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**Effectiveness of Computer-Aided-Instruction on Academic Performance in Electric Field Concepts among Integrated Science Undergraduate Students in Zaria, Nigeria**

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**BY**

**M. K. FALALU, *Ph.D***  
**Department of Science Education**  
**Ahmadu Bello University**  
**Zaria, Nigeria**

**&**

**Prof. M. M. ATADOGA**  
**Institute of Education**  
**Ahmadu Bello University**  
**Zaria, Nigeria**

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**ABSTRACT**

*This study investigated the effect of Computer-Aided-Instruction (CAI) on students' academic achievement in Electric Field concepts among undergraduate Integrated Science Students. The research design for the study was pre-test, post-test, quasi experimental design. The population of the study consisted of 210 (123 male and 87 female) year two University students in Zaria. Intact class participated in the study with 109 in experimental and 101 in control groups. Electric field concepts were taught using CAI in the experimental group. Electric Field Hockey Software and Electric Field Concept Achievement Test (EFCAT) with reliabilities 0.82 and 0.71 respectively were the instruments used. Two research questions and two null hypotheses guided the study. t-test statistic was used for data analysis. Major findings of the study revealed that the use of computer-aided-instruction was effective in enhancing students' academic performance and the impact of CAI was gender friendly. Based on the findings, it was recommended that science teachers should employ CAI strategy in their teachings and endeavor to acquire required skills for effective use of CAI in teaching sciences.*

**KEYWORDS: Computer-Aided-Instructions, Academic Performance, Effectiveness, Gender, Electric field concepts, Integrated Science**

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**Introduction**

Integrated science is an approach to teaching science education for the purpose of instilling problem solving techniques in learners and the development of future innovators (Robert 2012). The term integrated science is a synonym for interdisciplinary and unified science which could be applied to any curriculum setting in which two or more separate science subjects are combined (Showalter 1975, Blum 1991). According to Brown (1977) and Drake & Burns (2004) the integration may be characterized by a blending, fusion or collaboration of a number of subjects traditionally taught separately. Brown (1977) grouped the meaning of integrated science into four. It is seen as the unity of all knowledge, a conceptual unity of the sciences, a unified scientific inquiry and as an interdisciplinary approach of teaching. Arokoyu (2012) quoted UNESCO definition of integrated science as an approach to teaching of science in which concepts and principles are presented to express the

fundamental unity of science and avoid undue stress on the distinctions between the various scientific fields.

Integrated science curriculum covers the core materials of introductory Biology, Chemistry, Geography and Physics, all in integrated forms (Esomonu 1998, Wei 2009). Physics as one of the science subjects needed for scientific and technological development of any nation, it is one of the core course subjects included in the integrated science curriculum in Nigeria. Electric, gravitational and magnetic field concepts are some of the Physics concepts reflected in the Physics courses of integrated science curriculum in Nigeria. Learning about electromagnetic field concepts prepares for understanding electromagnetic theories and concepts which many electrical devices are designed (Nousiainen & Koponen 2017). Difficulty in teaching learning the concepts could jeopardize acquisition of relevant scientific knowledge and skills for technological and scientific development, which could be seen as a failure on attaining national goals of integrated science and science education in general.

Despite the appreciation of the need of physics in the integrated science curriculum, it was observed that the academic performance of undergraduate integrated science students on Physics related courses was poor with courses containing electromagnetic concepts worse (Otarigbo & Oruese 2013, Ibenegbu 2018). The poor performance was associated with the regular use of chalk and talk method and the abstract nature of the concepts. Other researchers like Esomonu (1998), Ibrahim (2014), Winamo, Rusdian, Riandi, Susilawati (2020) associated with the poor performance on integrated science is inappropriate selection and usage of relevant teaching and learning materials. The poor performance has not been shown to have gender dimension despite a lot of studies on performance in gender in science. Several studies have documented that female students have lower performance in science compared to male students (Amedu, 2015 & Nwona & Akogun, 2013). Some of the studies observed gender disparity in science in favour of males (Nwona & Akogun 2015), others report females' superiority (Balart & Oosterveen 2019, Szameit, Hamaida & Sayfik 2015) and others still, zero disparity (Jackman & Moraine-Webb 2019). Hence, studies on gender and students' performance are conflicting and inconclusive. Ibrahim (2014) and Winamo, Rusdian, Riandi, Susilawati (2020) recommended the use of innovative teaching strategies to address some of the poor performance issues of science and integrated science courses.

