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Integrating Digital Learning Platforms in Higher Education: A Study on The Impact of Virtual Classrooms on Student Engagement and Academic Performance

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Abstract: ***This study investigated the impact of virtual classroom engagement and digital learning conditions on students' academic performance and virtual learning effectiveness using descriptive survey with questionnaire administered to 249 respondents determined using Yamane's formula out of which 217 responses were retrieved. Data were analyzed using descriptive statistics and multiple regression. Findings from the three model reveal moderate relationship and H_{01} reveal virtual classroom participation showing a significantly impact on academic performance ($\beta = -0.179$, $t = -3.598$, $p = 0.00 < 0.05$), while motivation ($\beta = 0.084$, $t = 1.631$, $p = 0.105 > 0.05$) and interactive learning experiences ($\beta = -0.055$, $t = -1.118$, $p = 0.265 > 0.05$) showed no significant effects. Also, H_{02} coefficient of knowledge retention ($\beta = -0.051$, $t = -0.927$, $p = 0.355 > 0.05$), assessment outcomes ($\beta = -0.015$, $t = -0.277$, $p = 0.782 > 0.05$), and learning efficiency ($\beta = 0.013$, $t = 0.233$, $p = 0.816 > 0.05$) showing no significant influence and whereas H_{03} digital literacy ($\beta = 0.172$, $t = 2.385$, $p = 0.018 < 0.05$) and technological preparedness ($\beta = 0.201$, $t = 2.599$, $p = 0.010 < 0.05$) significantly enhanced virtual learning effectiveness, whereas internet accessibility ($\beta = 0.066$, $t = 0.911$, $p = 0.364 > 0.05$) did not. The study concludes that while participation, digital literacy, and technological preparedness contribute meaningfully to academic performance and virtual learning effectiveness others do not and recommend that colleges should improve active participation in virtual classrooms, providing continuous digital skills training, and ensuring reliable technological infrastructure.***

Keywords: ***Digital learning platforms, virtual classrooms, student engagement, academic performance, higher education, Nigeria***

I. INTRODUCTION

The integration of digital learning platforms into education system has become a transformative force in the delivery of teaching and learningparticularly when considering the aftermath of global disruptions caused by COVID-19 pandemicwhich totally made traditional teaching and learning useless and which made most institutions to engage in online classroom courses called virtual class. A virtual classroom which refers to an online learning environment where instructors and students interact in real time via video-conferencing, digital whiteboards, chat, and collaborative tools for effective replication of traditional face-to-face classroom in a remote setting. These includeZoom, Google Classroom, and Moodle which provide flexible, accessible, and interactive avenues for students to engage with course content, instructors, and peers, regardless of physical location (Babalola, Adeyoola, &Omolafe, 2023; Abdulrahman & Alimi, 2024).

In Nigerian educational system, these technological changeoffers numerous opportunities including enhanced learning flexibility, improved collaboration, and access to diverse educational resources, enabling students to learn at their own pace and promoting inclusive education (Santàs, Udende, &Modeyin, 2023). However, most Nigerian schools ranging from primary to tertiary institutions face different challenges especially when it comes to fund, infrastructural limitations, uneven digital literacy levels among students and lecturers, and disparities in access to reliable internet connectivity (Akanmu, Idris, & Adeniyi, 2023).

Effective integration of digital learning platforms requires more than mere access but it indeed a change in educational system that necessitates adequate digital skills, technological preparedness, and institutional support systems to foster meaningful engagement. Empirical evidence indicates that students who actively participate in virtual classrooms usually demonstrate high digital competence and benefit from supportive infrastructure tend to achieve better academic results (Babalola et al., 2023; Sappaile, Lasinggaru, &Mokodenseho, 2025). Conversely, inadequate

digital skills, limited interaction, and poor technological resources have been linked to decreased engagement and suboptimal learning outcomes (Olusola-Fadumiye, Harun, & Zakaria, 2023; Abdulrahman & Alimi, 2024).

