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The Effect of Moodle LMS on Distance Learning Undergraduates' Performance in Environmental Education

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Abstract: The research examined the impact of Moodle on the academic performance and satisfaction of distance learning undergraduates in Environmental Education. A repeated measures design was employed, involving 113 purposefully selected environmental education students. Data were collected using the Environmental Education Achievement Test (EEAT) and the Moodle Online Learning Satisfaction Inventory (MOLSI), both of which underwent validation and reliability testing. Students completed two pre-tests and pre-satisfaction assessments before the intervention, followed by two post-tests and post-satisfaction assessments afterward. Data analysis was conducted using repeated measures analysis of variance. The results indicate that Moodle significantly enhanced students' academic performance ($F(3,336) = 193.189$, $P = 0.00$, effect size = 0.963) and satisfaction ($F(3,336) = 154.112$, $P = 0.00$, effect size = 0.957). Additionally, Mauchly's test of sphericity showed no violations for either achievement ($W = 0.741$, $P = 0.621$) or satisfaction ($W = 0.604$, $P = 0.572$). The study also found that variables such as age, gender, location, and device type did not significantly moderate the impact of Moodle on students' achievement. These findings suggest that incorporating Moodle into distance learning curricula could benefit environmental education lecturers, researchers, and policymakers in Nigeria by fostering the development of skilled and environmentally literate graduates.

INTRODUCTION

Environmental education (EE) entails a learning process aimed at enhancing individuals' knowledge and awareness of environmental issues, equipping them with the necessary skills and expertise to address these challenges. The goal of EE is to foster attitudes, motivation, and commitment, enabling people to make informed decisions and take meaningful actions to protect, conserve, and improve the environment at all levels (Ekpo & Aiyedun, 2020). In Nigeria, where EE is an emerging discipline, it includes various techniques, tools, and programs designed to develop and support environmentally conscious attitudes, norms, values, awareness, knowledge, and skills, ultimately preparing individuals to take informed actions for environmental protection (Monroe & Krasny,

2016). EE serves as a conservation approach that brings together scientific communities, decision-makers, community members, and relevant stakeholders to protect and conserve the environment for sustainable development (Ardoin et al., 2020; Toomey et al., 2017). The primary objectives of EE, as outlined by UNESCO (1978), are to produce a generation that is aware of and concerned about environmental issues and to instill the knowledge, skills, attitudes, motivation, and commitment needed to work individually and collectively towards solving current problems and preventing new ones.

In Nigeria, EE is offered as an undergraduate degree program at a limited number of universities. The program aims to expose students to the significant environmental challenges facing the country, such as climate change, desertification, pollution, and global warming, while instilling the values, attitudes, awareness, and ethics necessary to protect, preserve, and conserve the Nigerian environment across all levels—air, land, and water (Mohammed & Ogar, 2023). On the global scale, EE addresses critical issues like climate change, unsustainable land practices, and biodiversity loss (Knight et al., 2019; Toomey et al., 2017). To effectively teach EE and produce environmentally literate students who can protect and conserve the environment, as per UNESCO's objectives from the Tblisi conference (1978), it is essential to incorporate modern technological advancements that make learning flexible, interactive, collaborative, and engaging (Mohammed et al., 2023; Mohammed et al., 2024b). One such technological platform is learning management systems (LMSs).

LMSs encompass various learning platforms, distributed systems, content and course management systems, online portals, instructional management systems, and tools for course or subject management and pedagogy, enabling the design, creation, and delivery of online learning environments (Ahmed & Mesonovich, 2019). The use of LMSs surged during the COVID-19 pandemic when schools worldwide were closed to prevent the spread of the virus (Dias et al., 2020; Raza et al., 2021). Consequently, many educational institutions adopted e-learning to continue teaching their students (Chang & Lan, 2021). LMSs were crucial in developing, managing, and distributing digital resources during online learning, bridging traditional methods and online resources to create a personalized and flexible learning experience for students (Aljawarneh, 2020). According to Capterra (2021), there are currently 561 LMSs used globally for educational purposes. Recent studies have shown that using LMSs like Moodle can enhance student engagement, motivation, and collaboration (Hwang, 2020; Araya & Collanqui, 2021; Jones et al., 2021). Other research (e.g., Ardianti et al., 2020; Bernacki et al., 2020; Hempel et al., 2020; Oguguo et al., 2021; Falode & Mohammed, 2023a) has demonstrated that LMSs improve student performance, satisfaction, retention, and critical thinking during classroom discussions. Additionally, various studies (e.g., Zakaria et al., 2019; Zheng et al., 2019; Hempel et al., 2020; Price et al., 2021) have shown that LMSs allow educators to track student learning outcomes and predict achievement, enabling them to tailor their teaching to better suit student preferences.

