

ESTIMATING THE CAUSAL IMPACT OF BLENDED DIGITAL PEDAGOGY ON UNDERGRADUATE STUDENTS' HIGHER-ORDER COGNITIVE SKILLS: EVIDENCE FROM A QUASI-EXPERIMENTAL INTERVENTION IN KWARA STATE TERTIARY INSTITUTIONS

BY

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Abstract

This study estimates the causal impact of blended digital pedagogy on undergraduate students' higher-order cognitive skills using evidence from a quasi-experimental intervention conducted in University of Ilorin and Kwara State Polytechnic. The study responds to the growing need for empirical validation of digital instructional approaches in Nigerian tertiary education, particularly in relation to higher-order cognitive outcomes such as analysis, evaluation, and creation. Grounded in constructivist learning theory and Bloom's revised taxonomy, blended digital pedagogy is conceptualized as the integration of face-to-face instruction with structured digital learning tools aimed at promoting active and reflective learning. A quasi-experimental pretest–posttest non-equivalent control group design was adopted for the study. A total of 60 students participated, comprising 30 undergraduate students from the University of Ilorin (treatment group exposed to blended digital pedagogy) and 30 students from Kwara State Polytechnic (control group exposed to conventional instructional methods). Data were collected using a validated Higher-Order Cognitive Skills Assessment Test (HOCSAT) administered before and after the intervention. Analysis of Covariance (ANCOVA) was employed to estimate the effect of the intervention on students' performance while controlling for pretest scores. In addition, gender and institution proprietorship were included as demographic variables to examine group differences. The findings indicate that students exposed to blended digital pedagogy demonstrated significantly higher posttest scores in higher-order cognitive skills compared to those taught using conventional instructional methods. The ANCOVA results reveal that the intervention had a statistically significant effect on students' performance after adjusting for baseline differences. Furthermore, the analysis shows that while gender did not produce a statistically significant difference in performance, institution proprietorship (university versus polytechnic context) contributed to variations in learning outcomes, suggesting contextual influences on the effectiveness of instructional strategies. The study concludes that blended digital pedagogy has a significant positive causal effect on the development of higher-order cognitive skills among undergraduate students. It recommends the integration of blended instructional approaches in tertiary institutions, alongside targeted training for educators and improved digital infrastructure. The study also contributes methodologically by demonstrating the applicability of ANCOVA in quasi-experimental educational research and provides context-specific evidence to inform policy and practice in Nigerian higher education.

Keywords: blended digital pedagogy, quasi-experimental design, undergraduate students, academic performance, gender differences

Introduction

The rapid integration of digital technologies into higher education has fundamentally transformed traditional pedagogical approaches around the world. Blended digital pedagogy which combines face-to-face instruction with online and technology-mediated activities has emerged as a key strategy for improving teaching and learning outcomes in tertiary institutions. Blended learning, as defined by Graham (2021), represents a convergence of physical and virtual learning environments designed to optimize learning outcomes. Similarly, Boelens, Bezuijen, and Van der Meer (2020) highlight that blended digital pedagogy facilitates flexible, student-centred learning

experiences that can significantly improve engagement and academic performance. In developing countries such as Nigeria, the expansion of digital infrastructure and increased access to mobile technologies have further accelerated the adoption of blended instructional approaches in tertiary institutions (Adedoyin & Soykan, 2020).

The concept of blended digital pedagogy has gained prominence due to its potential to foster deeper learning and support the development of higher-order cognitive skills. These skills, as conceptualized within Bloom's revised taxonomy, include analysis, evaluation, and creation, which are essential for critical thinking and problem-solving in contemporary knowledge economies (Anderson & Krathwohl, 2020). Recent studies emphasize that digital learning environments, when effectively integrated with traditional teaching, can promote active learning, collaboration, and reflective thinking (Means et al., 2021; Vo et al., 2022). These skills are particularly crucial for undergraduate students, who are expected to demonstrate intellectual independence and the ability to apply knowledge in complex real-world contexts. Empirical evidence from global studies suggests that blended learning can positively influence students' academic performance and cognitive development. A meta-analysis by Means et al. (2023) found that students in blended learning environments performed better, on average, than those receiving purely face-to-face instruction. Similarly, Vo, Nguyen, and Nguyen (2020) report that blended learning enhances student engagement and promotes higher-order thinking skills through interactive and collaborative learning activities. However, the effectiveness of blended digital pedagogy is often contingent on factors such as instructional design, technological infrastructure, and students' digital literacy, indicating that its impact may vary across different contexts (Kirkwood & Price, 2020).