Innovations in education are new ideas which are meant to bring effectiveness and change to the educational sector. Advancement in science and technology has brought innovations which are providing positive changes in the educational system. One of these effective innovations is the use of computers in education as an instructional medium. Computer as an instructional medium has been tagged as Computer Aided or Computer Assisted Instruction (CAI). Computer Aided instructional approach is a teaching approach in which the computer technologies and self-learning principles are combined (Yildiz & Aktas, 2015). Self-learning principle is a learner-oriented instruction in which learning occurs without necessarily requiring the physical presence of teachers (Marimothu & Saravanakumar 2019). CAI can be compartmentalised into six categories (Ahitrogah, Berewell & Yakubu, 2012). There is drill and practice, tutorials, problem solving, simulations, games and discovery computer programmes. Drill and practice issued the same way a worksheet is used while tutorials contain concepts, skills for users to learn and practice. Problem solving approach provides opportunity for user to manipulate variables and get feedback while simulation presents a representation of models of real events. Discovery programming form of CAI contains materials for multimedia use and tool software category contain software for students to use for learning required materials. Games software category

of CAI contains software for students to use for games in order to learn required materials. All the categories of the software are used in education. Since the researchers have learning of Electric field concepts in mind the tutorial approach was chosen and used.

The application of computer aided instruction has been found to empower the ability of learners in building skills and accessibility of knowledge in the technological world. Tareef (2010) conducted a study on effect of computer-assisted learning on the achievement and problem solving skills of Educational Statistics Students, of which findings showed that there was positive significant difference in achievement on behalf of the experimental group. Yusuf and Afolabi (2010) on their study on performance in Biology found that exposure to CAI individually or collectively made performance or study subject better; however, the difference was not related to gender. In a similar perspective Ahiatrogah, Berrell & Yakubu (2012) on their study found that the performance of students exposed to CAI was better than that of students taught using traditional approach of teaching. Gambari & Ezenwa (2014) reported positive improvement on achievement but no gender different in solid geometry when taught with the aid of computer. In the same vein, Suleiman, Hussaini, Naseer Ud Din & Igbal, (2017), showed that computer assisted instruction has a significant positive effect on students' academic achievement and retention in Physics among students in Pakistan. Hussaini, Gambari & Opayemi(2017) reported male students outperform male students in achievement and attitude when exposed to computer aided instructions among secondary school students' in Niger state. Muchiri (2018) conducted a study on the effect of CAI on student's achievement and gender in agricultural education. Findings of the research showed that CAI improved student's achievements in agriculture but male students perform better than the female. Arthur, Abaidoo & Arkorful (2019) conducted research on impact of computer assisted instruction and found that the strategy was effective on students' academic performance with gender dimension in favour of male students. Adolphus & Omeodu (2020) reported a positive impact on students' achievement on nuclear Physics when taught using computer aid. From the few literatures reviewed, those on performance on electromagnetic concepts in Integrated science were very few and gender issues inconclusive. This therefore makes further study on electromagnetic Integrated Science in relation to computer aided instruction worthy.