Despite the increase in the adoption of digital platforms in Nigerian system of education, research that specifically examine the impact of student engagement and academic performance within Colleges of Education are limited. Even with the widespread use of virtual classrooms and online learning tools,many students in tertiary education continue to experience low engagement and suboptimal academic outcomes and it is mostly often attributed to inadequate digital literacy, limited technological preparedness, unreliable internet access, and insufficient institutional infrastructure (Agina-Obu& Okwu, 2023; Olusola-Fadumiye, Harun & Zakaria, 2023). In addition, the extent to which virtual classroom participation, motivation, interactive learning, knowledge retention, assessment outcomes, and learning efficiency translate into improved academic performance in tertiary education especially colleges of education which serve as training grounds for future teachersremains under-explored. In retort to these gaps, this study aims to investigate the impact of virtual classroom engagement and digital learning conditions on student engagement and academic performance in Kwara State Colleges of Education by examining how participation, motivation, interactive learning experiences, knowledge retention, assessment outcomes, learning efficiency, digital literacy, internet accessibility, and technological preparedness influence academic performance and virtual learning effectiveness among students and lecturers in selected Colleges of Education in Kwara State and provide empirical evidence that can inform policy and pedagogical interventions for enhancing the effectiveness of digital learning platforms.

II. RESEARCH HYPOTHESES

H_{01}: Virtual classrooms in terms of participation, motivation, and interactive learning experiences have no significant impact on student academic performance in Kwara State Colleges of Education.

H_{02}: Digital learning platforms in terms of knowledge retention, assessment outcomes, and learning efficiency have no significant effect on students' academic performance in Kwara State Colleges of Education.

H_{03}: Challenges associated with virtual learning environments in terms of digital literacy, internet accessibility, and technological preparedness among students and lecturers have no significant influence on the effectiveness of virtual learning in Kwara State Colleges of Education.

III. LITERATURE REVIEW

Digital Learning Platforms in Colleges of Education

Digital learning platforms are increasingly integral to tertiary education by reshaping how knowledge is delivered and accessed. These platforms such as Zoom, Google Classroom, Moodle, and Microsoft Teams etc. provide features like video conferencing, discussion forums, and automated assessments, supporting interactive and student-centered learningfacilitate both synchronous (real-time) and asynchronous (self-paced) learning, enhancing flexibility and promoting inclusive education by eliminating geographical and time-based barriers(Dhawan, 2020; Means et al., 2020). These tools have evolved into indispensable instruments for cultivating immersive, adaptive, and intellectually stimulating learning environments, particularly as higher education systems worldwide undergo rapid transitions toward digitally mediated instruction and technologically enhanced pedagogical models necessitated by contemporary global educational transformations.

Student Engagement in Virtual Learning Environments

Student engagement is widely recognized as a central determinant of academic success in traditional face-to-face learning and digital learning environments. According to Henrie et al., (2021), student engagement refers to the degree of attention, curiosity, interest, optimism, and passion that learners exhibit when interacting with learning content, peers, and instructors which reflect behavioral, emotional, and cognitive involvement. This multidimensional construct encompasses observable participation, internal motivation, and mental investment in pedagogical task especially learning (Bond et al., 2020). Digital platforms provide a wide array of interactive tools which includes live discussions, collaborative tasks, real-time quizzes or test, and prompt feedback mechanismsthat can substantially

strengthen engagement when thoughtfully implemented. Features like breakout rooms and embedded polls stimulate interaction and foster active learning. Nevertheless, the absence of physical presence may diminish motivation and contribute to feelings of isolation, distraction, or reduced commitment if not effectively moderated (Martin & Bolliger, 2018). Consequently, deliberate engagement strategies, including consistent instructor feedback, structured peer collaboration, and well-designed interaction patterns, are essential to sustaining meaningful participation within virtual classroom environments.

