



## Effect of cloud-based collaborative learning management system on students' academic achievement and retention among undergraduate students in Bauchi State

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### Abstract

This study examined the effect of cloud-based collaborative learning management system on students' academic achievement and retention among undergraduate students in Science Method Course (SED 350). A pre-test, post-test non-equivalent control group quasi-experimental research design was employed, involving experimental and control groups to determine the effect of the intervention. The population of the study comprised all the 300 level science education students offering Science Method. A sample of 184 students was purposively selected comprising of 86 males and 98 females. An instrument titled Science Method Achievement Test (SMAT) was used for the data collection. The internal consistency of reliability of the item was estimated using Cronbach alpha reliability coefficient. The data collected were analysed using mean and standard deviation to answer the research questions while independent sample T-test was used to test the null hypotheses. A CBCLMS was developed, precisely Canvas Learning Management System (LMS) was deployed for the experimental group, providing access to course materials, interactive learning tools, and collaborative features. The control group received traditional face-to-face instruction without access to the Canvas. Academic achievement was measured through post-test scores, while retention was assessed using a follow-up test administered after a set interval. The findings revealed a statistically significant improvement in both academic achievement and retention among students exposed to the CBCLMS. Based on the findings, the researcher concluded that the integration of CBCLMS platforms, such as Canvas LMS, enhances learning outcomes and recommended its wider adoption for effective instructional delivery in tertiary institutions.

**Keywords:** Cloud computing, CBCLMS, Canvas, LMS, learning resources & ICT

### Introduction

In recent years, the relevance and implementation of distance education technologies have spread rapidly on a global scale. The integration of emerging technologies such as cloud computing in teaching and learning process is no longer a choice but a necessity due to the changing learning environment, demanding flexibility in methodology, and the need to enhance creativity and productivity in learning (Onyema, 2019). However, the use of innovative educational technologies such as cloud computing encourages learners to acquire internet-enable gadgets such as smartphones, laptops and using suitable learning management systems (LMS) such as cloud-based learning has improved on students' learning experience (Thuku, Ondigi & Muuro, 2022)<sup>[27]</sup>.

Cloud computing services are classified into three; Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Each of these services has its features and supports collaborative sharing among users (Edeh, Akaeze & Chukwu, 2020)<sup>[9]</sup>. Furthermore, Cloud computing has emerged as a viable and promising solution not only for emerging societies with limited funding and IT infrastructure, but also for developed countries where there are cuts in institutional IT budgets in the face of increasing demands for IT services (Aydin, 2021)<sup>[3]</sup>.

The educational systems that operate through cloud services encompass virtual learning environments, learning management systems, and collaboration tools, which include Google Classroom and Microsoft Teams alongside Moodle (El-Kanj, El Nar & Abdurashidova, 2025)<sup>[10]</sup>.

Cloud-based m-learning offers learners the opportunity to access text-based, audio and video content without having to worry about the storage capacity or computational capabilities of their mobile devices (Hiran & Dadhich, 2024)<sup>[13]</sup>. Nigeria, like other developing countries is faced with infrastructural challenges that have hindered the provision of quality IT services to facilitate teaching and learning with technology (Bubou & Job, 2021)<sup>[5]</sup>.

Sitting alongside this is the traditional classroom approach with limited use of technology (Mulyanti, Purnama, & Pawinanto, 2020)<sup>[21]</sup>. Given the widespread integration of mobile technology in the country and ownership of mobile devices by the majority of higher education students (Liadi 2016; Mojaye 2015; Utulu & Alonge 2012), CBLMS offers the possibility to reimagine the delivery of higher education. CBLMS is a social interaction that involves a group of learners and instructors where members of each group acquire and share an experience (Martin & Bolliger, 2022)<sup>[17]</sup>. Cloud-based technologies provide students and teachers full access to educational materials, digital classroom systems, and collaborative tools that students can use from any part of the globe (Daud & Mohd Amin, 2023)<sup>[7]</sup>. Furthermore, it plays a vital role in constructing a positive learning experience for students because its applications are more convenient for chatting, sending queries, recording audio meetings, processing documents, and delivering content (Baanqud, Al-Samarraie, Alzahrani & Alfarraj, 2020)<sup>[4]</sup>. It allows both instructors and students to construct and share knowledge and thus promote advanced thinking (Malkawi, Bakar & Dahlin, 2023)<sup>[16]</sup>.

