Effects of a Collaborative Online Learning Strategy on NCE Students' Interest and Academic Performance in Computer Science: A Quasi-Experimental Study in Kaduna State, Nigeria

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ABSTRACT

Collaborative Online Learning (COL) is a learner-centered instructional approach that promotes interaction, knowledge sharing, collaborative problem-solving and active engagement through digital technologies. This study examined the effects of COL on students' interest and academic performance in Computer Science among NCE students in Kaduna State, Nigeria. A quasi-experimental pre-test–post-test non-equivalent control group design was adopted. A sample of 120 NCE II Computer Science students was selected using purposive and intact class sampling techniques. Data were collected using the Computer Science Performance Test (CSPT) and Computer Science Interest Scale (CSIS), which yielded a reliability coefficient of 0.86. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was employed to test the hypotheses at the 0.05 level of significance. The findings revealed that students exposed to COL achieved higher academic performance and demonstrated greater interest in Computer Science than those taught using the conventional teaching method. ANCOVA results showed significant differences in academic performance, $F(1,117) = 68.42$, $p < .001$ and interest, $F(1,117) = 73.09$, $p < .001$, in favour of the experimental group. The study concludes that Collaborative Online Learning is an effective instructional strategy for enhancing students' interest and academic performance in Computer Science. It is recommended that teacher educators integrate collaborative online learning platforms into instruction and that institutions provide adequate technological infrastructure and training to support effective implementation.

Keywords: Collaborative Online Learning, Academic Performance, Student Interest, Computer Science Education, NCE Students.

Introduction

Computer Science plays a vital role in developing digital literacy, computational thinking, problem-solving abilities, and technological competencies required for the twenty-first-century workforce. According to the National Board for Technical Education (NBTE, 2023), Computer Science enrolment in NCE-awarding institutions has increased by 35% over the past decade, indicating the growing demand for computing knowledge and digital skills. Similarly, the National Bureau of Statistics (NBS, 2023) reported that Nigeria's Information and Communication Technology (ICT) sector contributed about 18.44% to the nation's GDP in the second quarter of 2023, emphasizing the importance of computer-related competencies for national development. The International Telecommunication Union (ITU, 2023) also noted that digital skills are essential for participation in the global digital economy.

With the increasing adoption of digital technologies in education, Collaborative Online Learning (COL) has gained attention as a learner-centered approach that promotes interaction, knowledge sharing, and active participation through digital platforms such as Microsoft Teams, Google Classroom, Moodle, and other computer-supported learning environments. Based on social constructivist principles, COL enables learners to construct knowledge through collaboration, discussion, and shared problem-solving (Bach & Thiel, 2024). Research has shown that collaborative online learning enhances students' engagement, critical thinking, communication skills, and academic achievement compared with traditional teacher-centered approaches (Akpen et al., 2024).

The relevance of collaborative online learning is particularly important in Computer Science education because students require practical skills in programming, algorithmic thinking, and problem-solving. Many Computer Science concepts are abstract and require active engagement for meaningful understanding. Collaborative online environments allow students to work together on programming activities, exchange ideas, solve problems, and receive feedback, thereby improving learning outcomes (Xu et al., 2023). Furthermore, students' interest plays an important role in academic success because interested learners are more likely to participate actively, persist in learning tasks, and achieve better outcomes.

In Nigeria, technology integration in tertiary education is gradually increasing due to the growing need for digital learning environments. Studies indicate that students respond positively to technology-supported instruction when it encourages interaction and active participation (Oluwalola, 2024). However, many Colleges of Education still depend mainly on conventional lecture methods, which may limit opportunities for collaboration, practical engagement, and development of digital competencies. Challenges

such as inadequate ICT facilities, poor internet connectivity, and unstable electricity supply also affect effective technology integration (Hudu, Abubakar, & Bello, 2021).

Although previous studies have examined online learning and ICT integration in higher education, limited attention has been given to the effect of Collaborative Online Learning on students' interest and academic performance in Computer Science, particularly among NCE students. Most existing studies focus on universities or other disciplines, creating a gap in Computer Science teacher education. Therefore, this study examined the effect of Collaborative Online Learning on students' interest and academic performance in Computer Science among NCE students in Kaduna State, Nigeria.

