



IMPACT OF COMPUTER-BASED SIMULATIONS ON THE TEACHING AND LEARNING OF COMPUTER SCIENCE: A CASE STUDY OF ABEOKUTA SOUTH LOCAL GOVERNMENT

¹Coker O. O., ²Adigun I. O.

^{1,2}Department of Computer Science, School of Secondary Education (Science) Federal College of Education, Abeokuta.

Abstract

This study investigates the effect of computer-based simulations on computer science students' achievement in Abeokuta South Local Government Area of Ogun State, Nigeria. The primary objectives were to assess the level of use of computer-based simulations in teaching and learning computer science, compare the academic performance of students exposed to simulation-based strategies with those taught using traditional teaching methods, identify challenges associated with the integration of simulations, and recommend strategies for effective implementation. A descriptive survey research design was adopted, and data were collected through questionnaires administered to 120 randomly selected senior secondary school students. The collected data were analysed using descriptive statistics with the aid of SPSS. The findings revealed that students are generally aware of and familiar with computer-based simulations and perceive them as engaging and effective in enhancing understanding of complex computer science concepts. The use of simulations was found to improve students' motivation, knowledge retention, confidence, and perceived academic performance when compared with traditional instructional methods. However, the study also identified key challenges limiting effective integration of computer-based simulations, including inadequate technological resources, insufficient teacher training, limited funding, resistance to innovation, and low stakeholder awareness. The study concludes that computer-based simulations have significant potential to enhance the teaching and learning of computer science at the secondary school level. It therefore recommends improved provision of technological resources, regular teacher training programmes, supportive educational policies, increased funding, and stakeholder sensitisation as essential measures for maximising the benefits of simulation-based learning.

Keywords: Computer-based simulation, computer science, achievement

Introduction

The integration of computer-based simulations in computer science education represents a transformative shift from traditional teaching methods to dynamic, interactive learning experiences that align with modern educational objectives. Computer-based simulations create dynamic, hands-on environments where learners interact with abstract ideas, promoting deeper reasoning and analytical skills vital for success in the modern digital age (Adams, Daly, and Mann, 2017). This paper explores the impact of computer-based simulations on the teaching and learning of computer science, addressing their advantages, effectiveness and implications for education.



Computer-based simulations provide dynamic learning environments that engage students in hands-on exploration. Unlike static lectures and textbook exercises, simulations allow students to experiment with programming scenarios, network configurations, cybersecurity threats, and more, making abstract concepts concrete and comprehensible. This interactive approach resonates with diverse learning styles, catering to students who may struggle with traditional teaching methods.

Research indicates that simulation-based learning enhances academic outcomes. Talan (2021) observed that simulation techniques lead to higher academic performance and long-term retention by restructuring students' knowledge. Similarly, Konak (2019) reported that simulations promote deeper learning through active problem-solving and critical thinking. Moreover, simulations address common challenges in computer science education, such as limited access to resources and real-world scenarios. By providing virtual laboratories and environments, simulations ensure all students have equitable opportunities for practical learning experiences.

The use of simulations supports current educational aims, such as encouraging learner autonomy and equipping students with technological skills relevant to the future workplace, in line with frameworks like the Nigerian National Policy on Education (NPE, 2014), which aims to equip students with necessary scientific knowledge, skills, and competencies for effective living in a technology-driven age. These tools empower learners to engage independently, experiment with various problem-solving paths, and reflect on outcomes without the fear of real-world consequences. The integration of computer-based simulations in computer science education represents a significant advancement in educational methods. By providing interactive, immersive, and practical learning experiences, simulations enhance student engagement, understanding, and retention of complex concepts. They address traditional teaching challenges, prepare students for future technological careers, and align with modern educational goals of equipping students with the necessary skills for success in a technology-driven world.

Statement of the Problems

Despite the critical role of computer science education in equipping students with essential technological skills, student performance in computer science examinations in Abeokuta South Local Government Area, Nigeria, remains below expectations. Statistics indicates that only a small percentage of students achieve credit level and above. Factors contributing to this issue include traditional, teacher-centered instructional methods, low student interests, and limited instructional materials (Adebanjo and Shogunle, 2020).

