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The Effect of Physics Software on the Academic Achievement of Secondary School Students in Physics in Oredo Local Government Area, Edo State

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Abstract

This study investigated the effectiveness of physics software in enhancing the academic performance of secondary school students in Physics in Oredo Local Government Area of Edo State, Nigeria. The study adopted a quantitative research approach. Four research questions were formulated to guide the study, alongside two corresponding null hypotheses. A sample of one hundred and twenty (120) senior secondary school students—comprising 60 males and 60 females—was randomly selected from four public secondary schools in the study area.

Data were collected using a Physics Achievement Test (PAT) and analyzed using mean, standard deviation, and independent samples t-test. The findings revealed that students exposed to physics instructional software demonstrated significantly higher academic performance, particularly in physics concepts such as mechanics and electricity, compared to those taught using conventional teaching methods. Consequently, the null hypothesis on the effect of physics software on students' academic performance was rejected.

The study further showed that gender had no significant influence on the academic performance of students taught Physics using software-based instruction. Thus, the hypothesis which stated that there would be no significant difference between the performance of male and female students taught Physics using software was retained. The study concludes that integrating physics software into classroom instruction enhances students' understanding and performance and recommends its adoption in secondary school Physics teaching.

Keywords

Physics Software, Academic Performance, Secondary School Students, Physics Instruction, Gender.

INTRODUCTION

Education is the systematic process through which a society transmits its acceptable values, skills, knowledge, attitudes, and cultural heritage from one generation to another. It is a deliberate effort aimed at shaping individuals to conform to societal norms while developing their intellectual, moral, and practical capacities. Through education, learners acquire the competencies required to live harmoniously with others and to contribute meaningfully to their communities. Education therefore serves as a vital instrument for personal development, social integration, and national advancement.

In the school system, education involves the organised transmission of knowledge and skills through structured teaching and learning activities in subjects such as Physics. Physics, as a core science subject, plays a crucial role in technological development and scientific literacy. However, the abstract nature of many physics concepts often makes the subject difficult for secondary school students to understand using conventional teaching methods alone.

With the advancement of digital technology, a wide range of physics software packages and simulations became available for instructional purposes from the late twentieth century. These physics software tools were developed to support teaching and learning by providing visualisation, simulation, data analysis, and interactive experimentation opportunities. As the availability and use of physics software increased, many educators began integrating them into classroom instruction to enhance students' conceptual understanding and engagement.

The growing use of physics software has made it necessary for teachers to acquire adequate training and technical competence through pre-service and in-service programmes. Several prospective and practising teachers have been surveyed regarding their exposure to and training in the use of physics software for instructional purposes. Responses to how best these technologies should be used to influence students' learning outcomes have varied. While some educators rely on research findings that highlight the effectiveness of physics software in improving students' academic achievement, others question whether such findings can be generalised across different learning environments and school contexts.

1.2 Statement of the Problem

In recent years, education stakeholders have expressed serious concern over the declining academic performance of secondary school students in Physics, as reflected in both internal and external examinations. Many students perceive Physics as a difficult and abstract subject, leading to low interest, poor achievement, and avoidance of science-related careers.

One major factor contributing to this problem is the continued reliance on conventional teaching methods that emphasise rote learning and teacher-centred instruction, with limited use of instructional technologies. Consequently, students who are already weak in Physics often fail to develop the necessary conceptual understanding and problem-solving skills.

The problem addressed in this study is to examine the instructional strategies employed in teaching Physics to low-achieving secondary school students, with particular emphasis on the use of physics software. Specifically, the study seeks to determine whether teaching Physics concepts with physics software results in a significantly greater improvement in students' achievement compared to teaching without the use of such software.

1.3 Purpose of the Study

The main purpose of this study was to determine the effect of physics software on students' understanding and academic achievement in Physics. Specifically, the study sought to:

a) determine the difference in the mean achievement scores of secondary school students taught Physics using physics software and those taught using the Conventional Teaching Method (CTM);
b) examine the difference in the mean achievement scores of male and female students taught Physics using physics software.