Nigeria and other developing countries could benefit from CBLMS where students and faculty members could have

access to online facilities to collaborate effectively achieving the potential aims of their courses and programs. Even though the wide spread of mobile devices would encourage and enhance the utilisation of CBLMS, there are still some concerns that would limit or even eliminate the whole initiative based on the fact that every technology or project would face during different phases of the implementation (Al Hajri, 2020) <sup>[1]</sup>.

### Statement of the problem

Despite the increasing integration of digital technologies in higher education, many tertiary institutions in Nigeria continue to rely heavily on traditional teaching and learning methods that limit collaboration and students' engagement. The emergence of cloud-based collaborative Learning Management Systems (CBLMS) such as Google Classroom, Canvas, Blackboard and Moodle offers new opportunities for interactive, student-centered, and flexible learning experiences (Yadav & Bondre, 2025) <sup>[29]</sup>. However, the extent to which these platforms enhance students' academic achievement and retention remains unclear within the developing countries, particularly among undergraduates in Nigeria (Okigbo & Ikechukwu, 2025) <sup>[23]</sup>.

Preliminary observations and reports from lecturers and students reveal that although institutions have deployed LMS platforms, but adoption and effective utilization remained inconsistent and poorly monitored. Many students face challenges such as inadequate digital literacy, limited internet connectivity, and lack of structured institutional support, which hinder full participation in cloud-based collaborative learning environments.

Therefore, there is a pressing need to empirically investigate the effect of cloud-based collaborative LMS on students' academic achievement and retention in Bauchi State. Understanding this relationship will provide valuable insights into how technology-mediated learning can be optimized to promote deeper understanding, sustained engagement, and long-term knowledge retention among undergraduates.

### Purpose of the Study

The purpose of the study was to investigate the effect of Cloud-Based Collaborative Learning Management System on Students' Academic Achievement and Retention Among Undergraduate Students in Bauchi state. Specifically, the study seeks to:

1. determine the mean scores of the students exposed to CBLMS and those taught using conventional method.
2. determine the mean scores in the pretest and post-test of the students exposed to CBLMS.
3. Determine the mean retention score of the students exposed to CBLMS and those taught using conventional method.

### Research Question

1. What is the performance mean scores of the students exposed to CBLMS and those taught using conventional method?
2. What is the performance mean scores in the pretest and post-test of the students exposed to CBLMS?
3. What is the difference in mean retention scores of the students exposed to CBLMS and those taught using conventional method?

### Hypotheses

1. H<sub>01</sub> There is no significant difference in performance mean scores in the pretest and post-test of the students exposed to CBLMS and those taught using conventional method.
2. H<sub>02</sub> There is no significant difference in performance mean scores in the pretest and post-test of the students exposed to CBLMS.
3. H<sub>03</sub> There is no significant difference in mean retention scores the students exposed to CBLMS and those taught using conventional method.

### Significance of the Study

The findings of this research will be significant to educators with actionable evidence that incorporating technology-driven instructional strategies substantially improves students' conceptual understanding and memory retention in complex courses like Science Methods (SED 350). It offers a practical model for moving away from conventional, rigid teacher-centred methods toward flexible, interactive, and constructivist learning environments that promote peer teamwork and asynchronous engagement.

The findings would also serve as an empirical justification for tertiary institution administrators to prioritize and systemize the adoption of Learning Management System (LMS) platforms like Canvas. It underscores the urgent need for institutions to move beyond simple deployment and instead focus on organizing targeted workshops, digital literacy training, and structured instructional support for faculty to ensure consistent and effective utilization.

### Literature Review

Empirical studies worldwide have demonstrated the benefits of cloud-based platforms for enhancing engagement, motivation, and academic performance.

Cloud computing refers to the computer resources and systems available on-demand via the Internet that can provide several integrated computing services without being restricted to local resources to facilitate the user.

In a study conducted by Gaad (2022) <sup>[12]</sup> on the Effects of Online Collaborative Learning (OCL) on Student Achievement and Engagement. The study employed a one-group pretest/post-test pre-experimental design. The population comprised 30 senior high school students from one physical science class in Congressional District 1, Quezon City, Philippines. Purposive sampling was applied to select 30 students (4 males and 26 females) from the 42 students enrolled in the class. Physical Science Achievement Test (PSAT) was developed as an instrument for data collection. The findings of the reported that there is a significant difference between the student's pretest and post-test mean scores in the three factors of engagement (cooperation, interest, and participation) before and after exposure to the OCL strategy. These findings indicate that OCL has a significant effect on improving students' engagement in physical science.