Despite the benefits of LMSs in education, previous research has identified a gap in their application within environmental education. One widely recognized LMS that could address this gap is Moodle. Moodle, short for Modular Object-Oriented Dynamic Learning

Environment, is a well-known, free software package widely used by educators in universities. Moodle is based on the social constructivist learning theory which posits that learners better understand concepts when they actively participate in the knowledge creation process (Oguguo et al., 2021; Feizabadi et al., 2016). Since lecturers in Nigeria are aware and ready to use various open educational resources for distance education (Mohammed et al., 2024c), Moodle, as a course management system (CMS), is designed to help educators create high-quality, primarily online courses. It enables instructors to enroll students, manage attendance, create courses, deliver learning materials, conduct quizzes, and provide feedback. Moodle also features a discussion board for teacher-student interaction (Kauts & Kaur, 2021). As a popular LMS, Moodle offers flexible, self-paced learning, promoting student independence and improving academic achievement (Mlotshwa et al., 2020). Moreover, Moodle provides various learning materials and tools, such as videos and text, to help students grasp complex information (Chen et al., 2022). Moodle, a cloud-based LMS, was ranked among the top 20 LMSs based on user experiences in 2018 (Henrick, 2018).

Moodle has seen a significant increase in users, growing by over 250% from 78 million in 2015 to more than 294 million by 2021 (Singh, 2015; Moodle Project, 2020). It offers learners various options through numerous plugins that facilitate self-assessment of their knowledge. This flexibility makes Moodle scalable and user-friendly, allowing students to create personalized learning paths (Zabolotskikh et al., 2021). Moodle enables the creation, distribution, tracking, and management of diverse learning resources. Technological advancements have made Moodle a powerful LMS capable of delivering rich curricular content to achieve positive educational outcomes and assessments (Mershad et al., 2019). As one of the largest and most popular LMSs, Moodle can monitor and record student activities, enabling teachers to refine the learning process to better meet students' needs, interests, and abilities (Shettar et al., 2020). Moodle's ability to create plugins that analyze forum participation provides educators with valuable insights. Through Moodle-based social network analysis, teachers can enhance the learning process, leading to better learning outcomes (Gamage et al., 2022).

However, despite Moodle's importance, there is limited literature on its effectiveness in environmental education within Nigeria. Addressing this gap is essential. While several studies have examined Moodle in other areas, such as educational technology (Falode & Mohammed, 2023a) and measurement and evaluation (Oguguo et al., 2021), research on Moodle's effectiveness in environmental education is scarce. Therefore, this study seeks to evaluate the effectiveness of Moodle LMS for distance learning students in environmental education and to determine whether factors such as age, gender, location, and device type influence student performance.

THEORETICAL SUPPORT

Moodle and Students' Achievement

Achievement refers to the performance level of students after undergoing instruction, serving as a measure of how well they have accomplished a specific task at the end of a given instructional period (Falode & Mohammed, 2023b). Numerous studies have

demonstrated the effectiveness of the Moodle LMS in enhancing student achievement. For instance, Chen et al. (2022) investigated the impact of Moodle-based e-learning on e-collaborative learning, perceived satisfaction, and academic achievement among nursing students, finding a significant improvement in achievement in favor of the Moodle platform. Falode and Mohammed (2023a) explored the performance of educational technology students in a distance learning course using three different course formats print, video, and Moodle and found that Moodle significantly enhanced students' performance after the experiment. Agustina et al. (2020) reported that Moodle improved students' writing skills. Oguguo et al. (2021) examined the effect of the Moodle platform on students' achievement in measurement and evaluation, discovering that students exposed to Moodle outperformed those using the CAI4ME package, with female students outperforming their male counterparts. Similarly, Kauts and Kaur (2021) found that students' achievement in mathematics and their satisfaction levels significantly increased after using Moodle. Ristic et al. (2023) observed that adaptive e-learning via Moodle significantly boosted student achievement. Al-Bataineh et al. (2019) investigated whether blended learning using the Moodle platform could enhance students' grammar achievement, concluding that students' performance improved after using Moodle. Bataineh and Mayyas (2017) also found that blended learning with Moodle was more effective in enhancing students' grammar and reading comprehension compared to traditional teaching methods.

While these empirical studies generally conclude that Moodle effectively enhances student achievement across various disciplines, most were not conducted within the context of environmental education. This creates a gap that needs to be addressed regarding the effectiveness of Moodle for distance learning undergraduate students in EE. Thus, in view of the foregoing, we formed this hypothesis, namely there is no significant difference in the performance of environmental education undergraduates before and after exposure to Moodle LMS.

Moodle and Students' Satisfaction

In the context of online learning, satisfaction refers to learners' evaluations, opinions, feelings, and experiences regarding the effectiveness of the services provided by online learning platforms (Yu, 2022). It involves individuals' judgments on how well the platform meets their expectations and interests (Alqahtani et al., 2022). Research on online learning satisfaction has yielded varying outcomes. For instance, Falode and Mohammed (2023a) examined educational technology students' performance in a distance learning course using three different courseware formats print, video, and Moodle and found a significant increase in student satisfaction after using Moodle. Choe et al. (2019) investigated students' satisfaction levels and learning outcomes in asynchronous online lecture videos, finding that students were highly satisfied with the multimedia online learning methods used.