Impact of Virtual Classrooms on Academic Performance

Virtual classrooms can enhance academic performance when implemented effectively, as they provide structured opportunities for interactive participation, real-time feedback, and personalized learning pathways. When supported by adequate digital literacy, technological readiness, and pedagogical alignment, virtual learning environments foster deeper comprehension, sustained engagement, and improved mastery of course content.Studies indicate that students who actively participate in online class discussions, attend live sessions, and consistently access learning materials tend to achieve better academic performance (Kebritchi et al., 2017). Features like automated quizzes, recorded lectures, and timely instructor feedback support personalized learning, flexible study schedules, and improved knowledge retention. However, challenges such as unreliable internet connectivity, high tariff data plan, limited digital literacy, and insufficient instructor training can undermine effectiveness (Adedoyin &Soykan, 2020). Addressing these barriers is crucial for maximizing learning outcomes in digital environments.

Challenges facing tertiary education in the use of virtual classroom

Several challenges are facing the full integration of digital learning platforms in tertiary education especially colleges of education as most institutions continue to grapple with unstable internet connectivity, inconsistent electricity supply, and widening digital skill gaps between students and lecturers. Despite national investments such as NITDA, USPF, NCCE, Tetfundin ICT expansion, many Colleges of Education still lack adequate technological infrastructure, updated learning management systems, and sustained technical support. These deficiencies undermine the effectiveness of virtual classrooms, limiting opportunities for real-time interaction and meaningful engagement(Olasile et al., 2023). Furthermore, the rising cost of data, device insecurity, and uneven digital preparedness continue to impede students' participation in online learning activities. As virtual learning becomes increasingly indispensable in contemporary pedagogy, these unresolved structural challenges pose significant threats to academic quality, student satisfaction, and equitable access to digital education.

IV. EMPIRICAL REVIEW

Most recent empirical investigations highlight the significant role of digital learning platforms in shaping student engagement and academic performance. For instance, a study conducted by Babalola et al., (2023) explored the influence of virtual learning on undergraduate academic performance at the University of Ilorin during the COVID-19 pandemic using a descriptive survey and 200 sample undergraduates. The study revealed that Google Classroom emerged as the most utilized virtual platform and virtual learning positively influenced academic outcomes. Notably, no significant differences were observed in performance across gender or specialization, suggesting that the impact of virtual classroom participation is broadly consistent across student demographics. Similarly, Amaonye and Anyaeji (2023) examined the readiness of Nigerian university students for online learning using 333 sample undergraduate'sstudents across public institutions and reported a high level of preparedness (mean = 3.73), highlighting students' digital literacy, motivation, and self-efficacy as critical enablers of virtual learning adoption. The study emphasizes that students' intrinsic motivation and technological competencies are crucial in promoting engagement and sustaining participation in online learning platforms, which are central constructs of the present study.

However, Olusola-Fadumiye et al., (2023) investigate the efficacy of authentic-based multimedia learning on students' performance and engagement in Nigerian higher institutions using a quasi-experimental with 90 sampled students in Ekiti State University. The findings reveal that interactive learning experiences, including multimedia and

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authentic learning tasks, significantly enhance learning efficiency, knowledge retention, and overall academic performance with a pre-test (M = 16.96, SD = 7.18) to post-test (M = 74.44, SD = 12.57).Lastly, Adesina et al., (2024) evaluate student engagement in online facilitation at the National Open University of Nigeria by surveying 2,350 students and found that 61.9% of respondents actively participated in synchronous online sessions, 38.1% reported non-participation due to internet connectivity issues, scheduling conflicts, and workload constraints which indicate that infrastructural and logistical factors are critical determinants of academic outcomes in online education.

