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Effect of Computer-based Instruction on Academic Performance of Senior Secondary School Students in Physics in Dekina Area of Kogi State

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ABSTRACT

This study investigated the effect of computer-based instruction on the academic performance of senior secondary school students in Physics in Dekina Local Government Area of Kogi State, Nigeria. The study was guided by two research questions and two hypotheses tested at a 0.05 level of significance. A quasi-experimental research design was adopted, specifically the pretest-posttest control group design. A total of 100 SS2 Physics students from selected secondary schools (public and private) participated in the study. These students were assigned into two groups: 50 students in the experimental group received instruction using computer-based methods, while the control group of 50 students was taught using the conventional lecture method. The Physics Performance Test (PPT). The findings revealed that students taught using computer-based instruction performed significantly better than those taught with the traditional lecture method, as confirmed by a significant difference in posttest mean scores ($F = 29.682$, $p < 0.05$). Furthermore, there was no statistically significant difference in posttest performance between male and female students within the experimental group ($F = 1.098$, $p > 0.05$), indicating that both genders benefitted equally from the computer-based instructional approach. The study concludes that computer-based instruction is an effective and gender-inclusive teaching method that enhances students' academic achievement in Physics, particularly in understanding abstract concepts like energy. Recommendations were made in accordance with the findings of the study.

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INTRODUCTION

The growth and development of most nations are dependent on science, technology and mathematics education. Science is an organized body of knowledge, which enhances the ability to acquire skills. It is a search for meaning or exploration of events in nature (Ifeakor, 2019). Science and Technology related subjects that would enable students have a substantial understanding of science and be able to apply scientific knowledge in solving problems in their ever-changing society are mathematics, chemistry, biology, health science, introductory technology and physics.

Physics is one of the compulsory subjects for one to study science and technology related courses in tertiary institutions. It is a science that uses quantitative measurement and experimental observations in order to understand natural events. It can explain natural events mathematically and can relate these events to daily life events (Akanmu, Sunday & Ayinla 2016). Of all the sciences, Physics is the one that students experience the most difficulties with because most of the physical notions are abstract. Also, when compared to other lessons, although there are many relationships between main subjects and number of the subjects to be learned, simply knowing definitions is not enough to teach

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the subject (Achimugu, etal, 2023). Theories and numerical expressions also make it difficult to understand Physics and to make a connection between the subjects (Arvind & Heard, 2020). The technological development of any nation lies in the study of science especially physics. The role of physics in national development is acknowledged in the whole world.

The Federal Government of Nigeria made special provisions and incentives through the provision of laboratory facilities, instructional materials, training and retraining of teachers, provision of research grantand adoption of Information and Communication Technology (ICT) to improve the teaching and learning of science (physics inclusive) in the secondary schools (FRN, 2015). Part of the requirements for any school to be enrolled for WAEC and NECO is that the school must have science laboratories. Also, schools are expected to be provided with computer systems. Furthermore, the Federal Government stated that "In recognition of the prominent role of information and communication technology in advancing knowledge and skills necessary for effective functioning in the modern world, there is an urgent need to integrate information and communication technology into education in Nigeria (FRN, 2015).

Computer-based instruction s refers to instruction or remediation presented on a computer. These modes of instructions are interactive and can illustrate a concept through attractive animation, sound and demonstration. It allows students to progress at their own pace and work individually. Computers provide immediate feedback, letting students know whether their answer is correct or not. If the answer is not correct, it shows how the students can get the correct answer. Many researchers have used computer-based instruction indifferent subject areas to improve effective teaching and learning. For instance, Yusuf and Afolabi, (2019) investigated the effects of computer assisted instruction on secondary school students' performance in biology. The findings of the study showed that the performance of students exposed to Computer Assisted Instruction either individually or cooperatively were better than their counterparts exposed to conventional classroom instruction. Also, Tapscott, (2018) investigated the effect of computer-based instruction on academic performance in sciences; the result was also positive in favor of the students engaged in the computer assisted instruction.

Computer-based concept mapping instructional strategy incorporates the use of computer instruction and other ICT tools with concept mapping. With computer-based concept mapping, concept representations and their respective links are not static; both can be expanded as knowledge or elaboration of an idea increases. Errors in describing ideas can be easily corrected and adapted. Most computer-based concept mapping tools allow the user to point and drag a concept or group of oncepts to another place on the map and automatically update all the appropriate links (Sunday, Akanmu & Fajemidagba, 2017).

