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Effect Of Problem-Based Learning with Simulation on Secondary School Students' Achievement in Computer Studies in IMO State

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Abstract

The impact of problem-based learning with simulation (PBLWS) on secondary school students' achievement in Computer Studies in Imo State, Nigeria was examined. Guided by two research questions and three hypotheses tested at a 0.05 significance level, the quasi-experimental design was employed. The population included 5,192 senior secondary school two (SS2) Computer Studies students, with a sample of 94 selected via purposive and simple random sampling techniques. Data were collected using the Computer studies Achievement Test (CSAT) which was validated by three experts and with reliability coefficient of 0.98 determined using Kuder-Richardson Formula 20. The experimental group was taught using PBLWS, while the control group received lecture-based instruction. Results from pretest and posttest analyses (using mean, standard deviation, and ANCOVA) showed that PBLWS significantly improved students' achievement compared to the lecture method. Gender had no notable influence on students' achievement. It was concluded that PBLWS is more effective than the lecture method in enhancing students' achievement as it actively engages them in technology-driven problem-solving, aligning with broader research that emphasizes interactive, student-centered learning for developing 21st-century skills. The study recommends among others that, teachers of Computer studies should be trained and encouraged to implement Problem-Based Learning with Simulation (PBLWS) as a core instructional strategy to enhance students' academic achievement and engagement in Computer studies learning.

Keywords: Computer studies, achievement, Problem-based learning, simulation, secondary school

Introduction

The rapid advancement of technology and the increasing reliance on digital tools in every facet of life have underscored the critical importance of the use of simulations in education; an essential for equipping students with the skills required to participate meaningfully in the 21st-century knowledge economy. In Nigeria, the introduction of Computer studies into the secondary school curriculum was intended to address this need by preparing students for the digital world. Perhaps, despite these efforts, secondary school students in Nigeria, particularly in Imo State, continue to exhibit low levels of achievement in Computer studies.

Academic achievement, according to Okigbo and Ozumba (2024) refers to the extent to which a student has attained specific learning goals or educational benchmarks in various subjects or disciplines. It is typically evaluated through measurable outcomes such as test scores, grades, assignments, projects, and standardized examinations. Academic achievement reflects the knowledge, skills, and competencies a student has acquired over a period of instruction and serves as an indicator of their educational progress and mastery of curriculum content. Academic achievement is a vital measure in education because it not only indicates individual student success but also serves as a benchmark for evaluating the effectiveness of educational programs, instructional strategy and institutions. In the context of this study, academic achievement specifically pertains to secondary school students' performance in Computer studies.

Academic achievement is shaped by several factors like students' cognitive abilities, motivation, and attitude toward learning, as well as the effectiveness of instructional strategies, the quality of the learning environment, and the availability of educational resources (Slavin, 2006). Academic achievement is not only a

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measure of individual learning but also a critical determinant of future opportunities. High academic achievement enhances students' ability to pursue higher education, secure employment, and contribute to society. It also serves as a foundation for lifelong learning and adaptability in an increasingly knowledge-driven economy (York, Gibson, and Rankin, 2015). In secondary education, particularly in subjects like Computer studies, academic achievement reflects students' understanding of essential concepts and their readiness to apply these in real-world scenarios.

The persistent unsatisfactory achievement in Computer studies by secondary school students in this digital era has been attributed to various factors, including inadequate infrastructure and qualified teachers, and the predominance of traditional teaching methods such as lectures and rote learning, which fail to foster critical thinking, problem-solving, and the practical application of knowledge especially in school subject like Computer studies. Secondary education in Nigeria serves as a critical bridge between basic education and tertiary learning, encompassing both junior and senior secondary levels, typically covering ages 12 to 18. The system is structured into three years of junior secondary school (JSS), now Upper Basic three (UB1-3) and three years of senior secondary school (SSS), as outlined in the National Policy on Education (Federal Republic of Nigeria, 2013). Upper Basic education is designed to be broad-based, offering foundational subjects such as mathematics, English, basic science, and social studies, while senior secondary education allows for some specialization in science, arts, or commercial fields. Despite these structural frameworks, disparities exist between public and private schools in terms of infrastructure, teacher quality, and learning outcomes. Public secondary schools, which are government-funded, often face challenges such as overcrowded classrooms, inadequate teaching materials, and inconsistent teacher training, leading to varying academic performance (Adeyemi and Akpotu, 2016). In contrast, private secondary schools, which are tuition-driven, generally boast better facilities, smaller class sizes, and more qualified teachers, contributing to comparatively higher student achievement (Okeke, 2017).