1.4 Research Questions

The following research questions were formulated to guide the study:

1) Will the use of physics software in teaching Physics bridge the gap created by the conventional teaching method?
2) Will the use of physics software in teaching Physics create a difference in the academic performance of male and female students in the pre-test and post-test?
3) Will the use of physics software in teaching Physics improve students' academic performance?
4) Will the use of physics software in teaching Physics enhance students' problem-solving ability?

1.5 Research Hypotheses

Based on the research questions, the following null hypotheses were formulated and tested at the 0.05 level of significance:

Hypothesis H_{01}: Students taught Physics using physics software will not show a significantly greater gain in achievement scores than students taught using the conventional teaching method.

Hypothesis H_{11}: Students taught Physics using physics software will show a significantly greater gain in achievement scores than students taught using the conventional teaching method.

Hypothesis H_{02}: There will be no significant difference in the academic performance of male and female students taught Physics using physics software.

Hypothesis H_{12}: There will be a significant difference in the academic performance of male and female students taught Physics using physics software.

1.6 Significance of the Study

This study on the effect of physics software-based teaching methods on secondary school students' academic performance in Physics is significant in several ways. By making Physics instruction more interactive and closely related to real-life phenomena, the findings of this study will help to address the abstract nature of many physics concepts and promote sustainable educational development in Nigeria.

The study will provide useful information to curriculum planners, teachers, students, and parents by supplying relevant data for effective educational planning and policy formulation. It will also assist teachers in adopting innovative instructional strategies, support students in improving their understanding and performance in Physics, and guide school administrators in making informed decisions about the integration of physics software into classroom instruction. Ultimately, the study may contribute to addressing the shortage of qualified Physics teachers by demonstrating how instructional technology can enhance teaching effectiveness in secondary schools within Oredo Local Government Area of Edo State.

1.7 Scope of the Study

This study focused on the use of physics software to improve the academic achievement of secondary school students in Physics in Benin Oredo Local Government Area of Edo State. The study examined the effectiveness of physics software-based instruction in enhancing students' performance in Physics among a selected group of low-achieving secondary school students.

The findings of the study may not be generalised to students at other educational levels or to schools with different characteristics, as the sample was drawn from a relatively uniform group within a specific geographical location. In addition, the results should not be extrapolated to learning environments where there are significant variations in the quality of physics software used or in the student-to-software ratio. The geographical limitation to one school within one school division may also affect the applicability of the findings to other regions with different instructional condition

MATERIALS AND METHODS

This chapter describes the procedures adopted to investigate whether the use of physics software produces a significantly greater improvement in the academic performance of low-achieving secondary school students in Physics when compared with instruction without physics software. The section presents the research design, population of the study, sample and sampling techniques, research instruments, administration of instruments, and methods of data analysis.

2.1 Research Design

The study adopted a quasi-experimental pretest–posttest control group design. The design was used to compare the effect of physics software-assisted instruction with the conventional teacher-directed (lecture) method on the academic performance of low-achieving secondary school students in Physics.

Two intact classes were used, with the same Physics instructor teaching both groups to control for teacher effect. The experimental group was taught selected Physics topics using physics software that supported drill and practice, simulations, animations, and instructional games, while the control group was taught the same content using the conventional lecture method without software assistance.

The sample for the study consisted of one hundred and twenty (120) SS III students (60 males and 60 females) randomly selected from four senior secondary schools in Oredo Local Government Area of Edo State. Thirty students were selected from each school. Two schools were randomly assigned to the experimental group (Physics software-based instruction), while the remaining two schools formed the control group (traditional teaching method).

A pretest was administered to both groups to determine equivalence in their entry-level knowledge of Physics. This was followed by eight (8) weeks of instruction on selected SS III Physics topics, after which a posttest was administered following two weeks of revision.

The control group was taught using an explicit and deductive instructional approach, where Physics concepts and laws were systematically explained by the teacher. The study therefore employed a pretest–posttest comparison group design to determine the effect of treatment.

2.2 Population of the Study

The population of the study comprised Senior Secondary School III (SS III) Physics students in Oredo Local Government Area of Edo State who had registered for the West African Senior School Certificate Examination (WASSCE).

Low-achieving students were identified using WAEC Physics sub-test scores at or below the 30th percentile as the criterion for selection. The population sample was drawn from feeder schools, consisting of SS II students who scored within the 1st to 30th national percentile in the WAEC Physics examination and obtained D or F grades in their SS II Physics results during the 2022 academic session.