Similarly, Kauts and Kaur (2021) reported a significant increase in student satisfaction following exposure to the Moodle platform. Ristic et al. (2023) also found that an adaptive e-learning system using Moodle significantly improved student satisfaction. Al-Bataineh et al. (2019) explored the effectiveness of blended learning via Moodle on students' writing performance and reported high levels of satisfaction with the platform.

Yilmaz (2022) surveyed students using various LMS tools for instruction, who expressed positive satisfaction with the tools for distance learning. Mwangi et al. (2023) assessed student satisfaction with Moodle in Kenya, finding that over 93% of respondents were satisfied with the platform. Al-Musharraf and Khahro (2020) examined student satisfaction with online learning during the COVID-19 pandemic, discovering that students were satisfied with the various online learning resources used during this period. While several studies (e.g., Chen et al., 2022; Dooley et al., 2018; Green et al., 2018; Riddle & Gier, 2019) found high satisfaction with online learning, some studies, such as Pickering and Swinnerton (2019), reported no significant difference in online learning satisfaction. The reviewed studies do not offer a definitive conclusion regarding the impact of the Moodle LMS on increasing student satisfaction, particularly as they have not focused on environmental education. This gap highlights the need for further research to address these uncertainties. In view of the foregoing, we hypothesized that namely There is no significant difference in the satisfaction of environmental education undergraduates before and after exposure to Moodle LMS.

Influence of Demographic Factors on Students' Achievement

Numerous studies have investigated the impact of demographic factors on student achievement. For instance, Ugwuanyi (2022) found that factors such as age, gender, and location did not significantly affect the achievement of primary school students in Basic Science after they were exposed to a flipped classroom model. Similarly, Egbedokun and Afolabi (2023) examined how demographic variables influenced students' achievement and motivation in distance learning and discovered that age, marital status, and workplace had no significant effect on performance following flipped learning exposure. Amuda et al. (2016) also reported that age and marital status did not significantly impact students' achievement in Nigerian colleges of education. The study of Mohammed et al. (2025) found that demographic factors such as age, gender and experience with technology did not have a significant moderating influence on computer science undergraduates' achievement after exposure to an online-based instruction using artificial intelligence ChatGPT chatbot. On the other hand, Oguguo et al. (2021) found that gender significantly influenced student performance in Moodle-based instruction, with female students outperforming their male peers.

These studies indicate that there is no definitive conclusion about the influence of demographic variables on students' achievement during an online instruction. Moreover, most of these studies did not focus on environmental education, leaving a gap in the literature. To address this, our study aims to investigate how demographic factors such as age, gender, location, and device type affect the achievement of students in environmental education. Thus, we formed this hypothesis:

H_3: There is no significant influence of age, gender, location and device type on the achievement of environmental education undergraduates after exposure to Moodle LMS.

The previous discussion highlights numerous well-documented studies on the effectiveness of the Moodle platform in enhancing students' performance across various fields. While there is substantial research focused on improving learning outcomes through

Moodle in areas such as educational technology (Falode & Mohammed, 2023a), e-learning (Ristic et al., 2023), nursing (Chen et al., 2022), measurement and evaluation (Oguguo et al., 2021), mathematics (Kauts & Kaur, 2021), reading and writing (Agustina et al., 2020), and grammar (Al-Bataineh et al., 2019), there is a noticeable lack of studies specifically targeting environmental education (EE). Moreover, there is limited research on the effectiveness of Moodle LMS in Nigeria, particularly within the context of EE. To address these gaps, our study aims to examine the effectiveness of Moodle LMS on the achievement and satisfaction of EE undergraduates. Additionally, it will investigate how demographic factors such as age, gender, location, and device type moderate the performance of EE students using Moodle LMS.

METHOD

The study employed a simple repeated measures design, where a single group of participants was tested at multiple points in time, both before and after the treatment began. This design allows researchers to collect multiple data points over an extended period, enabling the examination of changes attributable to the treatment or time. It also provides a control within the same unit of analysis, helping to minimize the effects of treatment (Edmond & Kenedy, 2017; Mohammed et al., 2024a; Mohammed & Bello, 2024).

A total of 113 third-year distance education students in Environmental Education from the University of Abuja, Nigeria, were purposively selected for this study. Purposive sampling was employed for two main reasons: (i) these students have regular internet access due to their enrollment in the distance learning program, making them well-acquainted with online academic activities, and (ii) their three years of experience in the program make them more familiar with the registration portal and other ICT tools used in their academic activities, unlike newly admitted students who may be less experienced.