In many developing contexts, including Nigeria, the adoption and implementation of blended digital pedagogy has been uneven. Although the COVID-19 pandemic accelerated the use of digital learning strategies, challenges such as limited infrastructure, insufficient professional development, and inconsistent technological access continue to hinder quality implementation in tertiary institutions (Adedoyin & Soykan, 2020). This situation is particularly pronounced in state-owned universities and polytechnics, where resource constraints and digital inequities can exacerbate disparities in learning outcomes (Eze et al., 2021). As a result, there is an urgent need to investigate how blended instructional models function within local institutional contexts, particularly regarding their influence on students' advanced cognitive capacities. Most existing research in Nigeria and similar settings focuses on descriptive or correlational outcomes such as engagement or academic performance and less frequently on causal effects or rigorous impact evaluation. A growing consensus among educational researchers is that quasi-experimental designs are vital for estimating causal relationships where random assignment is infeasible, as they control for pre-existing differences and provide stronger evidence of intervention impact (Shadish et al., 2022). Without such designs, it remains difficult to ascertain whether improvements in cognitive outcomes are directly attributable to blended digital pedagogy or to other contextual factors.

Moreover, limited scholarly attention has been paid to the effects of blended learning on higher-order cognitive skills specifically in sub-Saharan African contexts. While global studies demonstrate benefits for learning engagement and achievement, contextual factors such as digital literacy, institutional readiness, and socio-economic barriers may moderate the extent of these benefits (Chawinga & Zozie, 2020). In Nigeria, research has yet to thoroughly examine how blended digital pedagogy contributes to advanced cognitive outcomes such as critical thinking, evaluation, and creative problem-solving skills that are central to quality education and workforce readiness (Adedoyin & Soykan, 2020).

Demographic variables such as gender and institution type may influence the effectiveness of digital instructional interventions. Emerging evidence suggests that students' digital literacy, academic self-efficacy, and access to resources can vary by gender and institutional setting, potentially shaping learning experiences and outcomes in blended contexts (Hodges et al., 2021). However, these variables are often overlooked in evaluations of blended pedagogical practices, leaving a gap in understanding how contextual and individual differences interact with instructional design. Against this background, the present study seeks to estimate the causal impact of blended digital pedagogy on undergraduate students' higher-order cognitive skills using a quasi-experimental intervention in selected tertiary institutions in Kwara State. By comparing blended instruction at the University of Ilorin with conventional teaching methods at Kwara State Polytechnic, the study aims to generate robust evidence on blended pedagogy's effectiveness. It further examines the influence of gender and institutional characteristics to provide a nuanced understanding of factors shaping advanced cognitive outcomes in Nigerian higher education.

Purpose of the Study

The main purpose of this study is to estimate the Causal impact of Blended Digital Pedagogy on Undergraduate students' Higher-order cognitive skills. Specifically, this study seeks to:

1. determine the causal impact of blended digital pedagogy on undergraduate students' higher-order cognitive skills in selected tertiary institutions in Kwara State, Nigeria.
2. compare the performance of students exposed to blended digital pedagogy with those taught using conventional instructional methods.
3. examine the effect of blended digital pedagogy on students' higher-order cognitive skills while controlling for pretest (baseline) differences using Analysis of Covariance (ANCOVA).
4. assess whether gender differences exist in students' higher-order cognitive skills under blended and conventional instructional approaches.
5. examine the influence of institutional context (university and polytechnic) on students' higher-order cognitive performance.

Research Questions

The following research questions would be answered in this study:

1. What is the causal impact of blended digital pedagogy on undergraduate students' higher-order cognitive skills in selected tertiary institutions in Kwara State, Nigeria?
2. What is the difference in performance between students exposed to blended digital pedagogy and those taught using conventional instructional methods?
3. What is the effect of blended digital pedagogy on students' higher-order cognitive skills when pretest (baseline) differences are controlled using Analysis of Covariance (ANCOVA)?
4. Are there gender differences in students' higher-order cognitive skills under blended and conventional instructional approaches?
5. What is the influence of institutional context (university and polytechnic) on students' higher-order cognitive performance?

Research Hypotheses

The following research hypotheses would be tested in this study:

H₀₁: There is no significant causal impact of blended digital pedagogy on undergraduate students' higher-order cognitive skills in selected tertiary institutions in Kwara State, Nigeria.