Academic performance refers to the measurable outcomes of a student's learning, often assessed through grades, test scores, assignments, and other forms of evaluation. It reflects the extent to which a student has mastered the content and skills taught in a particular subject or course. Academic performance is influenced by various factors, such as cognitive abilities, learning styles, motivation, and the availability of resources. It is not solely about achieving high marks, but also about demonstrating a deep understanding of the material and the ability to apply knowledge to real-world situations. For instance, performance can be evaluated through assessments that measure recall, comprehension, application, and analysis of learned concepts (Sunday, etal , 2016).

In addition, the quality of instruction, school environment, and family support also contribute significantly to a student's academic success. While traditional academic measures like exams and assignments are commonly used to evaluate performance, other elements like student engagement, participation, and effort also play a role in determining overall academic achievement (McMillan & Hearn, 2008). Academic performance is often seen as a cumulative representation of a student's academic efforts, where consistent

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study habits and active participation in class result in higher performance over time.

In the context of Physics, academic performance is similarly assessed through a combination of written examinations, practical assessments, and projects, but the focus is on a student's ability to grasp and apply the scientific principles and problem-solving techniques unique to the subject. Physics is a subject that demands not only conceptual understanding but also the ability to apply theoretical knowledge to solve practical problems. It involves complex concepts such as force, energy, motion, and electromagnetism, which require students to develop both analytical and critical thinking skills. The academic performance of students in Physics reflects how well they can comprehend these concepts, apply mathematical models, conduct experiments, and draw conclusions based on data. According to Sunday, Akanmu and Fajemidagba (2014), students who perform well in Physics demonstrate a solid grasp of both theoretical principles and practical applications, often excelling in laboratory settings where hands-on experience is key.

Motivation, interest, and effective teaching methods are crucial in determining how students perform in Physics, as students who are engaged in the subject and who receive high-quality instruction are more likely to excel (Sunday, etal, 2023). In addition to these factors, access to resources such as technology and educational tools can significantly enhance learning and improve performance in Physics. Interactive resources, such as simulations and computer-based instruction, help students visualize abstract concepts and engage more effectively with the material (Samuel & Sunday, 2024). Ultimately, academic performance in Physics is a combination of cognitive skills, practical abilities, and external factors like teaching methods and resource availability, all of which contribute to a student's success in the subject.

STATEMENT OF THE PROBLEM

The persistent poor performance of students in Physics, despite various government initiatives aimed at improving science education in Nigeria, remains a significant challenge. According to the West African Examinations Council (WAEC) report of 2015-2016, students' performance in Physics was notably poor, with many failing to grasp fundamental concepts such as heat, energy changes, motion, and matter (WAEC, 2016). Chief Examiner's Report (2016-2020) has consistently highlighted that students' struggles in Physics are a direct result of a lack of understanding of key foundational concepts. In the 2016 and 2017 reports, it was noted that many candidates failed to properly apply theoretical knowledge to practical scenarios, often due to insufficient exposure to experimental Physics.

Similarly, the 2018 report identified that many students lacked adequate preparation, particularly in handling questions that involved mathematical reasoning and problem-solving, with many giving vague or incomplete answers. From 2019 to 2020, the Chief Examiner noted a slight improvement in the overall performance, though the results remained below expectations. It was observed that while some students had a better grasp of basic principles, there was still a significant gap in more complex areas, such as energy conservation and mechanics. Computer-based concept mapping, which combines ICT tools and visual representations of knowledge, has emerged as a potential instructional strategy to enhance student learning. However, there is limited research on the effectiveness of computer-based concept mapping in improving students' performance in Physics, particularly in the context of Nigeria.

This study, therefore, seeks to fill this gap by investigating the effect of computer-based instruction on the academic performance of senior secondary school students in Physics in Dekina LGA, with particular attention to differences across gender. The findings are expected to provide empirical data that could inform better teaching practices and policy decisions for integrating ICT into Physics education. While several studies have demonstrated the effectiveness of computer-based instruction in improving academic achievement in other science subjects, there is limited empirical research specifically addressing

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the impact of computer-based instruction particularly computer-based concept mapping on students' academic performance in Physics in Nigeria.