To gather data, the researchers developed the Environmental Education Achievement Test (EEAT), which comprised 30 multiple-choice questions based on the curriculum outlined in the departmental handbook. The questions were drawn from a course titled *Environmental Impact Assessment* and featured four answer options (A, B, C, and D), with one correct answer and three distractors. Each correct answer earned 2 points, while incorrect answers received 0 points, resulting in a maximum possible score of 60 and a minimum score of 0. The questions were drafted using Benjamin Bloom's taxonomy table of specification to ensure a balanced representation across different cognitive levels of educational objectives. Additionally, the researchers created the Moodle Online Learning Satisfaction Inventory (MOLSI) to assess students' satisfaction with online learning. This inventory consisted of 10 statements rated on a four-point Likert scale: Very Satisfied (VS), Satisfied (S), Not Satisfied (NS), and Very Not Satisfied (VNS).

The instruments used in the study were validated by experts in science and environmental education, as well as in test and measurement from the researchers' institutions. These experts reviewed the face and content validity of the instruments and provided several recommendations, which were incorporated into the final versions used in the experiment. To evaluate the internal consistency of the instruments, copies of the EEAT were administered to a similar sample of environmental education undergraduates,

and the results were analyzed using the Kuder-Richardson 20 formula, yielding a reliability coefficient of 0.89. For the Moodle Online Learning Satisfaction Inventory (MOLSI), the same set of students completed the inventory, and its reliability was assessed using Cronbach's alpha, resulting in a coefficient of 0.81. According to Ali et al. (2019), a reliability index of 0.7 or higher indicates that the survey instrument is highly effective.

Before the experiment began, informed consent was obtained from all participants. A pre-test was conducted to assess the students' initial knowledge, and the first pre-satisfaction inventory was administered concurrently with the pre-test. Two weeks later, a second pre-test and a second pre-satisfaction measure were administered. Following these initial assessments, the students were enrolled on the Moodle platform, where they accessed various online learning materials, including text, images, and videos, created by the researchers. The research process that will be produced will be able to provide a clear and accurate picture of how distance learning can be used to encourage and provide good facilities in maintaining the quality and learning outcomes of students. The quality and comfort of the learning process must be maintained properly so that the learning process in various situations and conditions can run optimally and produce a learning process that remains good and quality, where in this study using the Moodle platform. The Moodle platform, as a course management system, allowed students to engage with the learning materials at their convenience. They could also collaborate and interact with peers and tutors through discussion forums, and received feedback from tutors who used the platform to deliver content, facilitate discussions, and grade quizzes and assignments.

The treatment period lasted two months, with a contact session of one hour every two weeks, totaling four sessions. At the end of the treatment period, the first post-test and post-satisfaction inventory were administered to evaluate any improvements in achievement and satisfaction. Three weeks later, the second post-test and post-satisfaction measures were also conducted. Repeated measures analysis of variance (RM-ANOVA) was used to compute the result obtained from the various measures. Specifically, descriptive statistics was used to show the mean score differences of the four different measures for achievement and satisfaction while RM-ANOVA was used to check for significant differences for the four different measures. Sidak and Bonferroni post-hoc pairwise tests were used to indicate where the significant differences occurred for both achievement and satisfaction measures respectively. Mauchly's test of sphericity for the within subject effect was equally computed to determine whether the variance of all the pairings were equal. Kolmogorov-Smirnov and Shapiro-Wilk normality test were conducted to check the normality distribution of the data set and the results discovered that $P>0.05$, hence, the data were from a normal distribution which warranted the adoption of parametric statistics. A moderation analysis was conducted to check the influence of the demographic factors of age, gender, location and device type on the effect of Moodle LMS on students' achievement.

RESULT AND DISCUSSION

The results of the research that has been conducted reveal some critical data and information that can show how the Influence of LMS Moodle on the Learning

Achievement of Environmental Education Students in Distance Learning, where the impacts and also the influences that occur from distance learning can be clearly described and explained. From the results of the data analysis, various information can reveal the real role and impact of the distance learning process. The data reviewed from this study, among other things, reviewing the demographic characteristics of the participants who were the subjects of this research can be seen in Table 1.

Table 1. Demographic Characteristics of the Participants

Demographics	Category	Frequency	Percentage(%)
Age	18-25	30	26.5
	25-30	49	43.4
	30-Above	34	30.1
Gender	Male	79	69.9
	Female	34	30.1
Location	Urban	72	63.7
	Rural	41	36.3
Device Type	Smart	54	47.8
	Phone	0	0
	Tablet	15	13.3
	Computer	44	38.9

Table 1 shows the demographic characteristics of the participants. The table revealed that 30 (26.5%) respondents were between the age of 18-25, 49 (43.4%) were between the age of 25-30, and 34 (30.1%) were between the age of 30 and above. The table also revealed that 79 (69.9%) respondents were male, while 34 (30.1%) were female. 72 (63.7%) were located in urban areas, while 41 (36.3%) were from rural locations. The table also revealed that 54 (47.8%) participants used smartphones, 15 (13.3%) used tablets, and 44 (38.9%) used computers.