In a study conducted by Oguguo, Nannim, Agah, Ugwuanyi, and Nzeadibe (2021) <sup>[22]</sup> on the Effect of learning management system on Student's performance in educational measurement and evaluation. A quasi-experimental research design was used as the design for the study. The population comprised of all the undergraduate students in Imo State University, Nigeria. A sample of 232 students was purposively selected comprising of 109 males

and 123 females. An instrument titled “Measurement and evaluation Achievement Test (MEAT)” was used for data collection. The findings of the study revealed that students taught using LMS (Moodle) performed better than those exposed to the CAI4ME Package. It was equally revealed that female students performed better than the males in both the two approaches although the male students recorded a higher gain score.

A similar study was conducted by Firat (2016) [11] on Determining the effects of LMS learning behaviours on academic achievement in a learning analytic perspective. explanatory mixed method, which allows collection of quantitative and qualitative data together was used for the study. A total of 71 undergraduate students participated in the study. The results revealed that the students used LMS as a support to face-to-face education more intensively on course days (at the beginning of the related lessons and at nights on course days) and that they activated the content elements the most. Lastly, almost all the students agreed that LMS helped increase their academic achievement only when LMS included such features as effectiveness, interaction, reinforcement, attractive design, social media support, and accessibility.

## Methodology

### Research Design

The study would adopt a pre-test, post-test non-equivalent control group quasi-experimental research design. McCoy (2025) [19] sees pre-test, post-test non-equivalent control group quasi-experimental research design as a design that administer a post-test to two selected groups of participants in which one on the groups has been administered the experimental treatment condition. The design would be considered appropriate for the study because intact classes would be used to avoid disruption of normal class lessons. The researcher would assign the intact classes into to experimental and control groups.

This design is presented diagrammatically:

**Table 1:** Diagrammatic Representation of the Research Design

Groups	Pre-test	Treatment	Post-test
Experiment (Group1)	T <sub>1</sub>	X <sub>1</sub>	T <sub>2</sub>
Control (Group 2)	T <sub>1</sub>	X <sub>0</sub>	T <sub>2</sub>

Adapted from Damayanti, Nur, Anggereni and Taufiq (2023) [6]

Where:

X<sub>1</sub> = Treatment (CBLMS)

X<sub>0</sub> = Treatment (lecture method)

T<sub>1</sub> = Pre-test (To be conducted before the intervention of CBLMS to determine their performance)

T<sub>2</sub> = Post-test (To be conducted after the intervention of CBLMS to determine the effect of the CBLMS)

### Population

The population comprised all the seven hundred and thirty-six 300-level undergraduate science education students offering SED 350 in Bauchi State in the 2025/2026 academic session. The choice of 300 level students is as a result of the course chosen (SED 350 Science Method).

### Sample and Sampling Technique

The sample for this study consists of 184 science education students (300 level) from two intact classes randomly selected from two tertiary institutions in Bauchi state.

Simple random sampling would be used to assign two schools each into experimental and control groups. Creswell (2015) sees simple random sampling as sampling technique where the researcher selects participants for the sample so that any individual has an equal probability of being selected from the population.

Experimental (n=92) and Control (n=92). The experimental group would be taught SED 350 using a cloud-based collaborative LMS integrating Canvas for group tasks, all necessary instructional materials would be uploaded to the Canvas, the students in the experimental group would also be registered to the Canvas LMS platform. The Canvas has the following features; (a) Management of Subject Contents such as documents, Graphics, webpages or videos; (b) Communication with Students through forum or social networking sites. (c) students’ assessment such as grading, monitoring assignments and providing immediate feedback anywhere and anytime. while the control group would receive conventional face-to-face instruction. Science Method Achievement Test (SMAT) would be developed and validated by experts and reliability of the coefficient would be determine using Cronbach Alpha reliability test. Data collection would involve administering the SMAT as a pretest and delayed post-test after two weeks to determine their retention level. Data were analysed using mean, standard deviation, and independent t-test statistics at a 0.05 significance level.

## Results

The result from table 1 shows the performance mean scores of students exposed CBLMS and those taught using conventional method. A mean gain score of 18.25 was reported for the CBLMS while the group that was taught using conventional method accounted for a mean score of 12.14. This result shows that the group exposed to CBLMS achieved higher than those taught using conventional method. Cohen effect calculator was used, from the calculation of effect size which yielded the effect size of 1.509, According to Lenhard and Lenhard (2016) if *d* (magnitude of the effect size) > 1, this indicates large effect of CBLMS over conventional method.

**Table 1:** Performance mean scores of the students exposed to CBLMS and those taught using conventional method

	Group	N	$\bar{x}$	SD	Effect size
Achievement	CBLMS	92	18.25	8.165	1.509
	Conventional Method	92	12.14	6.795	

The result in table 2 shows the performance mean scores of students exposed CBLMS before and after the intervention. A mean gain score of 14.86 was reported for the students at the post-test level while a mean score of 12.11 was accounted at the pre-test level. This result shows that the group exposed to CBLMS achieved higher at their post-test level.