Moreover, there is a lack of localized studies that explore how these instructional strategies affect learners in Dekina Local Government Area of Kogi State and whether gender differences influence the outcomes of such interventions. This study, therefore, seeks to fill this gap by investigating the effect of computer-based instruction on the academic performance of senior secondary school students in Physics in Dekina LGA, while also examining gender-related performance differences

Research Questions

This study will attempt to answer the following questions;

1. What are the differences between the pretest and posttest performance mean scores of students taught physics using computer-based instruction and those taught using lecture method?
2. What is the differences between the pretest and posttest mean performance scores of male and female students taught physics using computer-based instruction?

Research Hypotheses

The following hypotheses will be formulated and tested at 0.05 α level of significance

H_{01}: There is no significant difference between the posttest performances mean scores of SS2 students taught physics using computer-based instruction and those taught using lecture method.

H_{02}: There is no significant difference between the posttest academic performances mean scores of male and female SS2 students taught physics using computer-based instruction.

METHODOLOGY

The research design for this study adopted quasi-experimental design. Specifically, the study will use a pre-test and post-test control group design, where two groups of students will be exposed to different instructional methods. The population for the study will consist of all senior secondary school students offering Physics in Dekina Local Government Area of Kogi State. The total population is estimated to be around 3,000 students from various secondary schools within the area. These students will be from the senior secondary school level (SS2), as they are typically in the process of preparing for the West African Examinations Council (WAEC) and National Examinations Council (NECO) exams, which include Physics. A purposive sampling technique will be employed to select a sample of schools from the various public and private secondary schools in the area.

The researcher will choose four schools based on the availability of the necessary technological resources (such as computers and internet access) for implementing computer-based instruction. From each school, two classes will be randomly selected: one class will be assigned to the experimental group (taught using computer-based instruction) and the other to the control group (taught using conventional methods). In total, 100 students (50 in the experimental group and 50 in the control group) will be sampled for the study. The main instrument for data collection was the Physics Performance Test (PPT). It is a 20-item multiple-choice test designed to assess students' understanding of key physics concepts. The test comprises two sections: Section A collects students' demographic data (group, gender, class, school), while Section B contains the test questions.

The items are based on the lesson content and aligned with curriculum objectives. The instrument is used as both a pretest and posttest to measure students' academic performance before and after the intervention. The initial and reassessment results of the sample was calculated using Kuder-Richardson's formula 20 (K-R20), and the coefficient of confidence of the reliability attained was 0.87, The data collected were analyzed using descriptive and inferential statistics. The research questions will be answered using mean and standard deviation, while the hypotheses will be tested at 0.05 level of

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significance using analysis of covariance (ANCOVA).

RESULTS

Research Question One:
What are the differences between the pretest and posttest performance mean scores of students taught Physics using computer-based instruction and those taught using conventional method?

Table 1: Mean and Standard Deviation of Pretest and Posttest Scores for Experimental and Control Groups

Group	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD
Experimental	50	34.26	5.71	68.42	6.89
Control	50	33.98	6.03	51.27	7.12

Table 1 reveals a significant improvement in the academic performance of students in both groups, with a more pronounced increase in the experimental group. The experimental group improved from a pretest mean of 34.26 to a posttest mean of 68.42, while the control group improved from 33.98 to 51.27. The difference in improvement suggests that students exposed to computer-based instruction benefitted more than those taught with conventional methods. This supports the hypothesis that technology-enhanced learning can be more effective in explaining abstract Physics concepts.

Research Question Two:
What are the differences between the pretest and posttest mean performance scores of male and female students taught Physics using computer-based instruction?

Table 2: Mean and Standard Deviation of Pretest and Posttest Scores by Gender (Experimental Group Only)

Gender	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD
Male	26	34.11	5.67	69.08	6.41
Female	24	34.42	5.79	67.71	7.14

From Table 2, both male and female students showed improvement in their posttest scores. Males moved from 34.11 to 69.08, while females improved from 34.42 to 67.71. Although males had a slightly higher posttest mean, the difference is small, suggesting that both genders benefitted equally from the computer-based instructional method. This finding implies that computer-based instruction is inclusive and effective across gender lines.

