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E-LEARNING AND DIGITAL PEDAGOGY IN NIGERIAN UNIVERSITIES FOR STUDENTS' LEARNING IN SOUTH-WESTERN NIGERIA

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Abstract

The purpose of this study is to investigate the process of digital pedagogy uptake, utilization, and efficacy at a selection of universities located in Southwestern Nigeria. A mixed-methods strategy was utilized to collect data from a total of 300 students and 100 instructors through the use of structured surveys. Finally, descriptive and inferential statistics were utilized to analyze the extracted information. According to the data, younger students between the ages of 18 and 25 are the most active users of e-learning platforms, whilst older professors (those aged 36 and older) are less engaged, most likely because of their lower level of digital competency. The utilization of digital learning technologies, like Learning Management Systems (LMS) and mobile learning apps, continues to be lower among professors than it is among students, despite the ubiquitous availability of these resources. With 85 percent of respondents believing that digital pedagogy enhances knowledge, engagement, and accessibility to resources, the findings suggest that digital pedagogy has a beneficial impact on the outcomes of learning.However; the full adoption of digital pedagogy is impeded by challenges such as inadequate infrastructure, limited technical support, and poor internet accessibility. The study, using a chi-square test, has shown a statistically significant correlation ($p < 0.05$) between digital pedagogy and learning outcomes. To fully harness the benefits of e-learning at Nigerian universities, the study underscores the need for urgent improvements in faculty training, infrastructure, and the implementation of policy interventions.

Keywords: Digital Pedagogy, E-Learning, Learning Outcomes, Higher Education, Nigeria

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Introduction

The swift progression of technology has profoundly altered numerous areas, including education. In the modern digital age, e-learning and digital pedagogy have become essential elements of higher education, improving accessibility, flexibility, and efficacy in knowledge transmission. Nigerian institutions, especially in Southwestern Nigeria, are progressively investigating the incorporation of e-learning approaches to enhance students' educational experiences. This study analyses the application of e-learning and digital pedagogy in Nigerian institutions, emphasizing its effects on student learning, related issues, and potential solutions.

E-learning, the use of electronic technology, primarily the Internet, to enhance educational processes, and digital pedagogy, instructional practices that utilize digital resources and platforms to improve teaching effectiveness, are not just buzzwords. They represent a potential revolution in Nigerian higher education. The implementation of e-learning in Nigerian colleges has been driven by factors like a growing student demographic, inadequate physical infrastructure, and the demand for adaptable learning frameworks. Research indicates that e-learning increases student engagement, fosters interactive learning, and offers access to extensive educational resources.

Despite the promising potential of e-learning, Nigerian universities are grappling with significant obstacles in its comprehensive implementation. These issues range from insufficient technological infrastructure and a lack of skilled workers to inadequate internet access, especially in public colleges. Moreover, many professors and students have inadequate digital literacy, hindering the effective use of e-learning platforms. This underscores the urgent need to assess the degree of integration of e-learning and digital pedagogy in Nigerian universities and their efficacy in enhancing student learning.

The incorporation of e-learning in Nigerian universities has elicited both enthusiasm and skepticism. E-learning possesses the capacity to transform education by enhancing accessibility and interactivity; however, its implementation has been sluggish and beset by problems. Research has highlighted several obstacles, including insufficient ICT infrastructure, lecturer reluctance, budgetary limitations, and erratic government policies (Babatunde, 2018; Walola&Awodiji, 2019). In Southwestern Nigeria, despite advancements in e-learning adoption by certain colleges, there is a deficiency in the comprehensive use of digital pedagogy to improve students' learning results.

A significant issue that needs to be addressed is the inequity in e-learning accessibility between private and public universities. Private institutions, with their superior financing and technology infrastructure, have successfully integrated digital teaching more efficiently than public universities. This disparity is a stark reminder of the need for equity in the digital transformation of education in Nigeria.

Instructors' readiness and proficiency significantly influence the efficacy of e-learning in utilizing digital teaching tools. Studies reveal that numerous professors continue to favor conventional face-to-face teaching techniques owing to insufficient preparation in digital pedagogy (Nuhu, 2018). Consequently, students frequently must autonomously explore e-

learning platforms, thereby hindering their capacity to fully exploit available learning opportunities.

Moreover, the COVID-19 pandemic highlighted the necessity for resilient e-learning infrastructures in higher education. During the lockdown, numerous universities shifted to online learning; nonetheless, this experience exposed considerable deficiencies, including students' inability to afford data, insufficient technical assistance, and unsuitable learning management systems (Olaniyi, 2019). These concerns underscore the necessity for sustainable e-learning initiatives that rectify both technological and pedagogical deficiencies in Nigerian universities.

A significant concern is the influence of government policies and institutional support in advancing e-learning. Although certain policies have been established to improve digital education, their execution is patchy (Umoru, 2023). The absence of explicit standards on e-learning implementation and the advancement of digital infrastructure has exacerbated the difficulties encountered by universities.

It is imperative to conduct a comprehensive examination of e-learning and digital pedagogy in universities located in Southwestern Nigeria. This study aims to assess the degree of e-learning adoption, identify principal difficulties, and recommend ways for effective digital integration to enhance students' learning experiences. By addressing these difficulties, Nigerian institutions can fully leverage e-learning to cultivate a more inclusive and dynamic educational system.