V. METHODOLOGY

This study adopted a descriptive survey research design to examine the impact of integrating digital learning platforms on student engagement and academic performance among Business Education students and lecturers in public Colleges of Education in Kwara State. The design was appropriate because it allow collection of quantitative data describing existing learning behaviors, technological interactions, and instructional practices while exploring relationships between academic performance and virtual classroom engagements variables. The population comprised all 200 and 300 level Business Education students and lecturers from the three public Colleges of Education. From the total population of 694 (662 students &32 lecturers), sample size was determined using Yamane's (1967) formula, which yielded 254 respondents while only 217 responses were retrieved. The retrieved sample consisted of 83 participants from Kwara State College of Educaton, Ilorin (11 lecturers and 72 students), 67 from Lafiagi campus (9 lecturers and 58 students), and also 67 from Oro campus (8 lecturers and 59 students). The instrument was a structured questionnaire titled "Integrating Digital Learning Platforms and Student Academic Performance in Colleges of Education." The questionnaire comprisedfive sections in which section A captured demographic information, B assessed frequency and type of digital platform usage, C measured engagement and motivation, D evaluated learning outcomes including knowledge retention, assessment performance, and learning efficiency, while E explored challenges such as digital literacy, internet accessibility, technological preparedness, and overall effectiveness of virtual learning. Using 4-point Likert scale, the instrument was validated by two research expert and reliability testing yielded a Cronbach's alpha of 0.780 indicating high internal consistency. Two trained research assistants supported the data collection process and the collected data were coded and analyzed using SPSS 25 using both descriptive and inferential statistics specifically multiple regression tested at 0.05 significance level.

VI. RESULTS

Demographic Information

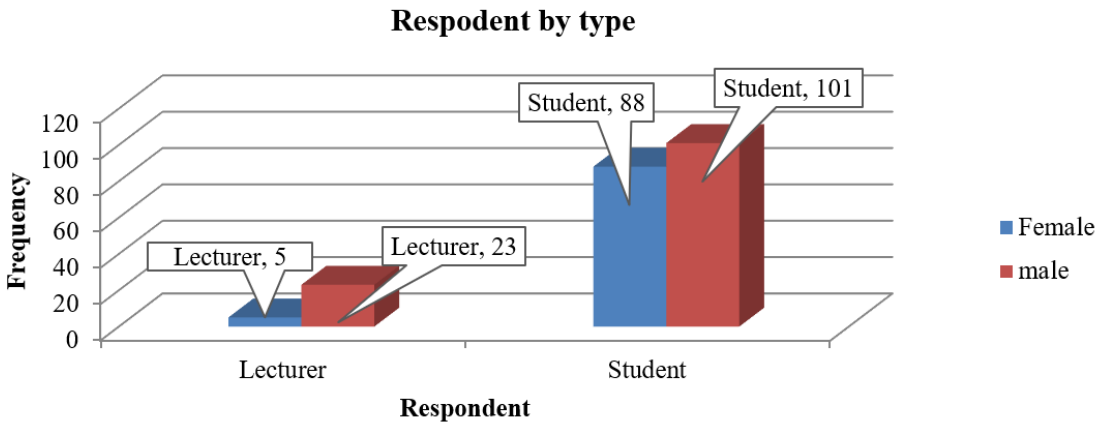

Fig.1Distribution of respondents by type

Source: Field survey, 2025

The figure above illustrates the distribution of respondents by gender and role. Male students constitute the largest group (46.5%), followed by female students (40.6%), while male and female lecturers represent 10.6% and 2.3%, respectively.

Table 1: Most Frequently Used Digital Platform

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Digital Platform Frequently Used	Lecturer	Student	Total
Google Classroom	7 (3.2%)	55 (25.3%)	62 (28.6%)
Moodle	1 (0.5%)	0 (0.0%)	1 (0.5%)
MS Teams	1 (0.5%)	0 (0.0%)	1 (0.5%)
Zoom	19 (8.8%)	134 (61.8%)	153 (70.5%)
Total	28 (12.9%)	189 (87.1%)	217 (100.0%)

Source: Author's Field survey, 2025

From table 1, Zoom is the most widely used platform with 153 (70.5%) respondents(19 (8.8%) lecturers&134 (61.8%) students), followed by Google Classroom with 62 (28.6%) respondents (7 (3.2%) lecturers &55 (25.3%) students) while Moodle and MS Teams record minimal usage with only 1 respondent each (0.5%).