Traditional teaching approaches often lead to passive learning experiences, reducing student engagement and academic achievement in computer science. To address this, there is a need for alternative, student-centered teaching strategies, such as computer-based simulations. These simulations create dynamic, interactive learning environments that challenge misconceptions, promote critical thinking, and facilitate higher-order learning (Talan, 2021; Konak, 2019). For example, simulations of network configurations can provide hands-on experience with network topologies and cybersecurity, while programming simulations allow students to write, debug, and test code in practical scenarios.



Research Objectives

This study aims to investigate the effect of computer-based simulations on computer science students' achievement in Abeokuta South Local Government Area of Ogun State, Nigeria. Specifically, the study seeks to:

1. Assess the current use of computer-based simulations in teaching and learning computer science in senior secondary schools in Abeokuta South Local Government Area of Ogun State.
2. Compare the academic performance of computer science students exposed to simulation strategies versus those taught using traditional teaching methods.
3. Investigate the potential challenges and barriers associated with integrating simulations into computer science teaching practices in Abeokuta South Local Government.
4. Recommend strategies for practicing teachers to effectively use simulations to enhance understanding of computer science concepts.

Research Questions

1. What is the current level of use of computer-based simulations in the teaching and learning of computer science in senior secondary schools in Abeokuta South Local Government Area of Ogun State?
2. Is there a significant difference in the academic performance of computer science students taught using computer-based simulation strategies and those taught using traditional teaching methods in Abeokuta South Local Government Area of Ogun State?
3. What are the challenges and barriers faced in integrating computer-based simulations into computer science teaching in Abeokuta South Local Government Area of Ogun State?

Concept of Simulation in Computer Science Education

In educational settings, simulation refers to the replication of real-life operations or scenarios, designed to offer students interactive and visually rich experiences that enhance understanding (Akpan & Pawar, 2022). It replicates real-world scenarios to facilitate learning, training, or research, providing learners with safe environments for practice and experimentation across various fields (Akpan & Pawar, 2022). In computer science education, simulations are crucial for providing virtual environments where students can practice coding, network configurations, and cybersecurity protocols (Konak, 2019). They enable visualization of abstract concepts, engage students in problem-solving, and apply theoretical knowledge practically. For instance, network simulation tools allow students to experiment with different topologies and understand data transmission and security issues (Konak, 2019).

In cases where actual systems are either too risky or unavailable for direct interaction, such as cybersecurity training, simulations provide safe platforms to practice responding to virtual threats, enabling experiential learning without real-life repercussions (Monday, 2021). They create



immersive learning environments where students can develop critical thinking and problem-solving skills (Talan, 2021; Monday, 2021). Moreover, simulations facilitate active learning and self-directed exploration by allowing students to manipulate variables and observe outcomes in a risk-free environment (Fallon, 2019). This hands-on experience is essential for deep understanding and preparation for real-world challenges. To effectively integrate simulation into computer science education, simulation *fidelity*, the degree to which a simulation replicates relevant real-world processes, is important because it influences how meaningfully learners can transfer simulated practice to real tasks (Lasater, 2016). High-fidelity simulations are understood to provide a more authentic representation of real-life scenarios, which enhances learners' engagement and the educational value of the simulated environment by aligning it more closely with the complexities of actual practice (Kuipers et al., 2018).

In essence, simulation is a powerful educational tool in computer science, offering dynamic and interactive platforms for exploring complex concepts. Through the creation of authentic virtual settings that promote student engagement, simulations enrich instructional practices and help learners build competencies required in today's digital economy.

The Effectiveness of Using Simulations in Computer Science Education

The use of simulations in computer science education is increasingly acknowledged as a powerful strategy for simplifying intricate topics through immersive and engaging digital environments. Simulations allow students to experiment with code and interact with difficult-to-visualize concepts in a virtual setting. Grounded in experiential and constructivist learning principles, simulations emphasize learner participation, exploration, and reflective thinking, key elements for mastering complex subject matter (Smetana and Bell, 2017). Computer-based programming and simulation environments promote inquiry-based learning by enabling students to *formulate logical steps, test hypotheses, debug code, and analyze outcomes*, which fosters core computational problem-solving and algorithmic thinking skills. Recent research shows that engaging with game simulators and interactive programming tools can significantly enhance students' algorithmic thinking and motivate deeper exploration and reflection during the coding process (Kovtaniuk, 2025).