The divide between public and private schools is further worsened by socioeconomic factors, as private institutions are often accessible only to families with higher incomes, reinforcing educational inequality (Ajayi and Ekundayo, 2019). Additionally, the curriculum in both school types is regulated by national examination bodies such as the West African Examinations Council (WAEC) and the National Examinations Council (NECO), yet private schools frequently outperform public schools in standardized tests, raising concerns about equity in educational opportunities (Uche, 2020). Teacher motivation also differs significantly, with public school educators frequently citing poor remuneration and delayed salaries as demotivating factors, whereas private school teachers, though sometimes underpaid, often benefit from more structured professional development (Ofoegbu, 2014). Government interventions such as the Universal Basic Education (UBE) program aim to improve access and quality, but implementation gaps persist, particularly in rural areas where public schools remain the primary option for most families (Adesina, 2015). Ultimately, while Nigeria's secondary education system has made strides in enrolment rates, the quality of education remains uneven, necessitating policy reforms that address funding disparities, teacher welfare, and infrastructural deficits to ensure equitable learning outcomes for all students. With the integration of technology in every sphere of life including education, achievement in Computer studies is vital for preparing students for the demands of a digital society.

Computer studies refer to the academic discipline that focuses on teaching students about the concepts, principles, and applications of computer science and information technology (Okigbo and Ozumba, 2024). Computer studies is a pivotal subject in modern education, designed to equip students with essential digital literacy skills and a solid understanding of information technology. As technology continues to drive global innovation and economic growth, Computer studies serves as a foundation for students to navigate the digital world effectively and contribute to

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technological advancements. It encompasses a broad range of topics, including the basics of computing, software development, digital literacy, computer hardware, and the practical use of technology in various fields. The goal of computer studies is to equip students with the necessary knowledge and skills to navigate the digital world, understand how computers work, and apply technology effectively in everyday tasks (Umoke, Abonyi and Ndukwe, 2022).

The situation in Imo State, Nigeria, underscores the urgency of addressing these educational challenges namely of poor academic achievement in Computer studies. Despite efforts by the state government to improve achievement through various initiatives, many secondary school students continue to struggle with achieving satisfactory outcomes in Computer studies. The persistence of this issue raises questions about the effectiveness of current instructional practices and highlights the need for evidence-based interventions to improve teaching and learning in this subject area (Nwankwo, Ugochukwu and Eze, 2022). In light of these challenges, there is need to examine some of the innovative teaching methods which has been shown to have the potency to improve academic achievement such as Problem-Based Learning with Simulation and its effect on secondary school students' achievement in Computer studies.

Problem-Based Learning (PBL) is a learner-centered instructional approach where students actively engage in solving real-world problems, fostering critical thinking, collaboration, and deep understanding. Simulation-Based Learning (SBL) according to Abdullah (2019), is an instructional approach that uses simulated environments to replicate real-world scenarios, enabling learners to gain practical experience in a controlled, risk-free setting. Integrating Problem-Based Learning (PBL) and Simulation-Based Learning (SBL) in the instructional process represents a powerful pedagogical approach that combines the best of both methods to enhance student engagement, critical thinking, and problem-solving skills. The integration of PBL and SBL begins by embedding the simulation into the PBL framework. This means that simulations are not used as isolated activities but are integrated into the process of solving the problem at hand forming the concept of problem based learning with simulation instructional strategy. The role of the simulation is to allow students to engage with a model of the real-world problem they are trying to solve, helping them visualize outcomes and consequences of their decisions (Kurt and Goktas, 2020). For instance, in a Computer studies class, students could use a simulation to model the effects of different programming solutions to a problem. They would then discuss the outcomes, analyze their decision-making processes, and refine their approach, all while continuing to focus on solving the problem. This approach also encourages collaboration and critical thinking, as PBL typically involves working in teams to solve problems. The interactive nature of simulations further facilitates collaboration, allowing students to engage with one another as they manipulate variables and interpret results (Cheslock and Giancola, 2020). In contrast to traditional lecture-based teaching, where students may be passive recipients of knowledge, the integration of PBL and SBL transforms them into active participants in their learning process. This active involvement is essential for deep learning, as students must analyze, synthesize, and evaluate information in dynamic environments.