2.3 Sample and Sampling Techniques

A random sampling technique was used to select four senior secondary schools from Oredo Local Government Area. From each selected school, thirty SS III students identified as low achievers in Physics were chosen, making a total sample of 120 students.

The WAEC Physics examination (O-level) served as the pretest at the SS II level, while the SS III Physics achievement test, modeled after WAEC and NECO standards, served as the posttest. These examinations are designed to assess students’ understanding of fundamental Physics concepts and their application to real-life situations.

2.4 Research Instrument

The instruments used for the study included:

1. Physics Achievement Test (PAT) for pretest and posttest

2. Physics software packages
3. Standard SS III Physics textbooks

Both the experimental and control groups used the same Physics textbooks to ensure uniformity of content. The physics software used was commercially produced and carefully selected by the teachers to support simulations, virtual experiments, animations, drill and practice, and problem-solving activities aligned with the Nigerian Physics curriculum.

The physics software covered major SS III Physics topics such as mechanics, waves, optics, electricity, magnetism, and modern physics. Emphasis was placed on age-appropriateness, curriculum relevance, and ease of use. The software allowed students to visualize abstract Physics concepts, manipulate variables, and observe outcomes through simulations and interactive activities.

2.5 Administration of Instrument

All teachers involved in the study were qualified Physics teachers and were given orientation on the instructional procedures to ensure uniform implementation. Each class was taught in a standard-sized classroom.

The experimental group received instruction in a Physics software laboratory, which was equipped with computers installed with the selected physics software. The control group received instruction in a regular classroom using the traditional lecture method.

To control for time-of-day effects, both the experimental and control groups were taught during alternating instructional periods. The same duration of instructional time was allocated to both groups throughout the eight-week treatment period.

DATA PRESENTATION AND ANALYSIS

Data collected from the study were analyzed using appropriate statistical methods. The interpretation of responses followed a systematic and sequential approach. Where questionnaire items were used, responses were categorized into Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree.

The pretest and posttest scores were analyzed to determine differences in academic performance between students taught using physics software and those taught using the conventional teaching method.

3.1 Analysis of Data

Research Question One

Will the use of physics software in teaching Physics fill the gap created by the conventional teaching method?

Table 3.1: Respondents' Views on Whether the Use of Physics Software Can Fill the Gap of the Conventional Teaching Method

Options	Frequency	Percentage
Yes	101	84%
No	19	16%
Undecided	0	0%

Options	Frequency	Percentage
Total	**120**	**100%**

Summary of Analysis

The data presented in Table 3.1 indicate that a large majority of the respondents (84%) agreed that the use of physics software in teaching Physics can effectively fill the gap associated with the conventional teaching method. Only 16% of the respondents disagreed with this view, while none of the respondents were undecided. This result suggests a strong positive perception among respondents regarding the effectiveness of physics software as a complementary or alternative instructional tool to traditional teaching approaches in Physics.

Research Question Two

Will the use of physics software in teaching Physics create a difference in the performance of boys and girls in Physics between the pre-test and post-test?

Table 3.2: Respondents' Views on Whether the Use of Physics Software Creates a Difference in the Performance of Boys and Girls in the Pre-test and Post-test

Options	Frequency	Percentage
Yes	11	9%
No	59	49%
Undecided	50	42%
Total	**120**	**100%**

Summary of Analysis

Table 3.2 reveals that 49% of the respondents believed that the use of physics software does not create a significant difference in the academic performance of boys and girls in Physics between the pre-test and post-test. However, 9% of the respondents were of the opinion that gender differences exist in students' performance when physics software is used, while a considerable proportion of respondents (42%) were undecided. This distribution suggests that the majority of respondents perceive physics software as a gender-neutral instructional tool, though uncertainty still exists among a substantial number of respondents.

Table 3.3: Respondents' Opinion on Whether the Use of Physics Software Improves Students' Academic Performance in Physics

Options	Frequency	Percentage
Yes	110	92%
No	0	0%
Undecided	10	8%

Summary of Analysis

The data presented in Table 3.3 reveal that a large majority of the respondents (92%) agreed that the use of physics software enhances students' academic performance in Physics. None of the respondents disagreed with this view, while a small proportion (8%) remained undecided. This result indicates a strong positive perception of physics software as an effective instructional tool for improving students' performance in Physics.