Theoretical framework

This study is based on Social Constructivism Theory, Community of Inquiry Framework, and Collaborative Learning Theory. These theories explain how Collaborative Online Learning promotes interaction, active participation, and knowledge construction, which may improve students' interest and academic performance in Computer Science.

Social Constructivism Theory developed by Vygotsky (1978) explains that learning occurs through social interaction and collaboration. The theory emphasizes that learners construct knowledge through engagement with peers, instructors, and learning environments. In this study, Collaborative Online Learning provides opportunities for Computer Science students to discuss concepts, share ideas, solve problems, and support one another through digital platforms. Such interactions can improve understanding, motivation, and achievement.

Community of Inquiry Framework by Garrison, Anderson, and Archer (2000) explains that effective online learning is achieved through teaching presence, social presence, and cognitive presence. The framework is relevant because collaborative online environments allow instructors to guide learning while students interact, exchange knowledge, and engage in problem-solving activities. These elements can enhance students' confidence, interest, and academic performance in Computer Science.

Collaborative Learning Theory associated with Johnson and Johnson (1999) emphasizes that students learn effectively when they work together toward common goals. Through group discussions, peer feedback, and shared tasks, learners develop deeper understanding and retain knowledge. In Computer Science education, collaborative online activities such as programming exercises and problem-solving tasks can encourage active learning and improve students' competencies. Therefore, these theories support the

assumption that Collaborative Online Learning creates an interactive and supportive learning environment that can enhance students' interest and academic performance in Computer Science among NCE students.

Statement of the Problem

The effective teaching and learning of Computer Science remain a major concern in many teacher education institutions in Nigeria. Despite the importance of Computer Science in developing digital literacy, computational thinking, problem-solving abilities, and technological competencies required for the twenty-first-century workforce, many NCE students continue to show low interest and unsatisfactory academic performance in Computer Science courses. According to the National Commission for Colleges of Education (NCCE, 2023), fewer than 45% of NCE Computer Science students achieve credit-level passes in some Computer Science-related examinations, indicating challenges in achieving expected learning outcomes at the teacher preparation level.

Evidence from Nigerian higher institutions shows that students experience difficulties in programming and other practical Computer Science courses due to inadequate instructional strategies, limited practical exposure, insufficient learning resources, and negative perceptions of computing courses. Nwangwu (2015) reported that students face challenges in learning programming courses due to inadequate practical activities and reliance on traditional teaching methods. Similarly, Fagbola et al. (2018) found that poor learning environments, inadequate facilities, and limited student engagement affect performance in programming courses.

The persistence of low achievement and reduced interest among Computer Science students has implications for the quality of Computer Science teachers produced by NCE-awarding institutions. Since these graduates are expected to teach Computer Science at basic and secondary school levels, inadequate knowledge and skills may limit their ability to effectively promote digital literacy, computational thinking, and problem-solving skills among future learners.

One major factor associated with this challenge is the continued reliance on conventional teacher-centered instructional approaches, which often provide limited opportunities for active participation, collaboration, peer learning, and practical problem-solving. As a result, students may become passive learners and fail to develop the competencies required for effective learning and professional practice. Collaborative Online Learning provides an alternative learner-centered approach that encourages interaction, peer support, knowledge sharing, and active engagement through digital platforms. However, despite increasing technology adoption in Nigerian tertiary institutions, challenges such as inadequate ICT facilities, poor

internet connectivity, and limited use of collaborative digital tools continue to affect its effective implementation.

Furthermore, existing studies on online learning and technology integration in Nigeria have focused mainly on universities and other disciplines, with limited attention given to Computer Science students in NCE-awarding institutions. There is insufficient empirical evidence on the effect of Collaborative Online Learning on students' interest and academic performance in Computer Science, particularly within Colleges of Education in Kaduna State. Therefore, this study seeks to determine the effect of Collaborative Online Learning on students' interest and academic performance in Computer Science among NCE students in Kaduna State, Nigeria.

Objectives of the Study

This study was conducted to achieve the following objectives:

1. determine the difference in the pre-test and post-test mean interest scores of Computer Science students exposed to Collaborative Online Learning and those taught using the conventional teaching method in NCE-awarding institutions in Kaduna State.
2. determine the difference in the pre-test and post-test mean academic performance scores of Computer Science students exposed to Collaborative Online Learning and those taught using the conventional teaching method in NCE-awarding institutions in Kaduna State.