### **Problem Statement**

Physics is one of the courses in Nigeria Integrated Science curriculum. Physics concepts, knowledge and skills are strong components of integrated science because of their expected needs for overall development in Nigeria. However, academic performance of students in Integrated Science has not been satisfactory especially on courses containing electromagnetic concepts (Otarigbo & Oruese 2013, Ibenegbu 2018). The poor performance was associated with the regular use of chalk and talk method and the abstract nature of the concepts. Electricity and magnetism concepts are reported to be complex and demanding to learning (Nousiainen & Koponen 2017). Researchers like Esomonu (1998), Ibrahim (2014), Winamo, Rusdian, Riandi, Susilawati (2020) associated the poor performance on integrated science with inappropriate selection and usage of relevant teaching and learning materials. Okwuduba and Okigbo (2018) found out that teaching methods significantly affects student's academic performances in sciences. Literature on efficiency and usage of computer aided instructions in integrated science subjects are few, and locations of researches made are far from the location of present study. Based on the problem of poor performance and ineffective teaching strategies employed with concern on electrical field concepts, studies in efficiency of computer aided-instruction on electric field concepts were perceived to see whether the approach may show its impact on academic performance.

## Research Questions

Based on the problems identified, the following research questions were raised and answered in this study

- i. What are the mean academic performance scores of study participants taught electric field concepts using Computer-Assisted-Instruction and lecture methods?
- ii. Is there any difference in academic performance mean score between students exposed to Computer-Aided-Instructions and those exposed to Lecture Method when taught electric field concepts?
- iii. Is there any gender difference in academic performance mean scores among students exposed to CAI when taught electric field concepts?

## Null Hypotheses

Based on the problem of study identified and research questions raised, the following null hypotheses were prepared and tested at  $p < 0.05$  level of significance:

- i. There is no any significant difference in the mean academic performance score between subjects exposed to Computer-Aided-Instruction and those taught electric fields concepts using Lecture Method.
- ii. There is no any significant difference in the mean academic performance scores between male and female subjects exposed to Computer-Aided-Instruction when taught electric field concepts.

## Objectives of the Study

This study looked at how the use of Computer-Assisted-Instruction in teaching and learning could improve students' academic performance. Specifically, the objectives of the study were to:

- i. determine the impact of CAI on student's academic performance on electric field concepts.
- ii. find out the impact of lecture method on student's academic performance scores between exposed to CAI and lecture method, and
- iii. determine gender difference in academic performances among students exposed to CAI strategy when taught electric fields concepts.

## Methodology

The population of the study was all Bachelor of Integrated Science students offering fields, wave and vibration courses at affiliated colleges of Education of Ahmadu Bello University Zaria offering Integrated Science of, Nigeria. Two hundred and ten (210) level three students were the sample that participated in the study. The research design was quasi-experimental. The instrument used was Electric field Hockey Software developed by Chabay (1990) which was reported to have a reliability of 0.82. Electric field concept performance test (EFCPT) containing 35 test multiple choice items were designed by the researchers and tested to be reliable at 0.71 level. Experimental and control groups were pretested using EFCPT for determination of equivalence at entry point. Control group was taught the Electric field concept using Lecture Method while the experimental group was exposed to the Electric Field Hockey Software as treatment. Both groups were post-tested. Results collected were analysed using t-test.

## Results

### Research Question 1

What are the mean academic performance scores of study participants taught electric field concepts using Computer-Assisted-Instruction and Lecture Method?

**Table 1: Summary of Mean Academic Performance Scores of Experimental and Control Group**

Group	<i>Pre-Test scores</i>			<i>Post-test scores</i>		
	N	Mean	SD	Mean	SD	Mean Diff.
Experimental	109	41.2	2.12	58.3	3.7	17.1
Control	101	39.3	4.71	40.1	4.3	01.4

From Table 1, the students taught using Computer-Assisted-Instruction had a pre-test mean score of 41.2 with a standard deviation of 2.12. The students in the control group had a pre-test mean score of 39.3 with a standard deviation of 3.7. The difference in the pre-test mean scores of experimental and control groups is 0.9 which indicates that the two groups were relatively equivalent. The difference in the post-test mean scores of control and experimental group was 18.2. The difference could be as a result of the treatment given to the experimental group. To find out whether the difference was significant, null hypothesis one was tested using t-test and the result is presented in Table 2.