Table 2. Mean and Standard Deviation of Students' Achievement Scores at Different Test Occasions

S/N	Test occasions	N	Mean	SD
1	Pre-test 1	113	48.50	14.68
2	Pre-test 2	113	51.12	13.04
3	Posttest 1	113	71.57	10.88
4	Posttest 2	113	73.20	10.21

Table 2 shows the mean and standard deviation of students' achievement at four different test occasions. The table revealed a mean of M = 48.50, SD = 14.68 and M = 51.12 and SD = 13.04 for pre-test 1 and pre-test 2 respectively. It also revealed a mean of M = 71.57, SD = 10.88 and M = 73.20, SD = 10.21 for posttest 1 and posttest 2 respectively.

Table 3. Mean and Standard Deviation of Students' Satisfaction Scores at Different Test Occasions

S/N	Test occasions	N	Mean	SD
1	Pre-satisfaction 1	113	49.62	13.99
2	Pre-satisfaction 2	113	51.43	14.00
3	Post-satisfaction 1	113	71.66	8.41
4	Post-satisfaction 2	113	74.88	10.80

The Table 3 shows the mean and standard deviation of students' satisfaction at the four different test occasions. The table revealed a mean of M = 49.62, SD = 13.99 and M = 51.43 and SD = 14.00 for pre-satisfaction 1 and pre-satisfaction 2 respectively. It also revealed a mean of M = 71.66, SD = 8.41 and M = 74.88, SD = 10.80 for post-satisfaction 1 and post-satisfaction 2 respectively. The research also produced data on the Normality Test for student achievement on four exam occasions which can be seen in Table 4.

Table 4. Normality Test For students' Achievement at Four Test Occasions

Test	**Kolmogorov-Smirnov**			**Shapiro-Wilk**		
Test occasions	Statistic	Df	Sig.	Statistic	Df	Sig.
Pre-test 1	.240	113	.133*	.887	113	.872*
Pre-test 2	.171	113	.174*	.927	113	.893*
Posttest 1	.176	113	.365*	.914	113	.943*
Posttest 2	.167	113	.392*	.916	113	.977*

Table 4 shows both the Kolmogorov-Smirnov and Shapiro-Wilk test for normality. The table revealed that P>0.05 and since a normality test holds the assumption that the data is from a normal distribution, it can therefore be deduced that the data is normally distributed. Data with a normal distribution clearly shows that in fact the largest frequency and average of the data is at the midpoint, so that the research data has shown that the distribution of data is in almost the same value stages and is not much different between the values of one individual in the study and another individual. Average values with almost the same distribution provide an indication that the research produces good data where the research data can be used as a conclusion and is indeed influenced by the treatment given by the research in the research, so that the research results can be trusted. Data for the normality test of student satisfaction on four testing occasions can be seen in Table 5.

Table 5. Normality Test For Students' Satisfaction at Four Test Occasions

Test	**Kolmogorov-Smirnov**			**Shapiro-Wilk**		
Test occasions	Statistic	Df	Sig.	Statistic	Df	Sig.
Pre-test 1	.196	113	.670	.870*	113	.904*
Pre-test 2	.196	113	.771	.885*	113	.921*
Posttest 1	.221	113	.854	.862*	113	.947*
Posttest 2	.205	113	.107	.893*	113	.978*

The table 5 shows both the Kolmogorov-Smirnov and Shapiro-Wilk test for normality of the four test occasions. The table revealed that P>0.05 and since a normality test holds the assumption that the data is from a normal distribution, it can therefore be deduced that the data is normally distributed. This test assumes that the data is normally distributed, so it can be concluded that the data is normally distributed. Normally distributed data is clearly a clear reference that this research provides a clear picture of the changes resulting from the understanding that researchers have made during the research which can lead to good conclusions. The tests carried out will show how the capabilities or distribution of the data actually occur, so that the results of the research provided can be the main benchmark that can be understood from an action given and not other factors outside the research.

Testing of hypothesis

There is no significant difference in the achievement of environmental education undergraduates before and after exposure to Moodle LMS (H_1)

Table 6. Repeated Measures Analysis of Variance (RM-ANOVA) of Students' Achievement

Source		Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	58151.086	3	19383.695	193.189	.000*	.963
	Greenhouse-Geisser	58151.086	2.491	23342.585	193.189	.000	.963
	Huynh-Feldt	58151.086	2.552	22783.269	193.189	.000	.963
	Lower-bound	58151.086	1.000	58151.086	193.189	.000	.963
Error(Time)	Sphericity Assumed	33712.664	336	100.335			
	Greenhouse-Geisser	33712.664	279.015	120.828			
	Huynh-Feldt	33712.664	285.864	117.932			
	Lower-bound	33712.664	112.000	301.006			

Table 6 shows the repeated measures analysis of variance (RM-ANOVA) of students' achievement at the four testing period after exposure to Moodle platform. The table revealed that $F_{(3,336)} = 193.189$, $P<0.05$ and $\eta_p^2 = 0.963$. This shows that the hypothesis is rejected, which means that the Moodle platform has a significant influence on the learning achievement of environmental education students. The significant influence given by the Moodle platform certainly provides information and hope for educators in carrying out the learning process, especially online. Learning will run well and appropriately if the learning strategy used is in accordance with the subject of study given, and in this study it is very appropriate for learning media on environmental material. The effect size of 0.963 means that Moodle LMS was responsible for improving environmental education undergraduates' achievement by 96.3 percent and this shows a very significant impact of the treatment on students' achievement levels after different test occasions.