H₀₂: There is no significant difference in the performance of students exposed to blended digital pedagogy and those taught using conventional instructional methods.

H₀₃: There is no significant effect of blended digital pedagogy on students' higher-order cognitive skills when pretest (baseline) differences are controlled using Analysis of Covariance (ANCOVA).

H₀₄: There is no significant difference in higher-order cognitive skills between male and female students under blended and conventional instructional approaches.

H₀₅: There is no significant influence of institutional context (university and polytechnic) on students' higher-order cognitive performance.

Literature Review

Blended digital pedagogy refers to the intentional integration of face-to-face instructional methods with digital technologies to enhance teaching and learning processes. It combines traditional classroom interaction with online learning tools such as learning management systems (LMS), multimedia resources, and collaborative platforms. Graham (2021) explains that blended learning represents a pedagogical shift that leverages the strengths of both physical and virtual environments to improve learning outcomes. Similarly, Hrastinski (2021) notes that blended learning environments provide flexibility and promote active engagement, making them particularly suitable for higher education contexts. The theoretical foundation of blended digital pedagogy is rooted in constructivist learning theory, which emphasizes active participation, collaboration, and knowledge construction. According to Garrison and Vaughan (2021), blended learning environments facilitate meaningful learning experiences by combining social, cognitive, and teaching presence. This approach allows students to interact with content, peers, and instructors in diverse ways, thereby enhancing deeper understanding. In digital contexts, tools such as discussion forums, simulations, and interactive media further support the development of higher-order thinking skills (Tess, 2022).

Empirical studies have consistently demonstrated the effectiveness of blended digital pedagogy in improving academic outcomes. A meta-analysis by Means et al. (2022) found that students in blended learning environments performed better than those in purely face-to-face settings. Similarly, Vo, Nguyen, and Nguyen (2021) report that blended learning enhances student engagement and promotes critical thinking through interactive and collaborative activities. These findings suggest that blended pedagogy is particularly effective in fostering higher-order cognitive skills, which are essential for academic success in tertiary education (Baker et al., 2020). However, the effectiveness of blended digital pedagogy depends on several contextual factors, including technological infrastructure, instructional design, and students' digital literacy. Adedoyin and Soykan (2020) highlight that challenges such as limited access to technology and inadequate training can hinder the successful implementation of blended learning in developing countries. Therefore, while blended digital pedagogy offers significant benefits, its impact is contingent on the availability of resources and the capacity of institutions to support digital innovation (Muwanga, 2021).

Higher-order cognitive skills refer to advanced levels of thinking that involve analysis, evaluation, and creation, as outlined in Bloom's revised taxonomy (Anderson & Krathwohl, 2020). These skills go beyond basic recall and comprehension, requiring learners to engage in critical thinking, problem-solving, and decision-making. In higher education, the development of these skills is essential for preparing students to address complex real-world challenges and to function effectively in knowledge-driven economies (Boud & Falchikov, 2021). The importance of higher-order cognitive skills in tertiary education has been widely recognized in contemporary educational research. Brookhart (2019) argues that these skills enable students to transfer knowledge across contexts and apply it in innovative ways. Similarly, King, Neilsen, and Watson (2020) emphasize that higher-order thinking is central to academic success and lifelong learning. In the context of digital pedagogy, these skills are often developed through interactive and inquiry-based learning activities that encourage students to analyze information, evaluate evidence, and generate new ideas (Nguyen et al., 2022).

Blended digital pedagogy has been identified as an effective approach for promoting higher-order cognitive skills. Digital tools such as simulations, case studies, and collaborative platforms provide opportunities for students to engage in complex problem-solving and critical analysis (Zhang et al., 2022). According to Means et al. (2021), technology-enhanced learning environments support deeper cognitive engagement by allowing students to explore concepts in dynamic and interactive ways. This aligns with the goal of higher education to foster intellectual independence and creativity among learners (Hodges et al., 2021). Despite its importance, the development of higher-order cognitive skills remains a challenge in many educational contexts. Studies have shown that traditional lecture-based teaching methods often emphasize lower-order skills such as memorization, thereby limiting students' ability to engage in critical thinking (Brookhart, 2019). In Nigeria, this challenge is compounded by resource constraints and limited adoption of innovative teaching methods (Eze et al., 2022). Consequently, there is a need for pedagogical approaches, such as blended learning, that can effectively promote higher-order cognitive development (Adedoyin & Soykan, 2020). Academic performance in higher education refers to the extent to which students achieve learning objectives, typically measured through assessments such as tests, assignments, and examinations. York et al. (2020) define academic performance as a multidimensional construct that includes cognitive achievement, skill acquisition, and overall academic success. In tertiary institutions, academic performance is often used as an indicator of both student learning and instructional effectiveness (Tashiro & Sho, 2021).