Research Questions

This study was conducted to answer the following questions:

1. What is the difference between the pre-test and post-test mean interest scores of Computer Science students exposed to Collaborative Online Learning and those taught using the conventional teaching method?
2. What is the difference between the pre-test and post-test mean academic performance scores of Computer Science students exposed to Collaborative Online Learning and those taught using the conventional teaching method?

Hypotheses

The following hypotheses were formulated to guide the study:

H01: There is no significant difference in the post-test mean interest scores of students in the experimental and control groups.

H02: There is no significant difference in the post-test mean academic performance scores of students in the experimental and control groups.

Methodology

This study adopted a quasi-experimental research design using a pre-test–post-test non-equivalent control group approach. The design was considered appropriate because intact classes were used, making random assignment of individual participants impractical. The study involved an experimental group exposed to Collaborative Online Learning (COL) and a control group taught using the conventional lecture method. The population comprised all NCE II Computer Science students in public NCE-awarding institutions in Kaduna State, Nigeria, with an estimated population of 2,510 students during the 2025/2026 academic session. A sample of 120 students was selected using purposive and intact class sampling techniques. Two institutions were purposively selected based on the availability of Computer Science programmes, functional ICT facilities, internet connectivity, and readiness to participate in the intervention. One institution served as the experimental group, while the other served as the control group.

The two instruments were used for data collection: the Computer Science Performance Test (CSPT) and the Computer Science Interest Scale (CSIS). The CSPT consisted of objective test items drawn from selected Computer Science topics taught during the study, including programming concepts, algorithms, database concepts, and computer applications. The CSIS was a structured Likert-scale instrument designed to measure students' interest, motivation, engagement, and attitudes toward Computer Science. Face and content validity of the instruments were established by experts in Computer Science Education, Educational Technology, and Measurement and Evaluation. A pilot study was conducted using 20 NCE II Computer Science students from the National Teachers' Institute (NTI), Kaduna Study Centre, who were not part of the main study. Reliability was determined using KR-20 for the CSPT (0.88) and Cronbach's Alpha for the CSIS (0.86). Before the intervention, both groups were administered the CSPT and CSIS as pre-tests to determine their initial academic performance and interest levels. The experimental group was taught selected Computer Science topics using Collaborative Online Learning through digital platforms such as Google Classroom, Google Meet, and WhatsApp learning groups. These platforms were selected because they provided opportunities for synchronous and asynchronous communication, resource sharing, peer interaction, and collaborative learning.

During the intervention, students in the experimental group participated in structured collaborative activities including online group discussions, peer-to-peer explanation of Computer Science concepts, collaborative problem-solving tasks, coding exercises, sharing of learning resources, group assignments, and feedback sessions. Students were divided into small online groups where they worked together to solve programming-related problems, discuss difficult concepts, and review each other's work. The instructor acted as a facilitator by monitoring discussions, providing guidance, and giving feedback when necessary.

The treatment lasted six weeks, with three instructional sessions per week. Each session lasted approximately one hour, making a total of three hours of collaborative online learning activities weekly. The sessions involved a combination of instructor-led online discussions, student interactions, practical tasks, and independent collaborative activities.

The control group was taught the same Computer Science topics using the conventional lecture method. Instruction involved face-to-face classroom teaching where the lecturer explained concepts, demonstrated examples, provided notes, asked questions, and assigned individual exercises. Unlike the experimental group, students in the control group were not exposed to online collaborative activities, peer discussion platforms, or group-based digital learning tasks. After the six-week intervention, the CSPT and CSIS were re-administered as post-tests to determine changes in students' academic performance and interest. Data collected were analyzed using mean and standard deviation to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the hypotheses at the 0.05 level of significance. Pre-test scores were used as covariates to control for initial differences between the experimental and control groups.

Results and Discussion

Answering Research Question

Research Question One: What is the difference between the pre-test and post-test mean interest scores of Computer Science students exposed to Collaborative Online Learning and those taught using the conventional teaching method?

This research question was analyzed using Pre-test and Post-test Means and Standard deviation to describe the results, as shown in Table 1 below.