Table 7. Mauchly's Test of Sphericity For Within Subject Effects

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	Df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Time	.741	43.269	5	.621	.830	.851	.333

Table 7 shows the Mauchly's test of spherecity for within subject effects for undergraduates' achievement after several testing occasions. Repeated measures ANOVA works on the assumptions of spherecity which is a condition in which the variance of all the within subject effects pairings is equal. The table revealed that Mauchly (W) = 0.741 and P = 0.621. Since $P>0.05$, it shows that the assumption of Mauchly has not been violated and this means that the variance of all the within subject pairings during the different test occasions is equal. The results of this analysis clearly provide an overview and information that the data taken will have value and consistent results and will not be too influenced by

external conditions that are not the focus of observation. in other words, the treatment given will produce valid and representative data.

Table 8. Sidak Post-Hoc Pairwise Comparison of Significance of Difference in Students' Achievement

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
1	2	-2.619	1.558	.453	-6.793	1.554
	3	-23.071*	1.178	.000	-26.226	-19.916
	4	-24.708*	1.326	.000	-28.259	-21.157
2	1	2.619	1.558	.453	-1.554	6.793
	3	-20.451*	1.436	.000	-24.297	-16.606
	4	-22.088*	1.493	.000	-26.088	-18.089
3	1	23.071*	1.178	.000	19.916	26.226
	2	20.451*	1.436	.000	16.606	24.297
	4	-1.637	.888	.345	-4.017	.742
4	1	24.708*	1.326	.000	21.157	28.259
	2	22.088*	1.493	.000	18.089	26.088
	3	1.637	.888	.345	-.742	4.017

Table 8 shows the Sidak post-hoc pairwise comparison of significance of difference undergraduates' achievement at four test occasions. While significant differences were observed in the different occasions particularly between the pre-test and post-test, the mean significant difference between test 4 (post-test 2) and 1 (pre-test 1) had the highest significant difference followed by the mean difference between test 3 (post-test 2) and test 1 (pre-test 1). There is no significant difference in the satisfaction of environmental education undergraduates before and after exposure to Moodle LMS (H_2). This study provides a clear picture of how damage to online learning occurs. The study also conducted measurements using Measures Analysis of Variance (RM-ANOVA) on student satisfaction where the results obtained can be seen in more detail in Table 9.

Table 9. Repeated Measures Analysis of Variance (RM-ANOVA) of Students' Satisfaction

Source		Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	59199.918	3	19733.306	154.112	.000*	.957
	Greenhouse-Geisser	59199.918	2.058	28771.323	154.112	.000	.957
	Huynh-Feldt	59199.918	2.097	28235.695	154.112	.000	.957
	Lower-bound	59199.918	1.000	59199.918	154.112	.000	.957
Error(Time)	Sphericity Assumed	43023.332	336	128.046			
	Greenhouse-Geisser	43023.332	230.451	186.692			
	Huynh-Feldt	43023.332	234.823	183.216			
	Lower-bound	43023.332	112.000	384.137			

Table 9 shows the repeated measures analysis of variance (RM-ANOVA) of undergraduates' satisfaction at the four testing period after exposure to Moodle platform. The table revealed that $F_{(3,336)} = 154.112$, $P<0.05$ and $\eta_p^2 = 0.957$. This shows that the hypothesis has been rejected and it means that Moodle platform had a significant impact on environmental education students' satisfaction. This shows that the hypothesis has been

rejected and means that the Moodle platform has a significant impact on the satisfaction of environmental education students. The significant impact on students shows that Moodle can be an alternative to distance learning. In today's modern era, with the development of knowledge and technology, the learning process must be able to meet global demands, especially learning tools or media that can support maximum learning outcomes without being burdened by hours and time. The learning process using technology can be the best suggestion in supporting student learning outcomes. The effect size of 0.957 means that Moodle LMS was responsible for improving environmental education undergraduates' satisfaction by 95.7 percent and this shows a very significant impact of Moodle the treatment on students' satisfaction levels after different test occasions.

Table 10. Mauchly's Test of Sphericity For Within Subject Effects

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	Df	Sig.	Epsilon Greenhouse-Geisser	Epsilon Huynh-Feldt	Epsilon Lower-bound
Time	.604	75.795	5	.572	.686	.699	.333

Table 10 shows the Mauchly's test of spherecity for within subject effects for undergraduates' achievement after several testing occasions. Repeated measures ANOVA works on the assumptions of spherecity which is a condition in which the variance of all the within subject effects pairings is equal. The table revealed that Mauchly (W) = 0.604 and P = 0.572. Since P>0.05, it shows that the assumption of Mauchly has not been violated and this means that the variance of all the within subject pairings during the different test occasions is equal. The study also analyzed using Bonferroni post-hoc pairwise comparisons on the significance of differences in student satisfaction on four exam occasions which can be seen in Table 11.