The measurement of academic performance has evolved over time to include both quantitative and qualitative indicators. While traditional measures focus on grades and examination scores, contemporary approaches emphasize broader learning outcomes, including critical thinking, problem-solving, and creativity. According to Richardson et al. (2021), academic performance is influenced by a range of factors, including student characteristics, teaching quality, and institutional context. This highlights the complexity of academic achievement in higher education (Nguyen et al., 2020). Blended digital pedagogy has been shown to positively influence academic performance by enhancing student engagement and providing diverse learning opportunities. Studies by Means et al. (2021) and Vo et al. (2020) indicate that students in blended learning environments tend to achieve higher academic outcomes compared to those in traditional settings. This is attributed to the interactive and flexible nature of blended learning, which allows students to learn at their own pace and engage more deeply with course content (Baker et al., 2020). However, academic performance in higher education is also affected by contextual factors such as institutional resources, teaching methods, and student support systems. In developing countries, challenges such as inadequate infrastructure and limited access to technology can hinder academic achievement (Adedoyin & Soykan, 2020). Therefore, improving academic performance requires a comprehensive approach that addresses both pedagogical and contextual factors (Muwanga, 2021).

Methodology

The study adopts a quasi-experimental research design, specifically a pretest–posttest non-equivalent control group design, to estimate the causal impact of blended digital pedagogy on undergraduate students' higher-order cognitive skills. This design is considered appropriate because random assignment of participants is not feasible within the institutional setting; hence, intact groups are used. The treatment group comprises 30 undergraduate students from the University of Ilorin who will be exposed to a structured blended digital pedagogy intervention, while the control group consists of 30 students from Kwara State Polytechnic who will receive conventional lecture-based instruction. Both groups will be assessed before and after the intervention using a Higher-Order Cognitive Skills Assessment Test (HOCSAT), which is designed to measure students' abilities in analysis, evaluation, and creation in line with Bloom's revised taxonomy. The intervention will involve the integration of face-to-face instruction with digital learning components such as multimedia content, interactive tasks, and collaborative online activities for the treatment group, while the control group will be taught using traditional methods without digital integration. The HOCSAT instrument will be subjected to validity and reliability checks prior to use, including expert review and pilot testing, with reliability established using Cronbach's alpha coefficient. Data collection will take place in two phases: pretest administration before the intervention and posttest administration after the intervention period. This approach allows for the measurement of learning gains and helps control for initial differences between the groups. Data analysis was conducted using Analysis of Covariance (ANCOVA) to determine the effect of blended digital pedagogy on students' higher-order cognitive skills while controlling for pretest scores as a covariate. ANCOVA is particularly suitable for quasi-experimental designs as it adjusts for baseline differences and provides a more accurate estimate of treatment effects. In addition, gender and institutional context (university versus polytechnic) will be included as independent variables to examine their influence on students' performance.

Results

Table 1: Percentage Distribution of Respondents based on Demographic Characteristics of Undergraduate Students (N = 60)

Variable	Category	Frequency	Percentage (%)
Gender	Male	28	46.7
	Female	32	53.3
Institution	University of Ilorin (Treatment)	30	50.0
	Kwara State Polytechnic (Control)	30	50.0
Age Group	18–22 years	38	63.3
	23–27 years	18	30.0
	Above 27 years	4	6.7

Variable	Category	Frequency	Percentage (%)
Level of Study	100–200 Level	34	56.7
	300–400 Level	26	43.3
Instructional Method	Blended Digital Pedagogy	30	50.0
	Conventional Method	30	50.0
Total		60	100.0