H_{01}: Virtual classrooms in terms of participation, motivation, and interactive learning experiences have no significant impact on student academic performance in Kwara State Colleges of Education.

Table 2: Regression Results Showing Effect of Participation, Motivation and Interactive Learning Experiences on Student Engagement

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	0.282	0.080	0.065	0.38792	0.080	5.330	3	185	0.002	1.879

ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	2.406	3	0.802	5.330	0.002
Residual	27.840	185	0.150		
Total	30.246	188			

COEFFICIENTS

Predictor	B	Std. Error	Beta	t	Sig.	Collinearity Statistics	
						Tolerance	VIF
(Constant)	3.645	0.190	—	19.163	0.000	—	—
Participation	-0.179	0.050	-0.274	-3.598	0.000	0.861	1.162
Motivation	0.084	0.051	0.125	1.631	0.105	0.851	1.175
Interactive Learning Experiences	-0.055	0.049	-0.083	-1.118	0.265	0.907	1.103

Source: Author's Field survey, 2025 *Dependent Variable: Academic Performance*

The table 2 results present the effect of virtual classroom participation, motivation, and interactive learning experiences on students'academic performance as the model shows moderate relationship with $R = 0.282$, $R^2 = 0.080$, and adjusted $R^2 = 0.065$, indicating that 8% of the variance in academic performance is explained by the predictors. The ANOVA results reveal that the model is statistically significant ($F(3,185) = 5.330$, $p = 0.002<0.05$), suggesting that, collectively, the predictors have a significant effect on academic performance. Also, the Coefficients of Virtual classrooms participation ($\beta = -0.179$, $t = -3.598$, $p < 0.001$) significantly influences academic performance, whereas motivation ($\beta = 0.084$, $t = 1.631$, $p = 0.105$) and interactive learning experiences ($\beta = -0.055$, $t = -1.118$, $p = 0.265$) do not show statistically significant effects. Additionally, collinearity diagnostics result of above 0.85, VIF values below 1.2 and Durbin-Watson statistic of 1.879 confirmed the absence of multicollinearity and no evidence of problematic autocorrelation in the residuals, supporting the reliability of the model estimates.

Overall, the result reveals a partial acceptance rejection of the null hypothesis (H_{01})as p-value (0.000) for virtual classroom participation is less than 0.05, the hypothesis regarding its effect on student academic performance is rejected, indicating a significant impact. Conversely, the p-values for motivation ($p = 0.105$) and interactive learning experiences ($p = 0.265$) exceed 0.05 leading to its

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hypotheses predictors to be accepted, indicating no statistically significant effect on academic performance.

H_{02}: Digital learning platforms in terms of knowledge retention, assessment outcomes, and learning efficiency have no significant effect on students' academic performance in Kwara State Colleges of Education.

Table 3: Regression Results Showing Effect of Learning Efficiency, Assessment Outcomes and Knowledge Retention on Academic Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	0.076	0.006	-0.010	0.40318	0.006	0.357	3	185	0.784	1.914

ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	0.174	3	0.058	0.357	0.784
Residual	30.072	185	0.163		
Total	30.246	188			

COEFFICIENTS

Predictor	B	Std. Error	Beta	t	Sig.	Collinearity Statistics	
						Tolerance	VIF
(Constant)	3.356	0.217	—	15.495	0.000	—	—
Knowledge Retention	-0.051	0.055	-0.073	-0.927	0.355	0.877	1.141
Assessment Outcomes	-0.015	0.055	-0.021	-0.277	0.782	0.915	1.093
Learning Efficiency	0.013	0.056	0.018	0.233	0.816	0.872	1.147

Source: Author's Field survey, 2025 *Dependent Variable: Academic Performance*

The table 3 results examining the effect of knowledge retention, assessment outcomes, and learning efficiency on students' academic performance and the model shows weak relationship with R = 0.076, R^2 = 0.006, and adjusted R^2 = -0.010 indicating that 0.6% of the variance in academic performance is explained by the predictors variable. Also, ANOVA results reveal that the model is not statistically significant ($F(3,185) = 0.357$, $p=0.784<0.05$) implying that collectively all the predictors variable do not significantly influence academic performance.

