1: Seven Years Results of N.C.E II Students in Electromagnetism

Year	No. Sat	Passed (A to C)	%	Below C	%
2011/2012	80	35	43.7	45	56.3
2012/2013	120	55	45.8	65	54.2
2013/2014	115	40	34.8	75	65.2
2014/2015	125	38	30.4	87	69.6
2015/2016	120	55	45.8	65	54.2
2016/2017	135	50	37.0	75	63.0
2017/2018	180	70	38.9	110	61.1

Source: (Exam Office FCE, Zaria (2017)

Table 1: Presented the trend in performance of students in Electromagnetism in FCE Zaria. Results indicated that in the entire seven years, percentage of students who scored below C grade is greater than the percentage score from A to C grades.

Objectives of the Study

The objectives of the study are to:

1. examine the effect of Computer-Aided Instruction on Retention between Field-Dependent and Field-Independent Physics students in Electromagnetism concept and
2. find out the effect of Computer-Aided Instruction on Retention between male and female Field-Dependent and Field-Independent Physics students in Electromagnetism concept.

Research Questions

The following research questions are set to be addressed in this study;

1. What is the difference between the mean Retention scores of Field-Dependent and Field-Independent students taught Electromagnetism concept using Computer-Aided Instruction and those taught using lecture method?
2. What is the difference between the mean Retention scores of male and female Field-Dependent and Field-Independent students exposed to Electromagnetism concept using Computer-Aided Instruction and those exposed to lecture method?

Null Hypotheses

The following null hypotheses are formulated for testing at $P \leq 0.05$ levels of significance.

HO_1: There is no significant difference between the mean Retention scores of Field-Dependent and Field-Independent students taught Electromagnetism concept using Computer-Aided Instruction and those taught using lecture method.

HO_2: There is no significant difference between the mean Retention scores of male and female Field-Dependent and Field-Independent students taught Electromagnetism concept using Computer-Aided Instruction and those taught using lecture method.

Methodology

The research design for this study is Quasi-experimental-control group design involving pre-test, post-test and post-post-test. Two groups of students were used for data collection, Experimental Group (EG) and Control Group (CG) and both were pre-tested (01) before treatment. The treatment (X1) is teaching using Computer-Aided Instruction for Experimental group (EG) while the Control group (CG) were exposed to lecture method (Xo). This was followed by Post-test (02) to determine students' academic performance and interest in electromagnetism. After an interval of two weeks, the same test was administered as post-post-test to determine Retention among groups.

The population of this research work covers all NCE II Physics students in Federal Colleges of Education in North-West, Nigeria. There are five Federal Colleges of Education in the zone. NCE II Physics students were used for this study. However, there was total number of 500 NCE II

Physics students that formed the population of this study. Out of this number, 298 are males and 202 are females.

For the purpose of this study, 135 NCE II Physics students were sampled. The choice of 135 students as a sample is supported by Central Limit Theorem; Sambo, (2008) and Bello, (2015). In an experimental research, a minimum sample of size of about 30 is sufficient to provide required effect from a study population (Sambo, 2008).

To identify Field-Defendant and Field-Independent students and used as sample, the researcher, with the help of course lecturers used previous examination record of the students for the past five semesters and analyzed students' responses. In addition, Group Embedded Figure Test adapted from Witkin helped in identifying Field-Dependent and Field-Independent. The sample of the students was selected using purposive sampling techniques.

A validated research instrument namely Physics Electromagnetism Performance Test (PEPT) as used at (R=0.836) to generate data for the study. Physics Electromagnetism Performance Test (PEPT) contains 40 item performance test developed by the researcher to examine the retention the retention of students before and after treatment on electromagnetism concept of Physics.

The research questions raised were answered using descriptive statistics of Mean and standard deviations, while null hypotheses were tested infrentially by means of SPSS Package. Null hypotheses related to performance were tested using ANCOVA.

Discussion of Results

Research Question 1: What is the difference between the mean Retention scores of Field-Dependent and Field-Independent students taught electromagnetism concept using Computer-Aided Instruction and those taught using lecture method?

Table 2: Means and Standard Deviations of Retention Scores of Field-Dependent and Field-Independent in Experimental and Control Groups

Groups	N	Mean	Std. Deviation	Mean Diff.
Exp. Field-Dependent	44	31.31	3.60	
				2.22
Exp. Field-Independent	31	29.09	5.10	
Control Field-Dependent	36	21.26	6.84	
				3.60
Control Field-Independent	24	17.66	6.28	

The Table 2 presents the post-post-test mean Retention scores of Field-Dependent and Field-Independent students in experimental and control groups. From the result, the post-post-tests score of Field-Dependent students in experimental group is 31.31 while that of Field-Independent was 29.09. A mean difference of 2.22 is recorded against Field- Independent students. For the control group, the post-post-test score of Field-Dependent students was 21.26 while that of Field-Independent is 17.66 with a mean difference of 3.60 against Field-Independent students. When compared between Field-Dependent of experimental and control groups, a mean difference of 10.05 is observed against control group. This also gives a mean difference of 13.65 when compared with Field- Independent of control group. Field-

Independent students in experimental group retains better than Field-Dependent of control group 10.05 and Field-Independent of control group 13.65. A mean difference of 3.6 is recorded between Field-Dependent and Field-Independent of control group. Field-Dependent students taught Electromagnetism using Computer-Aided Instruction have the highest retention score, followed by Field- Independent in the same group; Field-Dependent of control group and finally Field- Independent of control group.