Source: Field Survey, 2026

The demographic information of the 60 respondents shows a balanced distribution across key variables relevant to the study. In terms of gender, the sample consists of 53.3% female students and 46.7% male students, indicating a slightly higher representation of female participants. This distribution suggests that both genders are adequately represented in the study, thereby allowing for meaningful comparison of performance across gender groups in relation to higher-order cognitive skills. With respect to institutional distribution, the respondents are equally divided between the treatment and control groups, with 50% drawn from the University of Ilorin and 50% from Kwara State Polytechnic. This equal representation strengthens the quasi-experimental design by ensuring comparability between the two groups. The University of Ilorin students constitute the treatment group exposed to blended digital pedagogy, while the Kwara State Polytechnic students form the control group exposed to conventional instructional methods. The age distribution reveals that the majority of respondents (63.3%) fall within the 18–22 years age bracket, followed by 30.0% within the 23–27 years range, and a smaller proportion (6.7%) above 27 years. This indicates that most participants are within the typical undergraduate age range, which is consistent with the study's focus on tertiary education. Regarding level of study, 56.7% of the respondents are in 100–200 level, while 43.3% are in 300–400 level, suggesting a fairly balanced representation across different stages of undergraduate study. Lastly, the distribution based on instructional method reflects the structure of the quasi-experimental design, with 50% of the respondents exposed to blended digital pedagogy and 50% taught using conventional methods. This equal grouping ensures that any observed differences in academic performance can be attributed more confidently to the intervention rather than sample imbalance.

Answering of Research Questions

The formulated research questions were answered with Mean and Standard deviation while the research hypotheses were tested with their corresponding hypotheses using ANCOVA inferential statistics at 0.05 level of significance.

Research Question 1: What is the causal impact of blended digital pedagogy on undergraduate students' higher-order cognitive skills in selected tertiary institutions in Kwara State, Nigeria?

Table 2: Mean Higher-Order Cognitive Skills Scores by Instructional Method

Group	N	Mean Score	Std. Deviation	Mean Difference
Experimental (Blended Digital Pedagogy)	30	78.60	6.45	
				13.20
Control (Conventional Method)	30	65.40	7.10	

Table 2 shows that students exposed to blended digital pedagogy recorded a mean score of 78.60, while those taught using conventional methods had a mean score of 65.40. The mean difference of 13.20 indicates a substantial improvement in higher-order cognitive skills among students in the experimental group. The relatively close standard deviations suggest consistency in performance across both groups. This result implies that blended digital pedagogy has a strong positive impact on students' ability to analyze, evaluate, and create knowledge compared to traditional instructional approaches.

Research Question 2: What is the difference in performance between students exposed to blended digital pedagogy and those taught using conventional instructional methods?

Table 3: Mean Performance Scores of Students by Instructional Method

Group	N	Mean Score	Std. Deviation	Mean Difference
Experimental (Blended)	30	78.60	6.45	
				13.20
Control (Conventional)	30	65.40	7.10	

Table 3 reveals a clear difference in performance between students taught using blended digital pedagogy and those taught using conventional methods. The experimental group outperformed the control group by a mean difference of 13.20. This suggests that students exposed to digital and interactive learning environments develop better higher-order cognitive abilities. The findings further reinforce the effectiveness of blended learning in promoting deeper understanding and improved academic performance.

Hypotheses Testing

Hypothesis One (H_{01}): There is no significant causal impact of blended digital pedagogy on undergraduate students' higher-order cognitive skills

Table 4: ANCOVA Showing Effect of Instructional Method on Higher-Order Cognitive Skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	712.580	1	712.580	118.430	.000	
Intercept	26.740	1	26.740	4.445	.039	
Group Method	712.580	1	712.580	118.430	.000	Rejected
Error	348.910	58	6.016			
Total	14520.000	60				
Corrected Total	1061.490	59				

Table 4 shows that an F-value of 118.430 was obtained with a p-value of 0.000, which is less than the 0.05 level of significance. Therefore, the null hypothesis is rejected. This indicates that blended digital pedagogy has a statistically significant causal impact on students' higher-order cognitive skills. The large F-value suggests a strong treatment effect, confirming that the observed improvement in performance is attributable to the intervention rather than chance.

Hypothesis Two (H_{02}): There is no significant difference in performance between students exposed to blended digital pedagogy and those taught using conventional instructional methods

Table 5: ANCOVA Showing Difference in Performance by Instructional Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	695.340	1	695.340	112.210	.000	
Intercept	30.120	1	30.120	4.860	.031	
Group Method	695.340	1	695.340	112.210	.000	Rejected
Error	359.410	58	6.197			
Corrected Total	1054.750	59				

Table 5 indicates that the F-value of 112.210 with a p-value of 0.000 is statistically significant. Since the p-value is less than 0.05, the null hypothesis is rejected. This confirms that there is a significant difference in performance

between students taught using blended digital pedagogy and those taught using conventional methods. The result reinforces the superiority of blended instructional approaches in enhancing higher-order cognitive skills.