Despite its clear advantages, the integration of PBL and SBL is not without its challenges. Teachers must be well-trained in both methods, and adequate resources such as access to high-quality simulations and digital tools—are necessary for effective implementation. Additionally, the instructional process must be carefully planned to ensure that the integration of PBL and SBL remains coherent and aligned with learning objectives. Furthermore, some students may initially struggle with the open-ended nature of PBL and the technological aspects of simulations, so adequate scaffolding and support systems must be in place to ensure success (Hmelo-Silver, 2004). These challenges suggest that the use of problem-based learning with simulation may pose some difficulty in using it for instructional delivery. The need arises therefore to examine its effectiveness in improving students' achievement in Computer studies. By addressing the limitations of traditional teaching

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methods and exploring the potential of PBL with Simulation, this research aims to provide insights into how this innovative instructional strategy can enhance students' learning experiences and outcomes in Computer studies.

Purpose of the Study

The purpose of the study was to determine the effect of Problem-Based Learning with simulation on secondary school students' achievement in Computer studies in Imo state. Specifically, the study sought to determine the:

1 Mean achievement scores of secondary school students taught Computer studies using PBLWS and that of those taught using Lecture Method.
2 Mean achievement scores of secondary school male and female students taught Computer studies using PBLWS and that of those taught using Lecture Method.
3 Interaction effect of instructional strategies (PBLWS and LM) and gender (male and female) on students' achievement scores in Computer studies.

Research Questions

1. What are the mean achievement scores of secondary school students taught Computer studies using PBLWS and that of those taught using Lecture Method?
2. What are the mean achievement scores of secondary school male and female students taught Computer studies using PBLWS and that of those taught using Lecture Method?

Hypotheses

1 There is no significant difference between the mean achievement scores of secondary school students taught Computer studies using PBLWS and that of those taught using Lecture Method.
2 There is no significant difference between the mean achievement scores of secondary school male and female students taught Computer studies using PBLWS and that of those taught using Lecture Method.
3 There is no interaction effect of instructional strategies (PBLWS and LM) and gender (male and female) on students' achievement scores in Computer studies.

Method

The study adopted the quasi-experimental design; specifically the pretest-posttest non-randomized control group design was used. The study was conducted in Imo state, Nigeria. The population of the study comprised 5,192 senior secondary year two (SS2) students offering Computer studies in the state.

The sample size for the study is 94 SS2 students offering Computer studies in Imo state obtained through simple random and purposive sampling techniques. The instrument for data collection was Computer studies Achievement Test (CSAT) made up of 50-item multiple choice test on the concepts of computer viruses, spreadsheet packages, computer input devices and computer output devices, with four answers options denoted by the letters A through D. The questions were pulled from previous West African Examination Council (WAEC) test questions 2022-2024 that are in line with the lessons that were taught.

The instrument was validated by three experts in the Departments of Science Education and Educational Foundations (Measurement and Evaluation Unit) and one from Computer Science all at Nnamdi Azikiwe University, Awka. The validators required to examine the instruments for clarity, plausibility of distracters, ambiguity, and suitability for the level of the students under study. The validators also be required to mark any items they want the researcher to keep, change, or remove with a "K," "C," or "R," respectively. The validators' corrections, comments, and recommendations and those of the supervisor were effected in the final copy of the instrument. The reliability of CSAT was determined using the Kuder-Richardson Formula 20 (KR-20), because the instruments are dichotomously scored. This yielded reliability index of 0.98.