**Table 2:** Performance mean scores of the students exposed to CBLMS at the pre-test and post-test level

	Test	N	$\bar{x}$	SD	Effect size
Achievement	Post-test	92	14.86	8.165	1.214
	Pre-test	92	12.11	6.795	

Result in table 3 shows the performance mean retention scores of students exposed CBLMS and those taught using conventional method. A mean gain score of 22.58 was reported for the CBLMS while a mean score of 21.33 was

recorded for those taught with conventional method. This result shows that the group exposed to CBLMS achieved higher than those taught using conventional method in terms of retention.

**Table 3:** Performance mean retention score of the students exposed to CBLMS and those taught using conventional method

	Group	N	$\bar{x}$	SD	Effect Size
Retention	CBLMS	33	22.58	8.699	0.14
	Conventional Method	50	21.33	9.067	

The result in Table 4 shows the analysis of independent sample t-test on performance mean score of the students exposed to CBLMS and those taught using conventional method with  $p < 0.05$ , therefore the null hypothesis was

rejected. This indicate that there was a statistically significant difference between the mean score of Students exposed to CBLMS and those taught with conventional method.

**Table 4:** Independent analysis of t-test on performance mean scores of the students exposed to CBLMS and those taught using conventional method

Levene's test for equality of variance			t-test for Equality of Means			Decision
Achievement	F	sig	t	df	sig(2-tailed)	Rejected
Equal variances assumed	.635	.428	6.863	91	.000	
Equal variance not assumed			6.788	74.245	.000	

**Decision rule:** reject  $H_0$   $p < 0.05$ , otherwise accept  $H_a$

The result in Table 5 shows the analysis of paired sampled t-test on the performance mean scores of the students exposed to CBLMS at the pre-test and post-test level with  $p < 0.05$  as can be seen on in table 5 below. Therefore, the null

hypothesis was rejected. This indicate that there was a statistically significant difference between the mean score of Students exposed to CBLMS at the pre-test and post-test level.

**Table 5:** Paired Sampled analysis of t-test on the performance mean scores of the students exposed to CBLMS at the pre-test and post-test level

Levene's test for equality of variance			t-test for Equality of Means			Decision
Retention	F	sig	t	df	sig(2tailed)	Rejected
Equal variances assumed	.447	.506	5.818	91	.000	
Equal variance not assumed			5.757	74.60	.000	

**Decision rule:** reject  $H_0$   $p < 0.05$ , otherwise accept  $H_a$

The result in Table 6 shows the analysis of independent sample t-test on Performance mean retention score of the students exposed to CBLMS and those taught using conventional method with  $p < 0.05$ , therefore the null

hypothesis was rejected. This indicate that there was a statistically significant difference between the mean retention score of Students exposed to CBLMS and those taught with conventional method.

**Table 6:** Independent Sampled analysis of t-test on the Performance mean retention score of the students exposed to CBLMS and those taught using conventional method

Levene's test for equality of variance			t-test for Equality of Means			Decision
Retention	F	sig	t	df	sig(2tailed)	Rejected
Equal variances assumed	.447	.506	5.818	91	.000	
Equal variance not assumed			5.757	74.60	.000	

**Decision rule:** reject  $H_0$   $p < 0.05$ , otherwise accept  $H_a$

## Discussion

The findings of this study revealed that undergraduate students exposed to the Cloud-Based Collaborative Learning Management System (CBLMS) outperformed those taught using the conventional method in both academic achievement and retention. This indicates that the integration of cloud-based collaborative tools enhances students' engagement, understanding, and long-term retention of knowledge.

Results from Table 1 showed that students exposed to the CBLMS achieved a higher mean score ( $M = 18.25$ ,  $SD = 8.165$ ) compared to those taught using the conventional method ( $M = 12.14$ ,  $SD = 6.795$ ). The computed effect size of 1.509 indicated a large effect according to Lenhard and Lenhard (2016), suggesting that the CBLMS substantially

improved students' academic performance. Furthermore, the independent t-test result (Table 4) revealed a statistically significant difference ( $p < 0.05$ ) between the mean scores of the experimental and control groups, leading to the rejection of the null hypothesis. This finding aligns with previous studies such as those by Almarashdeh (2018)<sup>[2]</sup> and Sun and Chen (2016)<sup>[26]</sup>, which reported that Cloud-based learning management systems and cloud-based collaborative environments promote active participation, enhance motivation, and improve learning outcomes. The improved achievement can be attributed to the interactive and cooperative features of the CBLMS, which support peer-to-peer engagement, timely feedback, and easy access to learning materials. Unlike conventional teacher-centered instruction, the CBLMS encourages learner autonomy and

interaction, which are key principles of constructivist learning theory (Vygotsky, 1978)<sup>[28]</sup>.