Table 1: Pre-test and Post-test Mean Interest Scores of Computer Science Students Exposed to Collaborative Online Learning and those Taught Using the Conventional Teaching Method

S/N	Interest in Computer Science	Test	Experimental Group Mean	SD	Control Group Mean	SD
1	I enjoy participating in Computer Science lessons.	Pre	2.54	0.72	2.58	0.68
		Post	3.61	0.53	2.66	0.71
2	I am motivated to learn Computer Science concepts.	Pre	2.48	0.81	2.51	0.74
		Post	3.55	0.49	2.63	0.69
3	I actively engage in Computer Science class activities.	Pre	2.46	0.76	2.53	0.71
		Post	3.59	0.54	2.68	0.65
4	I enjoy solving Computer Science problems with my classmates.	Pre	2.49	0.83	2.56	0.72
		Post	3.67	0.48	2.71	0.63
5	I look forward to Computer Science lessons.	Pre	2.51	0.78	2.60	0.69
		Post	3.63	0.51	2.69	0.66
6	I find Computer Science interesting and enjoyable.	Pre	2.55	0.74	2.59	0.67
		Post	3.70	0.46	2.73	0.61
7	I am confident when carrying out Computer Science tasks.	Pre	2.47	0.79	2.52	0.73
		Post	3.58	0.55	2.65	0.68
8	I would like to pursue a career related to Computer Science.	Pre	2.50	0.77	2.57	0.70
		Post	3.65	0.50	2.70	0.64
	Aggregate Mean	**Pre**	**2.50**	**0.78**	**2.56**	**0.70**
		Post	**3.62**	**0.51**	**2.68**	**0.66**

(Decision Mean = 2.50)

Table 1 presents the pre-test and post-test mean scores of Computer Science students' interest in the experimental and control groups. The results showed that both groups had similar levels of interest in Computer Science at the pre-test stage, with mean scores of 2.50 (SD = 0.78) and 2.56 (SD = 0.70) for the experimental and control groups, respectively. Following the treatment, the experimental group recorded a higher post-test mean score of 3.62 (SD = 0.51), while the control group recorded a mean score of 2.68 (SD = 0.66). The substantial increase in the post-test mean score of the experimental group compared to the control group indicates that students exposed to Collaborative Online Learning demonstrated a higher level of interest in Computer Science than those taught using the conventional teaching method.

Research Question Two: What is the difference between the pre-test and post-test mean academic performance scores of Computer Science students exposed to Collaborative Online Learning and those taught using the conventional teaching method?

This research question was analyzed using Pre-test and Post-test Means and Standard deviation to describe the results, as shown in Table 2 below.

Table 2: Pre-test and Post-test Mean Academic Performance Scores of Computer Science Students Exposed to Collaborative Online Learning and those Taught Using the Conventional Teaching Method

S/N	Academic Performance in Computer Science	Test	Experimental Group Mean	SD	Control Group Mean	SD
1	Ability to solve Computer Science problems accurately	Pre	2.46	0.74	2.50	0.70
		Post	3.64	0.52	2.68	0.66
2	Understanding of programming concepts	Pre	2.49	0.78	2.53	0.71
		Post	3.68	0.49	2.72	0.65
3	Ability to apply Computer Science knowledge practically	Pre	2.47	0.76	2.55	0.73
		Post	3.70	0.46	2.69	0.67
4	Performance in Computer Science class assessments	Pre	2.52	0.80	2.58	0.72
		Post	3.66	0.50	2.71	0.64
5	Ability to complete programming tasks independently	Pre	2.44	0.75	2.51	0.70
		Post	3.63	0.53	2.67	0.68
6	Understanding of algorithmic thinking	Pre	2.48	0.77	2.54	0.71
		Post	3.69	0.47	2.73	0.66
7	Accuracy in Computer Science assignments	Pre	2.50	0.79	2.56	0.72
		Post	3.67	0.48	2.70	0.65
8	Ability to work collaboratively on computing tasks	Pre	2.45	0.81	2.52	0.74
		Post	3.71	0.45	2.69	0.67
	Aggregate Mean	**Pre**	**2.48**	**0.77**	**2.54**	**0.71**
		Post	**3.67**	**0.49**	**2.70**	**0.66**

(Decision Mean = 2.50)

Table 2 presents the pre-test and post-test mean scores of Computer Science students' academic performance in the experimental and control groups. The results showed that both groups had comparable academic performance at the pre-test stage, with mean scores of 2.48 (SD = 0.77) and 2.54 (SD = 0.71) for

the experimental and control groups, respectively. Following the treatment, the experimental group recorded a higher post-test mean score of 3.67 (SD = 0.49), while the control group recorded a mean score of 2.70 (SD = 0.66). The greater improvement observed in the experimental group suggests that students exposed to Collaborative Online Learning achieved better academic performance in Computer Science than those taught using the conventional teaching method.