The experiment was conducted in two phases. In the first phase, the research assistants, who are the regular SS2 Computer studies teachers in the experimental schools, received training. The training lasted for one week and includes three sessions. The second phase involved the implementation of the treatment. Students in the experimental group were taught using Problem-based learning with simulation,

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and the control group was taught using the lecture method.

The CSAT was given to the students as pretest before the commencement of the treatment in the first week. Students' pretest scores were recorded, but no performance feedback on their performance or corrections were given to them. After the teaching, CSAT was administered on the same students to obtain the posttest scores. The researchers collated the scores of the students after the data collection for analysis. Data relating to the research questions was analyzed using mean and standard deviation whereas data pertaining to the hypotheses was analyzed using analysis of covariance (ANCOVA). The hypotheses were tested at 0.05 level of significance. ANCOVA was used to eliminate the initial group differences among the students. The decision rule for rejecting or not rejecting the null hypothesis is as follows: if the probability value (p-value) is greater than 0.05 ($P>0.05$), do not reject the null hypothesis; otherwise, if p-value is less than or equal to 0.05 ($P\leq0.05$), reject the null hypothesis.

Results

Table 1: Mean Achievement Scores of Students taught Computer studies using PBLWS and Lecture Method (LM)

Group	*N*	Pretest Mean	Pretest *SD*	Posttest Mean	Posttest *SD*	Gained Mean
PBLWS	48	33.35	10.31	68.65	11.89	35.30
LM	46	32.00	7.17	55.39	10.31	23.39
Mean Diff.		1.35		13.26		11.91

Table 1 shows that students taught Computer studies using PBLWS had higher mean gain score that those taught using Lecture method.

Table 2: Mean Achievement Scores of Male and Female Students taught Computer studies using PBLWS and Lecture Method (LM)

Method	Gender	*N*	Pretest Mean	Pretest *SD*	Posttest Mean	Posttest *SD*	Gained Mean
PBLWS	Male	22	31.36	8.26	64.64	11.30	33.28
	Female	26	35.04	11.66	72.04	11.50	37.00
			3.68		7.40		3.72
LM	Male	21	34.71	7.51	60.62	9.11	25.91
	Female	25	29.72	6.11	51.00	9.29	21.28
			4.99		9.62		4.63

Table 2 shows that male students taught Computer studies using PBLWS had higher mean gained achievement score than those taught using LM and also, female students taught Computer studies using PBLWS had higher mean gained achievement score than the female students taught using LM.

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Table 3: ANCOVA Test of Significance of Difference in the Mean Achievement Score of Students taught Computer studies using PBLWS and LM

Source	SS	Df	Mean Square	F	Sig.	Decision
Corrected Model	8113.203[a]	4	2028.301	24.259	.000	
Intercept	11208.748	1	11208.748	134.058	.000	
Pretest	2277.601	1	2277.601	27.240	.000	
Method	3325.141	1	3325.141	39.769	.000	Sig.
Gender	12.351	1	12.351	.148	.702	Not Sig.
Method * Gender	792.466	1	792.466	9.478	.003	Sig.
Error	7441.404	89	83.611			
Total	378753.000	94				
Corrected Total	15554.606	93				

Table 3 shows that there is a significant main effect of the treatment on students' achievement in Computer studies, F (4, 89) = 39.769, P =.000 < 0.05. Therefore, the null hypothesis is rejected meaning that there is a significant difference between the mean achievement scores of secondary school students taught Computer studies using Problem-Based Learning with Simulation (PBLWS) and that of those taught using Lecture Method (LM) in favour of PBLWS.

Table 3 further shows that there is no significant main influence of gender on students' achievement in Computer studies, F (4, 89) = .148, P =.702 > 0.05. Therefore, the null hypothesis is not rejected meaning that there is no significant difference between the mean achievement scores of secondary school male and female students taught Computer studies using PBLWS and that of those taught using lecture method.