### Null Hypotheses one

There is no any significant difference in the mean performance scores between students exposed to Computer-Aided-Instruction and those taught Electric field concepts using Lecture Method.

**Table 2: Summary of t-test Analysis of Mean Academic Performance Scores of Experimental and Control Groups**

Group	N	Mean	SD	Df	t-value	p-value	Remark
Experimental	109	58.3	3.7	208	0.21	0.04	Significant
Control	101	40.1	4.3				

### Significant at $P < 0.05$

From Table 2, the P-value obtained is 0.04 which is lower than the critical significant value of 0.05. Null hypothesis one was therefore rejected. This implies that the difference in the mean academic performance scores between students exposed to Computer-Aided-Instruction and those taught using Lecture Method is significant.

### Null Hypothesis Two

There is no any significant difference in the mean academic performance scores between male and female students exposed to Computer-Aided-Instruction when taught electric field concepts.

**Table 3: Summary of t-test Analysis of Students exposed to Computer-Assisted-Instruction based on Gender.**

Group	Gender	N	Mean	SD	Df	t-cal	P-value	Remark
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	Male	61	60.2	4.0				
Experimental					107	3.1	0.58	NS
	Female	48	58.3	4.6				

### Not significant at $P > 0.05$

From Table 3, t-value calculated is 3.1 with a p-value of 0.58 which is higher than critical significant value of  $\leq 0.05$ . The null hypothesis two is therefore retained. This implies that the difference in the mean academic performance scores between male and female students exposed to CAI is not significant. This also implies that CAI is gender friendly.

### Discussion

Analysis of research question one and result for testing null hypothesis one indicated that students' academic performance scores were significantly enhanced by Computer-Aided-Instruction when taught Electric field concepts. The academic performance improvement was as a result of the principle of operant condition where consequences follow behavior in order to modify it. Positive reinforcement from the outcome of the computer interaction brought additional reinforcement which resulted in better performance as theorised by Skinner. This finding was in agreement with the result of Anamezie (2018) who found that Computer-Aided-Instruction enhanced students' retention in Physics than control group students taught using expository strategy. Present findings agree with the outcome of research conducted by Ahiatrogah, Barvell & Yakubu (2012) who found the performance of students taught using CAI was better than control group subjects on social studies. Tareef (2014) also attested to the efficacy of CAI for learning Educational Statistics. According to Yusuf & Afolabi (2010), the performance of students exposed to CAI either individually or cooperatively was better than the control group treated with lecture methods. This is in agreement with findings of Arthur, Arkorful & Abaidoo (2019) and Gambari & Ezenwa (2014).

Results of the test of null hypothesis two indicated that there is no significant difference between male and female students exposed to Computer-Assisted-Instruction. This finding agrees with findings of Yusuf & Afolabi (2010) who found no significant difference between male or female mean score when exposed to CAI. In the same vein, Fakomogbon, Adetayo, Oyeboode & Enuwg (2014) found a result showing no significant difference between male and female students taught mathematics using CAI. Bala (2018) in her study on gender effect on performance and retention among students exposed to CAI found the strategy gender friendly. The no gender difference in performance could be due to similar treatment given to members of the experimental group and generating similar response which is in line with operant conditioning theory of Skinner.

### Conclusion

Based on the findings from the study, it can be concluded that Computer-Assisted-Instruction (CAI) is effective in enhancing academic performance scores of students taught electric field concepts. Also, Computer-Assisted-Instruction is gender friendly.

### Recommendations

Based on the efficacy of CAI established by the study, the following recommendations are made:

- i. Teachers should endeavour to use Computer-Aided-Instructions in teaching physics and integrated science concepts.
- ii. Science teachers should be given in-service and school based training on strategies for using CAI.

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