Research Question 2: What is the difference between the mean Retention scores of male and female Field-Dependent and Field-Independent students taught electromagnetism concept using Computer-Aided Instruction and those taught using lecture method.

Table 3: Means and Standard Deviations of post-post test Retention Scores of Male and Female Field-Dependent and Field-Independent in Experimental Group

Groups	N	Mean	Std. Deviation	Mean Diff.
Male Field-Dependent	25	30.40	3.04	
				1.38
Female Field-Dependent	14	31.78	3.96	
Male Field-Independent	19	33.07	4.32	
				6.43
Female Field-Independent	17	26.64	4.35	

The Table 3 Presents the post-post-test mean Retention scores of male and female Field-Dependent and Field-Independent students in experimental group. From the result, the post-post-tests score of male Field-Dependent students in experimental group is 30.40 while that of female Field-Dependent was 31.78. A mean difference of 1.38 is recorded against male Field-Dependent students. Similarly, male Field-Independent students in experimental group recorded a mean of 33.07, while female Field- Independent scored a mean of 26.64. A mean difference of 6.43 is recorded against female Field-Independent students.

Hypothesis 1: There is no significant difference between the mean Retention scores of Field-Dependent and Field-Independent students taught Electromagnetism concept using Computer-Aided Instruction and those taught using lecture method.

Table 4: ANCOVA on Significant Difference in Retention Scores of Field-Dependent and Field-Independent in Experimental and Control Groups

Source	Sum of Squares	Df	Mean Square	F	Sig.	Remark
Corrected Model	3796.68	4	949.17	33.38	.00	
Intercept	2045.79	1	2045.79	71.95	.00	
Pretest	6.78	1	6.78	.23	.62	
Grouping	3764.71	3	1254.90	44.13	.00	Sig.
Error	3411.92	120	28.43			
Total	92073.00	125				
Corrected Total	7208.60	124				

Table 4 presents the Summary of ANCOVA on significant difference in Retention scores of Field-Dependent and Field-Independent students taught Electromagnetism concept using Computer-Aided Instruction and those taught using lecture methods in Colleges of Education in North-

West Nigeria. Results show that Sum of Squares observed is 3764.719; a mean square is 1254.906. An f-value observed is 44.13 and the p-value observed is 0.00. The p-value recorded is less than alpha value. The hypothesis is therefore rejected. There is significant difference in Retention among Field-Dependent and Field-Independent students taught Electromagnetism concept using Computer-Aided Instruction and those taught using lecture methods in Colleges of Education in North-West Nigeria. To determine the location of difference, the researchers further analyzed the result using Post-hock test and result is presented in Table 4.

Hypothesis 2: There is no significant difference between the mean Retention scores of male and female Field-Dependent and Field-Independent students taught Electromagnetism concept using Computer-Aided Instruction and those taught using lecture method.

Table 5: ANCOVA on Significant difference in Retention of Male and Female Field-Dependent and Field-Independent in Experimental Group

Source	Sum of Squares	Df	Mean Square	F	Sig.	Remark
Corrected Model	396.70	4	99.17	6.73	.00	
Intercept	1544.93	1	1544.93	104.86	.00	
Pretest	20.67	1	20.67	1.40	.24	
Gender	378.32	3	126.10	8.56	.00	Sig.
Error	1031.29	70	14.73			
Total	70740.00	75				
Corrected Total	1428.00	74				

Table 5 presents the Summary of ANCOVA on significant difference in Retention scores among male and female Field-Dependent and Field-Independent students taught Electromagnetism concept using Computer-Aided Instruction in Colleges of Education in North-West Nigeria. Results show that Sum of Squares observed is 378.320; a mean square is 126.107. An f-value observed is 8.560 and the p-value observed is 0.00. The p-value recorded is less than alpha value. The hypothesis is therefore rejected. There is significant difference in Retention among male and female Field-Dependent and Field-Independent students taught electromagnetism concept using Computer-Aided Instruction in Colleges of Education in North-West Nigeria.

Conclusions

Based on the findings from this study, it is concluded that the use of Computer-Aided Instruction in teaching Electromagnetism is more effective in enhancing Performance, Retention and interest of NCE Physics students than lecture method. The strategy is gender friendly.

Recommendations

Based on the findings of this study, the researcher recommends that:

1. The Federal Government of Nigeria through State Ministries of Education should collaborate with professional bodies such as STAN and train teachers through workshops, and seminars on using Computer-Aided Instruction in teaching physics at Colleges of Education.

2. The use of Computer-Aided Instruction improved the Retention ability of students in the present study. As such therefore, lecturers of Physics should be encouraged to use the strategy as alternative strategy that they can fall back on in order to improve the teaching and learning of Physics.

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