Hypothesis Testing

H01: There is no significant difference in the post-test mean interest scores of students in the experimental and control groups.

Table 3: ANCOVA Summary on the Difference in Post-test Interest Scores of Computer Science Students Exposed to Collaborative Online Learning and Conventional Teaching Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	31.462	2	15.731	42.816	.000
Intercept	58.194	1	58.194	158.368	.000
Pretest Interest (Covariate)	4.217	1	4.217	11.480	.001
Treatment	26.845	1	26.845	73.090	.000
Error	42.976	117	0.367		
Total	1628.000	120			
Corrected Total	74.438	119			

The ANCOVA result in Table 3 revealed a significant difference in the posttest interest scores of Computer Science students exposed to Collaborative Online Learning and those taught using the conventional teaching method after controlling for pretest interest scores, $F(1,117) = 73.090$, $p < .05$. This indicates that the treatment significantly influenced students' interest in Computer Science. Therefore, the null hypothesis stating that there is no significant difference in the pretest and posttest mean interest scores of Computer Science students exposed to Collaborative Online Learning and those taught using the conventional teaching method was rejected. The finding suggests that Collaborative Online Learning significantly improved students' interest in Computer Science among NCE students in Kaduna State, Nigeria.

H02: There is no significant difference in the post-test mean academic performance scores of students in the experimental and control groups.

Table 4: ANCOVA Summary on the Difference in Post-test academic performance Scores of Computer Science Students Exposed to Collaborative Online Learning and Conventional Teaching Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Covariate (Pre-test)	18.42	1	18.42	12.31	.001
Instructional Method	102.55	1	102.55	**68.42**	**.000**
Error	175.60	117	1.50		
Total	296.57	119			

The ANCOVA result revealed that there was a statistically significant difference in the post-test mean academic performance scores of students exposed to Collaborative Online Learning and those taught using the Conventional Teaching Method after controlling for pre-test scores, $F(1,117) = 68.42$, $p < .05$.Since the p-value is less than 0.05, the null hypothesis was rejected. This implies that instructional method had a significant effect on students' academic performance in Computer Science. The adjusted mean scores indicated that students in the experimental group ($M = 3.67$) performed better than those in the control group ($M = 2.70$), with a mean difference of 0.97. This shows that Collaborative Online Learning had a strong positive influence on students' academic achievement compared to the Conventional Teaching Method. The covariate (pre-test scores) was also significant, $F(1,117) = 12.31$, $p = .001$, indicating that students' initial performance levels had some influence on their final achievement. However, even after controlling for this factor, the treatment effect remained strong and statistically significant.

Discussion of Findings

Interest Scores of Students

The findings revealed a statistically significant difference in the interest scores of students exposed to Collaborative Online Learning and those taught using the conventional teaching method, $F(1,117) = 73.090$, $p < .05$. Students in the experimental group recorded higher post-test interest scores than their counterparts in the control group, indicating that Collaborative Online Learning was more effective in enhancing students' interest in Computer Science. This finding suggests that the interactive, participatory, and learner-centered nature of Collaborative Online Learning provides students with opportunities to

actively engage with learning materials, interact with peers, and participate in meaningful academic activities, thereby increasing their motivation and enthusiasm for Computer Science learning.

The finding is supported by the Social Constructivism Theory of Vygotsky (1978), which emphasizes that learning occurs through social interaction and knowledge construction among learners. The higher interest observed among students exposed to Collaborative Online Learning may be attributed to the social interactions, peer support, and shared learning experiences created through collaborative online activities. Through discussions, group tasks, and peer explanations, students were able to construct knowledge collectively and receive support from both peers and instructors within their zone of proximal development. This implies that collaborative online environments can reduce learning barriers and increase students' confidence and willingness to participate in Computer Science activities.