Table 11. Bonferroni Post-Hoc Pairwise Comparison of Significance of Difference in Undergraduates' Satisfaction at Four Test Occasions

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
1	2	-1.814	1.198	.797	-5.033	1.404
	3	-22.035*	1.371	.000	-25.717	-18.354
	4	-25.257*	1.966	.000	-30.538	-19.975
2	1	1.814	1.198	.797	-1.404	5.033
	3	-20.221*	1.369	.000	-23.899	-16.543
	4	-23.442*	1.757	.000	-28.161	-18.724
3	1	22.035*	1.371	.000	18.354	25.717
	2	20.221*	1.369	.000	16.543	23.899
	4	-3.221	1.206	.052	-6.461	.018
4	1	25.257*	1.966	.000	19.975	30.538
	2	23.442*	1.757	.000	18.724	28.161
	3	3.221	1.206	.052	-.018	6.461

Table 11 shows the Bonferroni post-hoc pairwise comparison of significance of difference in undergraduates' satisfaction at four test occasions. While significant differences were observed in the different occasions particularly between the pre-test and post-test, the mean significant difference between test 4 (post-test 2) and 1 (pre-test 1) had the highest significant difference followed by the mean difference between test 4 (post-test

2) and test 2 (pre-test 2). There is no significant moderating influence of age, gender, location and device type on the achievement of Environmental education undergraduates after exposure to Moodle LM (H_3).

Table 12. Moderating Influence of Age, Gender, Location and Device Type on Environmental Education Students' Achievement After Exposure to Moodle

Moderating influence	Coeff	Se	T	P
(Constant)	86.867	4.910	17.693	.000
Age	-5.435	1.231	-4.414	.463*
Gender	.094	2.070	.454	.651*
Location	-2.160	1.899	-1.137	.258*
Device Type	-.460	.960	-.479	.633*

Table 12 shows the moderating influence of age, gender, location and device type on students' achievement after exposure to Moodle LMS. The table revealed that there was no significant influence of age (t = -4.414, P = 0.463), gender (t = 0.454, P = 0.6515), location (t = -1.137, P= 0.258), and device type (t = -0.479, P = 0.633) on the effect of Moodle on students' achievement in environmental education.

DISCUSSION

The major purpose of this study was to check the effectiveness of Moodle LMS on distance learning undergraduate students of environmental education. As a result of the treatment using Moodle platform, it was discovered that the performance of students increased significantly following the different test occasions after exposure to Moodle. The result of the repeated measures analysis of variance revealed that, following the rejection of the null hypothesis, a significant difference exists in the achievement of distance learning students of environmental education. This means that students' achievement improved significantly after exposure to Moodle LMS. The result also revealed that by virtue of the partial eta squared effect size (η_p^2) of 0.963, Moodle LMS was responsible for improving students' achievement by 96.3% after the treatment. The effect size of 0.963 has been categorized to be above the 0.8 margin that indicates a very large impact (Cohen, 1988). As a result of this effect size, Moodle LMS has improved students' achievement by a very large margin. Moodle allows for the flexibility of learning by making it more flexible and self-scheduled thereby promoting students' independence which ensures an increase in achievement (Mlotshwa et al., 2020).

Learning under Moodle also provides students with various learning materials and tools to capitalize on such as videos and text that stimulate interest and understanding of complex information and this helps towards enhancing students' achievement (Chen et al., 2022). Therefore, these attributes of Moodle make it very flexible, scalable, and user-friendly for it offers students individualized training routes so as to create their own knowledge during engagement (Zabolotskikh et al., 2021). This finding agrees with a number of studies reviewed in the literature review. For example, this finding agrees with Falode and Mohammed (2023a) whose study discovered that Moodle LMS significantly improved educational technology undergraduates' achievement in a distance learning

course in a comparative study to check the effect of three courseware formats. In a study that checked the effect of Moodle LMS based e-learning on e-collaborative, perceived satisfaction and achievement, Moodle LMS has been found to significantly improve nursing students' achievement (Chen et al., 2022). When compared with CAI4ME package, Oguguo et al. (2021) discovered that Moodle LMS was more significantly effective in terms of improving students' achievement.

Moodle has been found to significantly improve students' mathematics achievement (Kauts & Kaur, 2021). In a study that checked the effectiveness of adaptive e-learning system on students' performance, Moodle LMS has been found to have a significant impact on students' achievement (Ristic et al., 2023). When used in blended learning settings to teach grammar, Al-Bataineh et al. (2019) and Bataineh and Mayyas (2017) discovered that Moodle significantly improved students' grammar and comprehension achievement. Finally, this finding agrees with Agustina et al. (2020) whose study found that Moodle significantly improved the reading and writing skills of students.