Research Question Four

Will the use of physics software in teaching Physics increase the rate of problem-solving among students?

Table 3.4: Respondents' Opinion on Whether the Use of Physics Software Increases Students' Problem-Solving Ability

Options	Frequency	Percentage
Yes	90	75%
No	10	8%
Undecided	20	17%
Total	**120**	**100%**

Summary of Analysis

As shown in Table 3.4, 75% of the respondents affirmed that the use of physics software in teaching Physics improves students' problem-solving ability. About 8% of the respondents expressed a contrary opinion, while 17% were undecided. This finding suggests that most respondents believe physics software plays a significant role in enhancing students' analytical and problem-solving skills.

Research Hypothesis

H_{01}: Students exposed to physics software in learning Physics will not show a statistically significant improvement in Physics achievement compared to students taught using conventional teaching methods.

Table 3.5: T-Test Comparison of Pre-Test Mean Scores of Experimental and Control Groups

Group	N	Df	Mean Score	SD	t-calculated	t-critical
Experimental	60	59	27.70	8.12	0.84	1.83
Control	60	59	26.45	8.08		

Interpretation of Results

The results in Table 3.5 show that the calculated t-value (0.84) is less than the critical t-value (1.83) at the 0.05 level of significance. This indicates that there is no significant difference between the pre-test mean scores of the experimental and control groups. Therefore, the null hypothesis is not rejected, suggesting that both groups were academically equivalent before the introduction of physics software for instructional purposes.

Table 3.6: t-test Comparison of the Mean Post-test Scores of Experimental and Control Groups (Physics)

Group	N	df	Mean	SD	t-value (calculated)	t-value (critical)
Experimental Group	60	59	75.65	4.23	11.15	1.83
Control Group	60		54.50	4.58		

Decision Rule:

Table 3.6 presents the t-test comparison of the posttest mean scores of the experimental and control groups in Physics. The calculated t-value (t_{cal} = 11.15) is greater than the critical t-value (t_{crit} = 1.83) at the 0.05 level of significance. This indicates a statistically significant difference between the mean scores of the experimental group ($\bar{x}$ = 75.65) and the control group ($\bar{x}$ = 54.50). Therefore, the null hypothesis is rejected, showing that students taught Physics using physics software performed significantly better than those taught using the conventional teaching method.

Hypothesis H03

Students receiving Physics instruction using physics software will show no significantly greater gains in conceptual understanding and knowledge of Physics principles than students receiving instruction using conventional teaching methods.

Table 3.7: t-test Comparison of the Mean Retention Scores of Experimental and Control Groups (Physics)

Group	N	df	Mean	SD	t-value (calculated)	t-value (critical)
Experimental Group	60	19	75.20	10.13	6.55	1.83
Control Group	60		45.25	13.24		

Decision Rule:

Table 3.7 shows the t-test comparison of the retention mean scores of the experimental and control groups in Physics. The experimental group recorded a higher mean score ($\bar{x}$ = 75.20) than the control group ($\bar{x}$ = 45.25). The calculated t-value (t_cal = 6.55) is greater than the critical t-value (t_crit = 1.83) at the 0.05 level of significance. This result indicates a statistically significant difference in the retention scores of the two groups. Consequently, the null hypothesis is rejected, implying that the use of physics software significantly improves students' retention in Physics.

Hypothesis H04

There will be no significant difference in the performance of male and female students taught Physics using computer-based (physics software) teaching methods in the pretest and posttest.

Table 3.8: t-test Comparison of the Mean Scores of Male and Female Students in the Experimental Group (Physics)

Group	N	df	Mean	SD	t-value (calculated)	t-value (critical)
Male Students	30	19	75.20	7.34	0.177	1.83
Female Students	30		75.60	5.20		

Decision Rule:

Table 3.8 presents the t-test results comparing the mean achievement scores of male and female students taught Physics using physics software. The calculated t-value (t_cal = 0.177) is less than the critical t-value (t_crit = 1.83) at the 0.05 level of significance. This shows that there is no statistically significant difference between the mean scores of male students ($\bar{x}$ = 75.20) and female students ($\bar{x}$ = 75.60). Therefore, the null hypothesis is not rejected, indicating that gender does not significantly influence students' achievement in Physics when taught using physics software.