Whereas, co-efficient of the individual predictor, knowledge retention ($\beta = -0.051$, $t = -0.927$, $p = 0.355$), assessment outcomes ($\beta = -0.015$, $t = -0.277$, $p = 0.782$), and learning efficiency ($\beta = 0.013$, $t = 0.233$, $p = 0.816$) all show no statistically significant effects on academic performance as the p-value is less than 0.05 level of significant. Moreover, collinearity diagnostics with tolerance values above 0.87, VIF values below 1.2, and a Durbin-Watson statistic of 1.914 confirm the absence of multicollinearity and no evidence of autocorrelation among the residuals.

Overall, since the p-values for knowledge retention (p = 0.355), assessment outcomes (p = 0.782), and learning efficiency (p = 0.816) all greater than 0.05 significant level, hence, null hypothesis (H_{02}) is accepted indicating digital learning platforms in terms of knowledge retention, assessment outcomes, and learning efficiency have no significant effect on students' academic performance in Kwara State Colleges of Education.

H_{03}: Challenges associated with virtual learning environments in terms of digital literacy, internet accessibility, and technological preparedness among students and lecturers have no significant influence on the effectiveness of virtual learning in Kwara State Colleges of Education.

Table 4: Regression results showing the effect of challenges associated with virtual learning environments on effectiveness of virtual learning

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Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	0.328	0.108	0.095	0.63327	0.108	8.579	3	213	0.000	2.126

ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	10.321	3	3.440	8.579	0.000
Residual	85.419	213	0.401		
Total	95.740	216			

COEFFICIENTS

Predictor	B	Std. Error	Beta	t	Sig.	Collinearity Statistics	
						Tolerance	VIF
(Constant)	1.635	0.261	—	6.265	0.000	—	—
Digital Literacy	0.172	0.072	0.171	2.385	0.018	0.815	1.227
Internet Accessibility	0.066	0.072	0.066	0.911	0.364	0.801	1.249
Technological Preparedness	0.201	0.077	0.187	2.599	0.010	0.812	1.231

Source: Author's Field survey, 2025Dependent Variable: Effectiveness of virtuallearning

The table 4 results examining the effect ofdigital literacy, internet accessibility, and technological preparedness on the effectiveness of virtual learning. The model indicates a moderate relationship with R = 0.328, R^2 = 0.108, and adjusted R^2 = 0.095, suggesting that 10.8% of the variance in the effectiveness of virtual learning is explained by the predictors and ANOVA results reveal that the model is statistically significant ($F(3,213) = 8.579$, $p < 0.001$), confirming that the predictors collectively influence virtual learning effectiveness.

Likewise, the coefficients for digital literacy (β = 0.172, t = 2.385, p = 0.018) and technological preparedness (β = 0.201, t = 2.599, p = 0.010) significantly influence the effectiveness of virtual learning, whereas internet accessibility (β = 0.066, t = 0.911, p = 0.364) does not show a statistically significant effect. Moreso, collinearity diagnostics of tolerance values were above 0.80, VIF values below 1.25, and a Durbin-Watson result of 2.126 confirm the absence of multicollinearity and no autocorrelation in the residuals.

Overall the result reveal a partial rejection of the null hypothesis (H_{03}) as the p-values for digital literacy (p = 0.018) and technological preparedness (p = 0.010) less than 0.05 indicates the null hypotheses regarding their effect on the effectiveness of virtual learning being rejected, indicating significant effect while p-value of internet accessibility (p = 0.364) greater 0.05indicate acceptance of its predictor, signifying no statistically significant effect on the effectiveness of virtual learning