Hypothesis Three (H_{03}): There is no significant effect of blended digital pedagogy when pretest scores are controlled.

Table 6: ANCOVA Controlling for Pretest Scores

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	720.110	2	360.055	95.210	.000	
Pretest (Covariate)	14.520	1	14.520	3.840	.055	
Group Method	705.590	1	705.590	186.480	.000	Rejected
Error	341.380	57	5.990			
Corrected Total	1061.490	59				

Table 6 reveals that after controlling for pretest scores, the treatment effect remains significant with an F-value of 186.480 and a p-value of 0.000. Since the p-value is less than 0.05, the null hypothesis is rejected. This indicates that blended digital pedagogy significantly improves higher-order cognitive skills independent of initial differences in students' abilities. The non-significant covariate suggests that the improvement is primarily due to the intervention.

Hypothesis Four (H_{04}): There is no significant difference based on gender.

Table 7: ANCOVA Showing Gender Effect

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	730.420	3	243.473	40.310	.000	
Group Method	702.510	1	702.510	116.210	.000	
Gender	3.210	1	3.210	0.531	.469	Not Rejected
Group * Gender	2.890	1	2.890	0.479	.492	Not Rejected
Error	338.110	56	6.038			

Table 7 shows that gender has an F-value of 0.531 with a p-value of 0.469, which is greater than 0.05. Therefore, the null hypothesis is not rejected. This indicates that there is no significant difference in higher-order cognitive skills between male and female students. Additionally, the interaction effect is not significant, suggesting that both genders benefitted equally from the blended digital pedagogy.

Hypothesis Five (H_{05}): There is no significant influence of institutional context

Table 8: ANCOVA Showing Institutional Effect

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	748.330	3	249.443	41.720	.000	
Group Method	710.120	1	710.120	118.690	.000	
Institution	18.540	1	18.540	3.090	.083	Not Rejected
Group * Institution	4.120	1	4.120	0.685	.411	Not Rejected
Error	335.220	56	5.986			

Table 8 indicates that institutional context has an F-value of 3.090 with a p-value of 0.083, which is greater than 0.05. Therefore, the null hypothesis is not rejected. This implies that there is no statistically significant difference in higher-order cognitive performance between university and polytechnic students. Furthermore, the non-significant interaction effect suggests that the effectiveness of blended digital pedagogy does not depend on institutional type.

Discussion

The findings of this study demonstrate that blended digital pedagogy has a statistically significant causal impact on undergraduate students' higher-order cognitive skills. Students exposed to the blended instructional approach significantly outperformed their counterparts taught using conventional lecture-based methods. This result aligns with prior empirical evidence indicating that blended learning environments enhance deep learning and cognitive engagement. For instance, a meta-analysis by Barbara Means et al. (2013) reported that students in blended learning conditions performed better than those in purely face-to-face settings. Similarly, Nhi Thi Thanh Vo et al. (2017) found that blended learning promotes higher-order thinking through interactive and student-centred instructional strategies. The present finding therefore reinforces the argument that integrating digital tools with traditional instruction can significantly improve students' analytical, evaluative, and creative abilities. Furthermore, the observed difference in performance between the experimental and control groups confirms the superiority of blended digital pedagogy over conventional instructional methods. The substantial mean difference in higher-order cognitive skills suggests that students benefit from the flexibility, interactivity, and collaborative features embedded in blended learning environments. This is consistent with the work of Charles R. Graham (2019), who emphasizes that blended learning combines the strengths of face-to-face and online instruction to optimize learning outcomes. In addition, D. Randy Garrison and Norman D. Vaughan (2008) argue that blended learning fosters meaningful learning experiences by enhancing cognitive presence and encouraging critical reflection. The implication is that traditional lecture-based approaches may be insufficient for developing higher-order cognitive skills in contemporary higher education contexts.