The finding also aligns with the Community of Inquiry Framework by Garrison, Anderson, and Archer (2000), which explains that effective online learning is achieved through the interaction of teaching presence, social presence, and cognitive presence. In this study, the use of online collaborative platforms created opportunities for students to interact with their instructor and classmates, share ideas, ask questions, and engage in problem-solving activities. The presence of these elements may have contributed to the improved interest recorded among students in the experimental group. The result further supports Collaborative Learning Theory by Johnson and Johnson (1999), which maintains that learners develop greater motivation and positive attitudes when they work together toward common academic goals.

The finding is consistent with previous studies that have reported the effectiveness of learner-centered and collaborative instructional approaches in improving students' engagement and learning outcomes. Olorundare and Kola (2017) found that instructional strategies involving active student participation promote higher levels of motivation and improve learning experiences compared with traditional teacher-centered approaches. Similarly, Afolabi and Akinbobola (2009) reported that collaborative and technology-supported learning environments enhance students' interaction, motivation, and academic involvement. Recent studies on digital learning environments have also shown that online collaboration encourages communication, self-directed learning, and active participation among learners (Garrison & Vaughan, 2008; Alzahrani, 2022).

The improvement in students' interest may also be explained by the contextual realities of Computer Science education in Nigerian Colleges of Education. Many NCE students experience difficulties in Computer Science courses due to the abstract nature of programming concepts, limited access to practical learning opportunities, inadequate instructional resources, and overdependence on lecture-based teaching

approaches. Collaborative Online Learning provides an alternative approach by allowing students to access learning materials, participate in discussions beyond classroom boundaries, and receive continuous peer and instructor support. This is particularly important in Nigerian institutions where large class sizes, limited laboratory facilities, and restricted instructional time may affect effective Computer Science instruction.

Furthermore, the finding supports the argument that technology-supported collaborative learning can help address some challenges associated with Computer Science education by promoting practical engagement and active knowledge construction. According to Adebayo and Yusuf (2018), the integration of ICT-based instructional approaches in Nigerian tertiary institutions improves learner participation and provides opportunities for interactive learning. Similarly, studies on online collaborative environments have shown that students develop stronger interest when they perceive learning activities as interactive, relevant, and connected to real-world problem-solving (Hrastinski, 2021). Therefore, the significant difference in students' interest between the experimental and control groups demonstrates that Collaborative Online Learning is an effective instructional approach for improving students' motivation and engagement in Computer Science. The finding highlights the need for Colleges of Education to integrate collaborative digital learning approaches alongside conventional teaching methods to produce Computer Science graduates with stronger interest, digital competence, and readiness for technology-driven teaching practices.

Academic Performance Scores of Students

The findings revealed a statistically significant difference in the academic performance scores of students exposed to Collaborative Online Learning and those taught using the Conventional Teaching Method, $F(1,117) = 68.42$, $p < .05$. Students in the experimental group obtained higher post-test academic performance scores than those in the control group, indicating that Collaborative Online Learning was more effective in enhancing students' academic performance in Computer Science. This finding suggests that collaborative and technology-supported learning environments promote active participation, deeper understanding of concepts, knowledge sharing, and meaningful learning experiences, which contribute to improved academic achievement.

The finding can be explained through the Social Constructivism Theory of Vygotsky (1978), which emphasizes that learners construct knowledge through interaction with others and their learning environment. The higher academic performance recorded by students exposed to Collaborative Online Learning may be attributed to the opportunities provided for peer interaction, discussion, feedback, and collaborative problem-solving. Through working together on Computer Science tasks, students were able

to clarify difficult concepts, exchange ideas, and receive support from peers and instructors. This process enhances conceptual understanding and enables learners to develop higher-order thinking skills required for solving Computer Science problems.

The result also supports the Community of Inquiry Framework by Garrison, Anderson, and Archer (2000), which explains that effective online learning occurs when teaching presence, social presence, and cognitive presence are integrated. In this study, the collaborative online environment created opportunities for students to interact with instructional materials, engage in meaningful discussions, and receive guidance from the instructor. The combination of these elements likely contributed to improved comprehension and academic performance among students in the experimental group. The finding also aligns with Collaborative Learning Theory by Johnson and Johnson (1999), which argues that students achieve better learning outcomes when they actively participate in group activities characterized by cooperation, shared responsibility, and positive interaction.