Simulations captivate students' interest and motivation, enhancing engagement with course content (Linnenbrink-Garcia et al., 2016). Group-based simulation tasks also support collaborative learning, improving students' interpersonal communication and ability to work effectively as part of a team. Effective integration of simulations requires careful assessment strategies, including formative assessments like quizzes and coding challenges, and summative assessments like exams and projects to measure mastery of objectives.

Implementing Simulation-Based Learning in Nigeria's Computer Science Education

Effective integration of simulation-based learning into Nigeria's computer science education demands strategic planning aligned with national curriculum standards. Simulation activities should be embedded across various curriculum topics with a gradual increase in complexity, supporting foundational skills and catering to diverse learner backgrounds. Aligning simulations with educational objectives from bodies like NERDC and syllabi such as WAEC and NECO

ensures relevance and coherence (NERDC, 2012; WAEC, 2020). Additionally, blending simulation with local pedagogical practices such as group work, project-based learning, and coding clubs enhances contextual engagement (Okebukola, 2020).

Designing effective simulation activities requires authenticity, interactivity, and cultural relevance. Simulations should reflect Nigerian societal realities, promote exploration, and accommodate diverse learner needs through customization and differentiation (Rane, Choudhary and Rane, 2023; Afolabi & Adebajo 2023). Assessment and feedback mechanisms must also be embedded within these tools, guided by Nigerian evaluation frameworks and cultural considerations (Obi, 2021).

Research Design and Methodology

A descriptive survey method was adopted for this study because it helps to describe and examine variables as they exist. The study involved senior secondary school computer science students in Abeokuta South Local Government Area of Ogun State. One hundred and twenty (120) respondents were randomly selected from the schools used for the study. Data were collected using a questionnaire designed by the researcher. The questionnaire had two sections: Section A contained respondents’ personal information, while Section B consisted of twenty (20) items on computer-based simulations and related issues. A four-point Likert scale of Strongly Agreed, Agreed, Disagreed, and Strongly Disagreed was used. The instrument was validated by experts, and its reliability was established using the test–retest method. The questionnaires were administered by the researcher and retrieved after completion. Data collected were coded and analysed using SPSS, while simple percentages, mean, and standard deviation were used for data presentation and interpretation.

Result and Discussion

Analysis of the respondent by Research Question

Research Question 1: What is the current level of use of computer-based simulations in the teaching and learning of computer science in senior secondary schools in Abeokuta South Local Government Area of Ogun State?

Table 1: The Prevailing Status of Computer-based Simulation in Present Teaching and Learning of Computer Science Education

Variables		SA		A		D		SD		MEAN	St. Dev.
		N	%	N	%	N	%	N	%		
1.	As a computer science student, am very aware of and familiar with Computer-Based simulation.	4	3.3	102	85.0	10	8.3	4	3.3	2.88	.488
2.	Computer Based Simulation helps in	18	15.0	80	66.7	12	10.0	10	8.3	2.88	.758

	understanding complex Computer science concepts										
3.	I am pleased with computer-based simulation which is more engaging than the traditional teaching method	20	16.7	82	68.3	10	8.3	8	6.7	2.95	.720
4.	Simulation enhances the retention of computer science knowledge.	4	3.3	103	85.8	10	8.3	3	2.5	2.90	.457
5.	I feel more motivated to participate in computer science classes that involve simulation activities.	19	15.8	79	65.8	15	12.5	7	5.8	2.92	.717

Source: Own Study

This study investigated the status of computer-based simulation learning in the teaching and learning of computer studies in senior secondary schools in Abeokuta South Local Government Area of Ogun State. The findings revealed that students are generally aware and familiar with computer-based simulations, as reflected by a mean score of 2.88, which is above the decision benchmark of 2.50. The study further showed that simulations significantly aid in understanding complex computer science concepts (mean = 2.88) and are more engaging than traditional teaching methods (mean = 2.95). Additionally, students believe that simulation-based instruction enhances knowledge retention (mean = 2.90) and increases their motivation to participate in computer classes (mean = 2.92). These results suggest that computer-based simulation is gaining prominence in computer science instruction and positively influencing students' learning abilities, particularly in private secondary schools.

Research question 2: Is there a significant difference in the academic performance of computer science students exposed to computer-based simulation strategies and those taught using traditional teaching methods?