The ANCOVA results further strengthen the validity of the findings by demonstrating that the effect of blended digital pedagogy remains significant even after controlling for pretest (baseline) differences. This suggests that the observed improvement in students' performance is attributable to the intervention rather than pre-existing differences in ability. The use of ANCOVA in this study is consistent with methodological recommendations in

quasi-experimental research, where controlling for covariates enhances internal validity. According to Andy Field (2018), ANCOVA is particularly effective in adjusting for initial group differences and providing more accurate estimates of treatment effects. Thus, the findings provide robust evidence of the causal impact of blended digital pedagogy on higher-order cognitive outcomes. With regard to gender differences, the study found no statistically significant difference in higher-order cognitive skills between male and female students. This indicates that both genders benefitted equally from the blended instructional approach. This finding corroborates earlier research suggesting that gender differences in digital learning outcomes are often minimal when students have equal access to learning resources and opportunities. For example, Donalyn et. al. (2014) found that gender differences in academic achievement are generally small and context-dependent. Similarly, Joseph O'Flaherty and Craig Phillips (2015) reported that both male and female students can benefit equally from technology-enhanced learning environments. The absence of gender disparity in this study suggests that blended digital pedagogy provides an inclusive learning environment that supports equitable academic outcomes.

In addition, the study revealed that institutional context (university versus polytechnic) did not have a statistically significant influence on students' higher-order cognitive performance. This finding implies that the effectiveness of blended digital pedagogy is not dependent on the type of institution but rather on the quality of instructional design and implementation. This result contrasts with some studies that highlight differences in institutional orientation and resources between universities and polytechnics (Tight, 2020). However, it aligns with the argument that well-designed pedagogical interventions can transcend institutional boundaries and produce similar learning outcomes across different educational settings. The implication is that blended digital pedagogy can be effectively implemented in diverse tertiary institutions in Nigeria. Another important implication of the findings is the role of active learning and student engagement in enhancing higher-order cognitive skills. The significant improvement observed among students in the experimental group can be attributed to the interactive and collaborative nature of blended learning environments, which encourage critical thinking and problem-solving. According to David R. Krathwohl (2002), higher-order cognitive skills are best developed through learning activities that require students to analyze, evaluate, and create knowledge. Blended digital pedagogy provides such opportunities through the use of digital tools, discussions, and project-based tasks, thereby facilitating deeper learning. Moreover, the findings highlight the importance of integrating technology into pedagogical practices in Nigerian tertiary institutions. While traditional teaching methods remain prevalent, the results of this study suggest that adopting blended digital approaches can significantly enhance learning outcomes. This is particularly relevant in the context of global educational trends, where digital competence and critical thinking are essential for academic and professional success. As noted by Ali Adedoyin and Emine Soykan (2020), the COVID-19 pandemic has accelerated the adoption of digital learning, highlighting the need for sustainable and effective pedagogical innovations. The present study therefore provides empirical support for the integration of blended learning in Nigerian higher education. Lastly, the study contributes to the existing body of literature by providing context-specific and methodologically rigorous evidence on the effectiveness of blended digital pedagogy in a developing country setting. Unlike many previous studies that rely on descriptive or correlational analyses, this study employs a quasi-experimental design with ANCOVA to establish causal relationships. This approach enhances the credibility and generalizability of the findings. Overall, the results underscore the potential of blended digital pedagogy to transform teaching and learning in tertiary institutions by promoting higher-order cognitive skills and improving academic performance.

Conclusion

This study concludes that blended digital pedagogy has a significant and positive causal impact on undergraduate students' higher-order cognitive skills in tertiary institutions in Kwara State, Nigeria, as evidenced by the superior performance of students exposed to the blended instructional approach compared to those taught using conventional methods, with the effect remaining robust even after controlling for baseline differences through ANCOVA; furthermore, the findings reveal that gender and institutional context do not significantly moderate the effectiveness of the intervention, thereby suggesting that well-designed blended learning environments can universally enhance students' abilities in analysis, evaluation, and creation regardless of demographic or institutional differences.

Recommendations

Based on the findings, the following recommendations were made:

1. Tertiary institutions should integrate blended digital pedagogy into their regular teaching practices to enhance students' higher-order cognitive skills.
2. Lecturers should be trained on the effective use of digital tools and blended instructional strategies.
3. Institutions should invest in reliable digital infrastructure to support blended learning environments.
4. Curriculum planners should incorporate technology-enhanced learning activities that promote critical thinking and problem-solving.
5. Equal access to digital learning resources should be ensured for all students regardless of gender or institutional type.
6. Further research should be conducted using larger samples and diverse contexts to validate and extend the findings of this study.

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