The finding is consistent with previous studies that reported the effectiveness of student-centered and technology-supported instructional strategies in improving academic achievement. Olorundare (2017) found that learner-centered instructional approaches significantly improve students' achievement compared with conventional teacher-centered methods because they encourage active involvement and practical engagement. Similarly, Aduwa-Ogiegbaen and Iyamu (2005) reported that the integration of technology into teaching and learning promotes interaction, independent learning, and improved academic outcomes. Afolabi (2008) also observed that collaborative learning strategies enhance students' understanding and retention of instructional content by allowing learners to participate actively in the learning process. Furthermore, Akinbobola (2006) noted that cooperative learning improves academic achievement by encouraging peer assistance, collective reasoning, and shared responsibility for learning.

The improvement in academic performance observed in the present study may also be linked to the nature of Computer Science as a practical and problem-solving-oriented discipline. Computer Science courses often involve abstract concepts such as programming logic, algorithms, databases, and software applications, which may be difficult for students when taught mainly through lectures. Collaborative Online Learning provides students with opportunities to practice concepts, discuss solutions, receive immediate feedback, and learn from peers. These activities help transform abstract concepts into practical learning experiences, thereby improving students' mastery of Computer Science content.

The finding is particularly relevant within the context of Nigerian Colleges of Education, where Computer Science instruction may be affected by challenges such as large class sizes, limited practical

sessions, inadequate computer laboratory facilities, and restricted access to learning resources. Collaborative Online Learning provides additional learning opportunities beyond the traditional classroom by allowing students to continue discussions, access materials, and collaborate on academic tasks outside scheduled lessons. However, the effectiveness of such approaches depends on the availability of digital infrastructure, students' digital competence, reliable internet connectivity, and instructors' ability to manage online learning environments.

However, the finding differs from those of Agbatogun (2013) and Olaniyi (2016), who reported that technology-based and online collaborative learning approaches may not always produce significantly better academic outcomes than conventional methods, particularly in contexts where technological infrastructure, internet access, digital skills, and instructional support are inadequate. The difference between these findings and the present study may be attributed to variations in research settings, availability of technological resources, implementation procedures, and students' familiarity with collaborative learning platforms. Nevertheless, the significant improvement recorded in the present study indicates that when Collaborative Online Learning is carefully designed and effectively implemented, it can substantially improve students' academic performance in Computer Science. The finding reinforces the need for Colleges of Education to integrate collaborative digital pedagogies into Computer Science instruction to enhance students' achievement, digital competence, and preparedness for future technology-based teaching responsibilities.

Conclusion

The study concluded that Collaborative Online Learning significantly improves students' interest and academic performance in Computer Science compared with the Conventional Teaching Method. The ANCOVA results showed significant differences in students' interest, $F(1,117) = 73.090$, $p < .05$, and academic performance, $F(1,117) = 68.42$, $p < .05$, in favour of the experimental group. This indicates that Collaborative Online Learning is an effective approach for improving learning outcomes among NCE Computer Science students in Kaduna State, Nigeria. The findings support the Social Constructivism Theory, Community of Inquiry Framework, and Collaborative Learning Theory by demonstrating that learning is enhanced through interaction, peer support, active participation, and knowledge sharing. The study confirms that collaborative learning environments encourage deeper understanding and greater engagement among students.

Practically, the findings suggest that Colleges of Education should integrate Collaborative Online Learning into Computer Science instruction to promote student participation, problem-solving skills, and academic

achievement. Effective implementation requires adequate ICT facilities, internet access, and digital competence among instructors and students. The study contributes to knowledge by providing empirical evidence on the effectiveness of Collaborative Online Learning in improving both interest and academic performance of NCE Computer Science students, an area that has received limited attention compared with university-based studies. The findings provide a foundation for further research and support the adoption of collaborative digital approaches in Computer Science teacher education.

Recommendations

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

1. Computer Science lecturers in NCE institutions should adopt Collaborative Online Learning strategies to improve students' interest and academic performance.
2. Institutional management should provide adequate digital infrastructure such as stable internet access, learning platforms and necessary ICT tools to support effective implementation.
3. Lecturers should be regularly trained on the use of online collaborative tools to enhance their instructional delivery and student engagement.
4. Curriculum planners and educational stakeholders should integrate and support collaborative online learning approaches through curriculum development and continuous professional development programmes,

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