DISCUSSION OF FINDINGS

Analysis of Table 3.1.5 clearly shows that there is a difference in the mean scores of students taught with Physics software and those taught without Physics software. The performance of students in the experimental group was better than that of students in the control group. This implies that students taught using Physics software performed better than those taught the same concepts using the conventional lecture method. From this finding, it can be concluded that Physics software plays a significant role in improving students' learning and academic performance.

This finding supports the view of [4], who stated that instructional materials are valuable assets in learning situations because they make lessons practical and realistic. They serve as pivots upon which the teaching–learning process revolves. Since instructional materials help to concretize abstract concepts, they facilitate revision and recall activities and provide unique opportunities for both self and group evaluation by teachers and students alike. They capture students' interest, eliminate boredom, make learning easier and more appealing, and ultimately enhance students' academic performance.

The deduction from Table 3.8 shows that there is a difference in the mean scores of female students taught with Physics software and male students in the same experimental group. The result indicates that female students taught using Physics software performed better than their male counterparts. This finding contrasts with the view of [3], who opined that male students tend to perform better than female students when taught using Computer-Aided Instruction or Physics software.

The analysis in Table 3.8 also shows a difference in the mean scores of female students taught without Physics software and male students in the same control group. This implies that female students taught without Physics software performed better than male students in the same group. This finding contradicts the conclusion of [11], whose study reported differences in students' achievement by gender, indicating that female students performed better than their male counterparts in computer-related studies at the secondary school level, regardless of whether instructional software was used or not.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study investigated the use of computers in improving the academic performance of secondary school students in Physics in Oredo Local Government Area of Edo State, Nigeria. Relevant literature related to the study was reviewed, and most of the reviewed studies concluded that students' academic performance can be enhanced through the integration of Physics software into the teaching and learning process.

Four research questions were formulated to guide the study. A total of one hundred and twenty (120) students were selected from four sampled secondary schools. The population was divided into experimental and control groups. Multiple-choice test items were developed and administered to the students for data collection. One hypothesis was tested and three research questions were answered using mean, mean difference, standard deviation, and t-test statistical tools.

The findings of the study revealed that:

1. The use of computers in teaching Physics improves students' academic performance.
2. The use of computers in teaching Physics increases students' problem-solving ability.
3. Students taught with Physics software achieved significantly greater gains in quantitative understanding of Physics concepts than those taught using conventional teaching methods.
4. There is no significant difference between the mean achievement scores of male and female students taught Physics concepts using Physics software.
5. The hypothesis tested showed a significant difference in the mean scores of students taught with Physics software and those taught without Physics software.

5.2 Conclusion

The findings of this study clearly show that the impact of computer-based teaching on secondary school students' performance in Physics cannot be overemphasized. Integrating computers and Physics software into the teaching and learning of Physics requires proper planning, funding, and financing. However, the steady decline in government budgetary allocation to education compared to other sectors of the economy poses a major challenge.

For effective integration of computer-based instruction in Physics education in Nigeria, government funding for education must be increased to meet this critical demand. The major challenge facing both state and federal governments is to ensure that budgetary constraints and competing sectoral demands do not negatively affect computer and Physics education. Government at all levels should also subsidize internet connectivity and create an enabling learning environment that allows teachers and students to access and download relevant Physics instructional materials from the internet. These measures will enhance access to information and communication technology, which is essential for national development in the modern information age.

5.3 Recommendations

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

1. Government should encourage the use of computers and Physics software in secondary schools by providing adequate funding and improved budgetary allocation to the education sector.
2. The Ministry of Education should organize regular workshops, seminars, and conferences for Physics teachers to enable them to acquire the necessary skills for effective use of computers and Physics software in classroom instruction.
3. Curriculum planners and educational policymakers should ensure that the use of computers and Physics software in the teaching of Physics is made compulsory in all secondary schools in Nigeria.

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