Table 3 also shows that there is a significant interaction effect of the instructional strategies and gender on students' achievement in Computer studies, F(4, 89) = 9.478, P =.003 < 0.05. Therefore, the null hypothesis is rejected meaning that there is a significant interaction effect of instructional strategies (PBLWS and LM) and gender (male and female) on students' achievement scores in Computer studies as shown below in Figure 1.

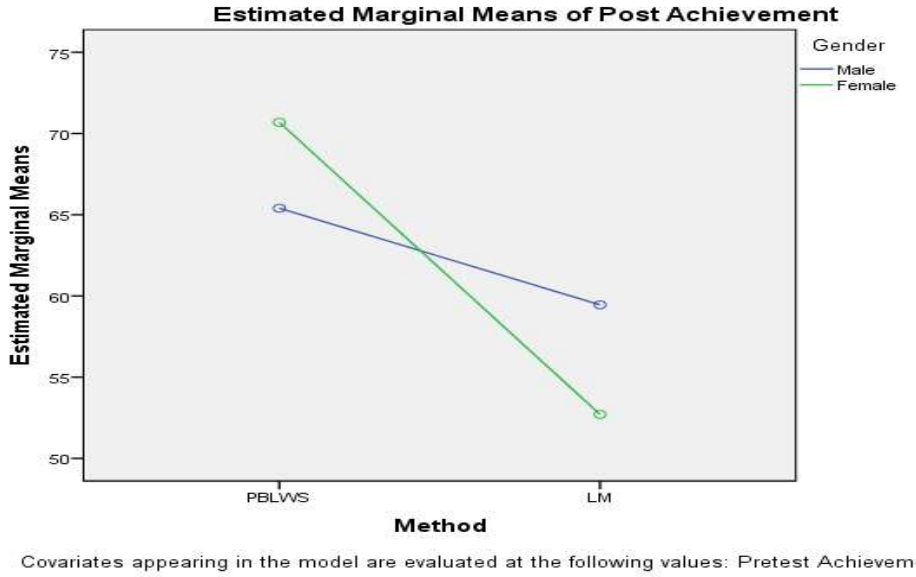

Figure 1: Plot of interaction effect of instructional strategies (PBLWS and LM) and gender on students' achievement score in Computer studies

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The plot of interaction effect of instructional methods and gender on students' achievement in Computer studies as shown in Figure 1 is significant and disordinal. This shows that the instructional strategies had different effect with respect to gender and are therefore gender-sensitive. Given the significant interaction effect, the possible interactions are shown in the simple main effect analysis as presented in Table 4 and Table 5

Table 4: Pairwise Comparison and Univariate Test of Simple Main Effect of Methods within Each Level of Combination of the other Effects

Gender	(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	F-value	Sig.[b]
Male	PBLWS	LM	5.948*	2.814	4.468	.037
	LM	PBLWS	-5.948*	2.814		.037
Female	PBLWS	LM	17.974*	2.628	46.786	.000
	LM	PBLWS	-17.974*	2.628		.000

Table 4 shows that there is a significant difference between the mean achievement score of male students taught Computer studies using PBLWS and male students taught Computer studies using LM in favour of PBLWS, F(1, 89) = 4.468, P =.037 < 0.05. Also, there is a significant difference between the mean achievement score of female students taught Computer studies using PBLWS and female students taught Computer studies using LM in favour of PBLWS, F(1, 89) = 46.786, P =.000 < 0.05. This implies that with respect to gender (male and female), PBLWS is a superior instructional method for teaching Computer studies to improve achievement than lecture method.

Table 5: Pairwise Comparison and Univariate Test of Simple Main Effect of Gender within Each Level of Combination of the other Effects

Gender	(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	F-value	Sig.[b]
PBLWS	Male	Female	-5.285	2.680	3.889	.052
	Female	Male	5.285	2.680		.052
LM	Male	Female	6.741*	2.762	5.956	.017
	Female	Male	-6.741*	2.762		.017

Table 5 shows that there is no significant difference between the mean achievement score of male and female students taught Computer studies using PBLWS, F(1, 89) = 3.889, P =.052 > 0.05. There is a significant difference between the mean achievement score of male and female students taught Computer studies using LM, F(1, 89) = .5.956, P =.017 < 0.05. This implies that with respect to instructional methods, male students are more favoured than female students when LM is used while both male and female students are equally favoured when the teacher adopts PBLWS.