Table 4: Academic Performance Levels of Computer Science Students Exposed to Simulation

Variables		SA		A		D		SD		MEAN	St. Dev.
		N	%	N	%	N	%	N	%		
6.	Student believe their grades in computer science have improved due to participating in computer-based simulation learning.	17	14.2	79	65.8	11	9.2	13	10.8	2.83	.803
7.	Students in computer-based simulation classes seem to be	4	3.3	84	70.0	25	20.8	7	5.8	2.71	.627

	more actively engaged in learning.										
8.	Computer-based simulation learning has enhanced students' ability to recall and apply various computer science concepts.	18	15.0	80	66.7	17	14.2	5	4.2	2.93	.676
9.	Students feel more confident in understanding computer science topics since experiencing computer-based simulation learning.	20	16.7	70	58.3	17	14.2	13	10.8	2.81	.843
10.	Computer-based simulation activities have positively impacted my performance in Computer science assessments	3	2.5	88	73.3	24	20.0	5	4.2	2.74	.572

Source: Own Study

To establish the level of academic performance of computer science students exposed to simulation strategy compared with those taught using traditional teaching methods. The table above shows that most students believe their academic performance in computer science has improved through participation in computer-based simulation learning, with a mean score of 2.83—above the 2.5 benchmark. Students also indicated higher engagement (mean = 2.71), better recall and application of concepts during examinations (mean = 2.93), and increased confidence in understanding computer science topics (mean = 2.81). Additionally, simulation activities were reported to have positively influenced their general academic performance, as reflected in a mean score of 2.74 and a standard deviation of 0.572. The chart below presents a summary of these findings.

Research question 3: What are the challenges and barriers faced in integrating computer-based simulation into computer science teaching practices within Abeokuta South Local Government Area of Ogun State?

Table 5: Various Challenges and Barriers faced in Integrating Simulation into the Teaching of computer science

(NB: Decision Rule: Below 2.5 is disagreed, 2.5 and above is Agreed)

Variables		SA		A		D		SD		MEAN	St. Dev.
		N	%	N	%	N	%	N	%		
11.	Limited access to resources (e.g. power supply, field resources etc.) poses a significant challenge to	35	29.2	71	59.2	5	4.2	9	7.5	3.10	.793

	implementing computer-based simulation learning.										
12.	Insufficient training and support for teachers hinder the effective integration of computer-based simulation.	46	38.3	44	36.7	27	22.5	3	2.5	3.11	.838
13.	There is resistance from some educators towards adopting Computer-based simulation learning methods in computer science classes.	46	38.3	44	36.7	25	20.8	5	4.2	3.09	.870
14.	Limited funding prevents schools from investing in the necessary technology and resources for computer-based simulation learning.	31	25.8	68	56.7	17	14.2	4	3.3	3.05	.732
15.	Lack of awareness or understanding among stakeholders about the benefits of computer-based simulation learning creates barriers to its implementation	9	7.5	103	85.8	3	2.5	5	4.2	2.97	.517

Source: Own Study

As part of the mission to establish the challenges and barriers faced in integrating simulation into the teaching and learning of computer science. The study revealed various challenges which include, limited access to resources (e.g. power supply, field resources, etc) which pose a significant challenge to implementing computer-based simulation learning, this was established with a mean score of 3.10. The table above further revealed that, with a mean score of 3.11, the majority of the respondent indicated that insufficient training and support for teachers had hinder the effective integration of Computer-based simulation into computer science teaching.

Also, the findings of this study revealed that the majority of the respondents think that, there is resistance from some of the educators towards adopting simulation-based learning methods in computer science classes. This was established with high a mean score of 3.09 and a standard deviation spread of 0.870. In addition, the findings also revealed another factor such as limited funding which prevents schools from investing in the necessary technology and resources needed for computer-based simulation learning, and little or no awareness/understanding among stakeholders about the benefits of computer-based simulation learning which creates barriers to its implementation. This was established with mean scores of 3.05 and 2.97 respectively, which is greater than the benchmark.