The study also discovered that students' satisfaction increased significantly after exposure to Moodle LMS. This was discovered when a significant difference was found in the satisfaction scores of the students following their exposure to Moodle LMS. This means that students' satisfaction periodically improved significantly after exposure to Moodle LMS. The result of the repeated measures analysis of variance also revealed that, by virtue of the partial eta squared effect size (η_p^2) of 0.957, Moodle LMS was responsible for influencing students' satisfaction by 95.7% after the treatment. The effect size of 0.957 is categorized to be above the 0.8 margin that indicates a very large impact (Cohen, 1988). Due to this effect high effect size, Moodle LMS has improved students' satisfaction by a very large margin. This finding agrees with some studies revealed in the literature review. This finding agrees with Falode and Mohammed (2023a) whose study to check educational technology undergraduates' performance in a distance learning course revealed a significant difference in the satisfaction of students exposed to Moodle LMS. It also agrees with the study of Yilmaz (2022) who surveyed the satisfaction of students that use different LMSs for instructional purposes in distance learning and the students expressed their positive satisfactions using various LMS tool for learning.

In a study that checked students' satisfaction levels using different LMS, 93% of the respondents felt highly satisfied with Moodle LMS (Mwangi et al., 2023). This finding also agrees with Al-Musharraf and Khahro (2020) who checked students' satisfaction with online learning during the COVID-19 pandemic and their findings revealed that the students felt very satisfied with the various online learning resources used during the pandemic. In a study that checked the effectiveness of adaptive e-learning system on the performance of students using Moodle, it was found that students' satisfaction significantly improved after exposure to Moodle LMS (Ristic et al., 2023). This finding also agrees with Kauts and Kaur (2021) that checked the effectiveness of Moodle on students' performance in mathematics and they discovered that the satisfaction of students significantly increased after exposure to Moodle platform. Students' satisfaction significantly improved when Moodle LMS was used to teach students writing (Al-Bataineh et al., 2019). This finding agrees with Choe et al. (2019) who checked the satisfaction level of students and their

learning outcomes in asynchronous online lecture videos and their findings revealed that the students felt highly satisfied with the multimedia online learning deployed to teach them. Various studies (Dooley et al., 2018; Green et al., 2018; Riddle & Gier, 2019) found online learning to be highly satisfying. Conversely, this finding is not in agreement with Pickering and Swinnerton (2019) who found no significant difference in terms of online satisfaction during online learning.

Finally, the finding of this study equally revealed no significant influence of gender, age, location and device type on the effects of Moodle LMS on students' achievement. This means that gender, age, location and device type do not have any influence on students' achievement after exposure to Moodle LMS. This finding agrees with a number of studies revealed in the literature review. This finding agrees with Ugwuanyi (2022) whose study found that demographic factors like age, gender and location did not have any significant influence on the achievement of primary school students of Basic Science after exposure to flipped classroom. In a study to check the influence of demographic variables on students' achievement and motivation in distance learning, Egbedokun and Afolabi (2023) found that age, marital status and work place do not have a significant influence on students' performance having been exposed to flipped learning. This findings also agree with Mohammed et al. (2025) whose study discovered no significant moderating influence of age, gender and experience with technology on students' performance exposed to artificial intelligence online-based ChatGPT chatbot instruction. The finding also agrees with Amuda et al. (2016) who discovered in their study that age and marital status did not have any significant impact on students' achievement in colleges of education in Nigeria. Opposingly, Oguguo et al. (2021) found that gender has a significant influence on students' performance after exposure to instructions on Moodle with female students performing better than their male counterparts after exposure to Moodle.

CONCLUSION

The use of Moodle has proven to be an effective LMS in terms enhancing the achievement of distance learning students of environmental education. As a result, distance learning authorities in Nigeria should adopt different online learning mediums like Moodle LMS in order to appeal to different learning styles of learners and equally to improve environmental education students' achievement. Furthermore, workshops and seminars should be organized in order to expose teachers on how to plan and execute online learning using Moodle LMS. The findings suggest that incorporating Moodle LMS into distance education curricula in Nigeria could significantly enhance student achievement and satisfaction. This is particularly important for environmental education, where improving performance and engagement can lead to better preparation for addressing environmental challenges. By integrating Moodle, educators can provide a more flexible, interactive, and effective learning environment, aligning with UNESCO's goals for environmental education and promoting sustainability. This integration also highlights the potential for Moodle to contribute to the development of environmentally literate graduates who are well-equipped to engage in environmental protection and conservation efforts. For educators, researchers, and policymakers, these insights underscore the value of adopting

and integrating modern LMS platforms like Moodle to enhance educational outcomes and align with global educational objectives. The study has some limitations that should be noted. First, it was limited to distance learning students, thus similar studies should be conducted on regular students to further test the validity of the Moodle platform. Additionally, the sample size of the study is small and therefore the generalizability of the findings cannot be ascertained; as a result, similar studies should be conducted on a large sample.

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