Discussion

The finding that there is a significant difference between the mean achievement scores of secondary school students taught Computer studies using Problem-Based Learning with Simulation (PBLWS) and those taught using the Lecture Method (LM), in favour of PBLWS, highlights the effectiveness of interactive, student-centered instruction over traditional didactic approaches. This suggests that PBLWS creates a more engaging and meaningful learning environment, where students actively construct knowledge, collaborate on problem-solving tasks, and apply computer concepts through realistic simulations. Such experiential learning not only deepens conceptual understanding but also fosters higher-order thinking skills, leading to improved

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academic performance. In contrast, the Lecture Method, which often emphasizes passive reception of information, appears less effective in promoting mastery of practical and theoretical components of Computer studies teaching approaches that reflect the demands of 21st-century learning.

The study's finding that secondary school students taught Computer studies using Problem-Based Learning with Simulation (PBLWS) achieved significantly higher mean scores compared to those taught using the Lecture Method (LM) aligns with and is strongly supported by existing research across various educational contexts. This outcome underscores the pedagogical superiority of PBLWS, which combines active, student-centered problem-solving with immersive simulation experiences, over traditional passive lecture-based instruction. The effectiveness of PBLWS can be attributed to its dual emphasis on experiential learning and critical thinking, as demonstrated by Young-ju and Young-A (2012), whose study on nursing education revealed that simulation and problem-based learning significantly enhanced students' critical thinking and problem-solving abilities. Their findings suggest that the interactive nature of PBLWS fosters deeper cognitive engagement, enabling students to apply theoretical knowledge to practical scenarios, a key factor in the higher achievement scores observed in the current study.

Further reinforcing this finding, Xie, Wang, Pang, Chen, Xu, and Wang (2022) examined the application of PBL combined with virtual simulation in clinical biochemistry teaching during the COVID-19 pandemic and found that this approach not only improved students' academic performance but also heightened their engagement and adaptability in a rapidly changing learning environment. Their research highlights how simulations within PBL create a dynamic, risk-free space for students to experiment, make mistakes, and refine their understanding, advantages that directly translate to the Computer studies context, where practical digital literacy skills are essential. The virtual simulation component of PBLWS likely provided students with hands-on experience in navigating real-world computer-based tasks, thereby bridging the gap between abstract concepts and their practical applications.

Additionally, Hae (2023) explored the impact of Simulation with Problem-Based Learning (S-PBL) on nursing students' clinical reasoning, using Tanner's Clinical Judgment Model as a framework. The study found that S-PBL significantly enhanced students' ability to analyze, interpret, and respond to complex scenarios, a skill set directly transferable to Computer studies, where logical reasoning and troubleshooting are paramount. Hae's work underscores the role of simulations in reinforcing problem-based learning by providing contextualized, realistic challenges that demand active decision-making. In the context of the current study, this would explain why PBLWS yielded higher achievement scores than LM: the simulations likely enabled students to internalize computer science concepts more effectively by repeatedly applying them in varied, interactive contexts, thereby solidifying their learning.

Conclusion

The findings indicate that Problem-Based Learning with Simulation (PBLWS) significantly enhances students' academic achievement in Computer studies compared to the traditional Lecture Method. This suggests that active, technology-enhanced instructional strategies are more effective for improving students' understanding and performance in computer-based subjects, like Computer Studies.

Recommendations

Based on the findings of the study, it was recommended as follows:

1. Teachers of Computer studies should be trained and encouraged to implement Problem-Based Learning with Simulation (PBLWS) as a core instructional strategy to enhance students' academic achievement and engagement in computer studies.
2. Students of Computer studies should use simulation video common in the internet to aid their learning and improve their skills in computer studies.
3. Computer studies teachers and educators implement Problem-Based Learning with Simulation (PBLWS) in teaching Computer studies to promote gender-inclusive learning and ensure equal academic opportunities for both male and female students.

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