Discuss of Findings



This study examined the role and impact of computer-based simulation learning in teaching computer science in senior secondary schools in Abeokuta South Local Government Area of Ogun State. The study revealed that students are generally aware of and engaged with computer-based simulations in their computer science lessons. Respondents reported that simulations made abstract concepts more understandable and provided interactive experiences that encouraged exploration of computational logic. This finding is consistent with research by Asadi et al. (2024), who demonstrated that interactive simulation environments improve learners' conceptual understanding and facilitate active engagement in technical subjects such as computer networking. Similarly, Alqahtani and Mohammed (2023) reported that students exposed to simulation-based learning in digital logic courses showed higher levels of interest and perceived usefulness compared with traditional instruction. These studies support the notion that simulations can transform abstract, difficult-to-grasp topics into interactive and comprehensible formats, enhancing student awareness and cognitive involvement.

Respondents in this study indicated that simulations positively influenced their academic performance, including improved recall, application, and problem-solving confidence in computer science tasks. This aligns with empirical work by Batamuliza et al. (2024), who found that simulation-based interventions in technical and STEM courses significantly improved students' post-test scores and retention compared with conventional methods. Similarly, Tuyizere and Yadav (2023) observed that learners in interactive simulation settings demonstrated higher achievement and motivation in technology-focused courses, highlighting the potential of simulations to enhance both cognitive and affective learning outcomes. These findings underscore the contribution of simulation-based learning to students' performance in computer science, reinforcing the value of interactive digital tools in technical education.

Despite these benefits, the study found that several challenges limit the effective integration of simulations, including insufficient hardware and software resources, weak infrastructural support, and inadequate teacher training. Students also reported low stakeholder readiness as a barrier to consistent use of simulations in classroom instruction.

These challenges are supported by research from Nwobodo and Udoka (2025), who identified infrastructural constraints and limited teacher professional development as significant impediments to technology adoption in Nigerian schools. Similarly, Olayinka and Ajayi (2023) highlighted that systemic issues, such as lack of institutional support and inconsistent access to digital tools, prevent effective use of simulation technologies in developing country contexts. This indicates that while simulations have pedagogical potential, contextual and capacity-related barriers must be addressed to realize their full benefits.

Therefore, the study shows a coherent pattern: students perceive computer-based simulations as beneficial for engagement, understanding, and academic performance, but their full potential is constrained by systemic limitations. These results are consistent with broader educational technology research, which emphasizes that simulation tools are effective when supported by adequate infrastructure, teacher readiness, and institutional investment (Asadi et al., 2024; Nwobodo & Udoka, 2025; Alqahtani & Mohammed, 2023; Tuyizere & Yadav, 2023; Olayinka &



Ajayi, 2023). This integrated view highlights that enhancing computer science education through simulations requires both effective pedagogical tools and enabling environments.

Conclusion

In conclusion, the study on the use of computer-based simulation learning in senior secondary schools in Abeokuta South Local Government Area of Ogun State highlights several key findings. Students are highly aware of and familiar with computer-based simulations, which they find engaging and effective in understanding complex computer science concepts. This method not only enhances student motivation and retention of knowledge but also improves their confidence and academic performance in computer science. Despite the clear benefits, several challenges hinder the full integration of computer-based simulations into teaching. These include limited access to necessary resources, insufficient training and support for teachers, resistance from some educators, financial constraints, and a lack of awareness among stakeholders about the advantages of simulation-based learning. While computer-based simulations have the potential to revolutionize the teaching and learning of computer science, overcoming these barriers is essential. Addressing issues related to resource availability, teacher training, financial investment, and stakeholder awareness will be crucial in fully harnessing the benefits of computer-based simulations in education. By tackling these challenges, schools can create a more interactive, engaging, and effective learning environment that better prepares students for the complexities of computer science.

Recommendations

Based on the above exploration, ranging from the identification of the problem, related literature, findings, and conclusion, the following recommendations were made;

1. Schools should prioritize access necessary technological resources such as, reliable power supply, adequate technological infrastructure, and necessary simulation tools. Partnerships with government agencies, private organizations, and NGOs can help secure funding and resources for effective implementation.
2. Regular training programs should be organized to equip teachers with both technical skills and pedagogical strategies for integrating computer-based simulations into the curriculum, while also addressing resistance to adopting new learning methods.
3. Educational authorities should develop policies that support simulation-based learning, including resource allocation and curriculum development. Additionally, awareness should be raised among administrators, parents, and policymakers about the benefits of simulations, and monitoring systems should be established to evaluate their impact on student learning outcomes.

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