As presented in Table 2, students recorded a higher mean score at the post-test level ( $M = 14.86$ ,  $SD = 8.165$ ) compared to their pre-test performance ( $M = 12.11$ ,  $SD = 6.795$ ). The calculated effect size of 1.214, which also represents a large effect, and the paired sample t-test result (Table 5) with  $p < 0.05$  confirmed a statistically significant improvement in students' performance after exposure to the CBLMS. This implies that the CBLMS had a positive influence on students' learning progress over the intervention period. This result corroborates the findings of Yilmaz (2017)<sup>[30]</sup> and Zhang, Zhao, and Tan (2020)<sup>[31]</sup>, who emphasized that technology-supported collaborative learning enhances conceptual understanding and academic development. The improvement observed among students may be linked to the system's flexibility and accessibility, which enable learners to review course materials repeatedly, interact with peers asynchronously, and clarify difficult concepts.

The findings from Table 3 and Table 6 showed that students in the experimental group recorded higher retention scores ( $M = 22.58$ ,  $SD = 8.699$ ) than those in the control group ( $M = 21.33$ ,  $SD = 9.067$ ). Although the effect size (0.14) was small, the t-test result indicated a statistically significant difference ( $p < 0.05$ ) in Favor of the experimental group. This suggests that exposure to CBLMS enhanced students' ability to retain learned information better than the conventional method. This finding is consistent with the works of Adejumo and Olayemi (2019)<sup>[14]</sup> and Johnson and Johnson (2019)<sup>[14]</sup>, who reported that collaborative and interactive learning environments contribute to improved knowledge retention by reinforcing information through discussion, peer feedback, and application. The collaborative and cloud-based nature of the system possibly allowed students to revisit learning materials, exchange ideas, and continuously engage with content, which strengthens memory consolidation and long-term recall.

Overall, the findings of this study emphasize the potential of cloud-based collaborative learning systems as effective tools for improving students' academic outcomes and retention. The significant improvement in achievement and retention supports the argument that technology-enhanced learning environments foster active participation, motivation, and deeper learning. These results provide empirical evidence for educators and policymakers to adopt cloud-based collaborative tools in Nigerian higher education, especially within science and technology-related courses where interaction and experimentation are crucial.

## Conclusion

This study examined the effect of a Cloud-Based Collaborative Learning Management System (CBLMS) on students' academic achievement and retention among undergraduate students in Bauchi State. The findings revealed that students exposed to CBLMS significantly performed higher than their counterparts taught using the conventional method in both academic achievement and retention. The computed effect sizes further confirmed that the CBLMS had a large positive impact on students' learning outcomes. The improved performance of students in the experimental group reported that CBLMS provide more opportunities for interaction, flexibility, and active engagement than traditional classroom instruction. The

results underscore the effectiveness of integrating technology-driven instructional strategies that promote peer collaboration and learner autonomy, as emphasized by constructivist learning theories. The positive effect on students' retention indicates that CBLMS not only enhances immediate academic performance but also supports long-term knowledge consolidation.

## Recommendation

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

1. Tertiary institutions should adopt and integrate cloud-based collaborative learning management systems into their instructional delivery, especially for science and technology-related courses. This will enhance students' engagement, collaboration, academic achievement and retention.
2. Institutions should organize regular workshops and training sessions for lecturers on the effective use of CBLMS and other digital learning tools. Adequate training will ensure that teachers can design, implement, and manage cloud-based collaborative environments effectively.
3. Government and educational administrators should invest in reliable internet connectivity, learning servers, and digital devices to support the effective implementation of cloud-based collaborative learning systems across tertiary institution.
4. Lecturers should employ pedagogical strategies that promote teamwork, discussion, and knowledge sharing within the CBLMS environment. This will strengthen students' learning experiences and improve both short-term achievement and long-term retention.
5. Education policymakers should incorporate the use of cloud-based learning technologies into the national curriculum guidelines for teacher education and science education programs. This will ensure the systematic integration of ICT innovations in higher education.
6. Future studies should investigate the long-term effects of CBLMS on students' performance across different disciplines and explore variables such as gender, learning styles, and digital literacy levels that may influence learning outcomes.

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