VII. DISCUSSION OF FINDINGS

Hypothesis One (H_{01}): The hypothesis stating that virtual classrooms, in terms of participation, motivation, and interactive learning experiences, have no significant impact on students' academic performance in Kwara State Colleges of Education was partially rejected. The regression analysis revealed that participation had a coefficient value of –0.179 and a p-value of 0.000, which is below the 0.05 level of significance, indicating a statistically significant impact on academic performance. Conversely, motivation (β = 0.084, p = 0.105) and interactive learning experiences (β = –0.055, p = 0.265) were not statistically significant, with p-values exceeding 0.05. This finding is consistent with Babalola et al., (2023), who demonstrated that active engagement in virtual learning platforms, particularly Google Classroom, positively influenced academic performance among University of Ilorin undergraduates during the COVID-19 pandemic. Similarly, Adesina et al., (2024) reported that participation in synchronous online facilitation enhances student engagement and outcomes at the National Open University of Nigeria. However, motivation and interactive learning experiences alone did not produce measurable effects without active participation, corroborating Olusola-Fadumiye et al., (2023), who emphasized that authentic multimedia

engagement yields positive outcomes primarily when students are actively involved.

Hypothesis Two (H_{02}): The hypothesis that digital learning platforms, in terms of knowledge retention, assessment outcomes, and learning efficiency, have no significant effect on students' academic performance was accepted. Regression results indicated that knowledge retention ($\beta = -0.051$, $p = 0.355$), assessment outcomes ($\beta = -0.015$, $p = 0.782$), and learning efficiency ($\beta = 0.013$, $p = 0.816$) were all statistically non-significant, with p-values exceeding 0.05. These results align with Amaonye and Anyaeji (2023), who found that despite high student readiness for online learning, the direct impact on academic performance remained minimal due to infrastructural and digital competency constraints. Similarly, Tung et al., (2023) observed that engagement with digital platforms enhances learning experiences but does not automatically translate into improved academic achievement without structured and guided interventions.

Hypothesis Three (H_{03}): The hypothesis asserting that challenges associated with virtual learning environments, specifically digital literacy, internet accessibility, and technological preparedness, have no significant influence on the effectiveness of virtual learning was partially rejected. Digital literacy ($\beta = 0.172$, $p = 0.018$) and technological preparedness ($\beta = 0.201$, $p = 0.010$) were statistically significant, indicating that these factors positively affect virtual learning effectiveness. In contrast, internet accessibility ($\beta = 0.066$, $p = 0.364$) was not significant, suggesting that mere access does not guarantee effective engagement or outcomes. These findings corroborate Olusola-Fadumiye et al. (2023), who emphasized the critical role of students' digital competencies and preparedness in enhancing engagement and academic performance, while access alone remains insufficient. Likewise, Babalola et al. (2023) noted that technology readiness is essential for achieving desired outcomes in virtual learning.

VIII. CONCLUSION

Based on the findings of this study, it can be concluded that virtual classrooms and digital learning platforms have a nuanced impact on students' academic performance in Kwara State Colleges of Education. Participation in virtual classrooms significantly enhances academic performance, while motivation and interactive learning experiences do not exhibit statistically significant effects. Similarly, digital learning platforms, in terms of knowledge retention, assessment outcomes, and learning efficiency, do not independently improve academic performance. Furthermore, challenges associated with virtual learning environments, particularly digital literacy and technological preparedness, significantly influence the effectiveness of online learning, whereas internet accessibility alone is insufficient. These results suggest that students' engagement and preparedness, supported by institutional guidance and technological resources, are critical for achieving positive learning outcomes. Consequently, higher education institutions should prioritize structured participation, skills development, and technological readiness to maximize the benefits of virtual learning for academic achievement.

IX. RECOMMENDATIONS

Based on research findings, the following recommendations were proposed:

1. Colleges should implement structured mechanisms to encourage active participation in virtual classrooms, such as interactive discussions, group activities, and prompt feedback systems.
2. Institutions should provide continuous training programs and workshops to enhance students' and lecturers' digital skills, including effective use of online platforms, multimedia tools, and learning management systems.
3. Institutions and government should provide updated reliable technological infrastructure, such as stable internet access, avoidable data or Wi-Fi, electricity, devices such as laptop, and technical support.

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