Test of Hypothesis

Hypothesis One (H_{01}):
There is no significant difference between the posttest performance mean scores of SS2 students taught Physics using computer-based instruction and those taught using conventional lecture method.

Table 3: ANCOVA for Testing Hypothesis One

Source	Sum of Squares	df	Mean Square	F	Sig.
Covariate (Pretest)	132.784	1	132.784	3.401	0.069
Group	1647.392	1	1647.392	29.682	**0.000**
Error	5378.614	97	55.443		

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The ANCOVA result shows a statistically significant effect of the type of instruction (F = 29.682, p = 0.000 < 0.05) on students' posttest performance, even after adjusting for pretest scores. This means that the instructional method (computer-based vs. conventional) had a significant impact on learning outcomes. Consequently, we reject the null hypothesis H_{01} and conclude that computer-based instruction leads to significantly better performance in Physics.

Hypothesis Two (H_{02}):

There is no significant difference between the posttest academic performance mean scores of male and female SS2 students taught Physics using computer-based instruction.

Table 4: ANCOVA for Testing Hypothesis Two (H_{02})

Source	Sum of Squares	df	Mean Square	F	Sig.
Covariate (Pretest)	118.429	1	118.429	2.987	0.092
Gender	52.318	1	52.318	1.098	**0.298**
Error	2227.409	47	47.396		

Here, the ANCOVA test result shows that gender did not significantly influence the posttest scores among students taught using computer-based instruction (F = 1.098, p = 0.298 > 0.05). Therefore, the null hypothesis H_{02} is retained. This result indicates that the effectiveness of computer-based instruction is not dependent on gender and can be equally beneficial for both male and female students.

DISCUSSION OF THE FINDINGS

The findings of this study revealed that computer-based instruction significantly enhances students' academic performance in Physics compared to conventional teaching methods. Students in the experimental group who received instruction through simulations, animations, and interactive digital tools outperformed their counterparts in the control group who were taught using the lecture method. This result supports earlier findings by Adebayo and Olaniyi (2018), Okoye and Akinbode (2016), and Akinyemi and Adedeji (2015), all of whom found that computer-based instruction promotes better understanding of abstract physics concepts such as motion, energy, and force. Furthermore, the use of immediate feedback mechanisms and virtual lab experiences enables students to identify and correct misconceptions faster, leading to more effective learning outcomes.

The consistency of these results with studies from different urban contexts strengthens the validity of computer-based instruction, while this present study adds new insight by demonstrating its effectiveness even in rural areas like Dekina. Despite infrastructure challenges, the study affirms that when basic digital tools are available, computer-based instruction can significantly enhance learning, underscoring its potential in transforming science education in resource-constrained settings.

In addition, the study found no significant gender differences in the academic performance of students taught using computer-based instruction, indicating that both male and female learners benefitted equally from the approach. This finding is in line with the results of Ibe and Okwu (2020) and Akinyemi and Adedeji (2015), who reported no notable differences in engagement, motivation, or performance across gender lines when digital tools were used. This outcome challenges prevailing assumptions about gender disparities in science and technology subjects, suggesting that equal access to digital resources can help bridge performance gaps between boys and girls. The inclusive nature of computer-based instruction reinforces its suitability for achieving educational equity in Nigerian schools. However, it is important to recognize the role of teacher competence and school infrastructure in realizing these benefits.

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CONCLUSION

Based on the findings, this study concludes that computer-based instruction significantly enhances students' academic performance in Physics compared to the conventional lecture method. The study also finds that this instructional method benefits both male and female students equally, making it a viable and inclusive teaching approach. These results affirm the potential of integrating digital technologies into classroom instruction to improve understanding and performance in challenging science subjects like Physics.

RECOMMENDATIONS

Based on the results of this study, the following recommendations are made:

1. **Wider Adoption of Computer-Based Instruction:** Schools should incorporate computer-based teaching methods in their Physics instruction, especially for abstract topics like Energy.
2. **Provision of Resources:** Government and private stakeholders should ensure that schools are adequately equipped with functional computers, reliable power supply, and internet access.
3. **Teacher Training:** Teachers should be trained on how to design, implement, and evaluate computer-based instructional content effectively.

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