Although e-learning and digital pedagogy provide significant advantages for student education, their use in Nigerian universities, especially in Southwestern Nigeria, is obstructed by infrastructural, budgetary, and pedagogical obstacles. Overcoming these obstacles necessitates a cooperative endeavor by governmental bodies, university officials, educators, and students. This study's findings will enhance the current literature on e-learning uptake in Nigerian higher education and offer insights for establishing sustainable digital learning frameworks.

The study's objectives are to evaluate the degree of e-learning and digital pedagogy integration in Nigerian universities, identify the obstacles hindering the implementation of e-learning technologies in education, assess the influence of digital pedagogy on students' academic performance and engagement, investigate lecturers' and students' perceptions of e-learning as a substitute for conventional classroom instruction, and propose strategies for enhancing the effective use of e-learning tools in higher education. The study will also evaluate several hypotheses related to e-learning's impact on academic achievement, its execution in Nigerian universities, and the perceptions of lecturers and students concerning e-learning as a substitute for conventional teaching methods.

The study will evaluate the following hypotheses: H_0: There exists no substantial correlation between the usage of e-learning technology and students' academic achievement in Nigerian universities. H_1: A substantial correlation exists between the usage of e-learning technology and students' academic achievement in Nigerian universities. H_0: The obstacles related to e-learning do not substantially impact its execution in Nigerian universities. H_1: The obstacles

related to e-learning substantially influence its execution in Nigerian universities, while H_0: There is no notable disparity in the perceptions of lecturers and students concerning e-learning as a substitute for conventional teaching methods. H_1: A large disparity exists in the perceptions of lecturers and students concerning e-learning as an alternative to conventional teaching methods.

This study is pertinent for many stakeholders in the education sector: the results will elucidate the efficacy of digital pedagogy and inform policy on technology integration in Nigerian universities. It will assist instructors in utilizing digital resources to enhance learning outcomes. The study will elucidate the advantages and obstacles of e-learning, assisting students in maximizing digital resources for academic achievement. The study will include recommendations to enhance the infrastructure and regulations that support e-learning in higher education institutions.

Review of Literature

E-learning denotes the incorporation of digital technologies into the educational process to enhance knowledge acquisition, collaboration, and evaluation. Digital pedagogy is beyond the simple application of technology and includes new teaching methods that utilize digital tools to improve student learning results (Kumar, 2018). The emergence of e-learning in higher education has transformed the conventional classroom by offering students flexible, self-directed, and interactive learning experiences (Ademiluyi, 2020). Nuhu (2018) asserts that the efficacy of e-learning is predominantly influenced by institutional preparedness, the accessibility of digital infrastructure, and the readiness of educators and students to adopt technology-enhanced instruction.

Multiple theoretical frameworks support e-learning and digital pedagogy. The Technology Acceptance Model (TAM) serves as a fundamental framework for comprehending the acceptance of digital learning aids by educators and students. The concept asserts that perceived usefulness and perceived simplicity of use are fundamental factors influencing users' acceptance of technology (Kamba, 2019). The Constructivist Learning Theory also highlights the importance of technology in promoting active, student-centered learning experiences. Olaniyi (2019) contends that digital pedagogy is congruent with constructivist principles by fostering interactive learning settings in which students generate knowledge through engagement with digital content and collaborative endeavors.

The implementation of e-learning in higher education has experienced substantial expansion, especially due to the COVID-19 pandemic, which required a transition from conventional classroom teaching to digital learning platforms. Babatunde (2018) indicates that Nigerian colleges are progressively incorporating Learning Management Systems (LMS), virtual classrooms, and mobile learning applications to enhance teaching and learning. Nonetheless, despite these developments, the degree of acceptance differs throughout institutions owing to variations in digital infrastructure and faculty preparedness (Odugboye, 2016). Oladeji and Nuhu (2021) emphasize that whereas several universities have effectively adopted blended learning models, others persist in facing technology limitations and challenges in pedagogical adaption.

Digital pedagogy is essential for improving student engagement, information retention, and critical thinking abilities. The incorporation of multimedia materials, interactive simulations, and gamification aspects has demonstrated enhancement in learning experiences and outcomes (Olawuyi, 2016). Oluwadare, Adekunle, and Ebiniyi (2019) assert that digital pedagogy promotes individualized learning by enabling students to advance at their own speed and access educational resources at any time and from any location. Furthermore, e-learning systems facilitate collaborative learning via discussion forums, peer assessments, and real-time feedback mechanisms, hence improving student interaction and academic performance (Ayemhenre&Okolo, 2019).

There are many advantages of e-learning in Nigerian colleges. It facilitates educational access, particularly for pupils in isolated regions, diminishes educational expenses, and encourages lifelong learning (Babalola, Dambo, &Bupo, 2019). Moreover, e-learning cultivates the acquisition of digital literacy competencies vital for the contemporary workforce (Adedayo, 2016). Nonetheless, numerous obstacles impede the successful execution of e-learning in Nigerian colleges. Prominent among these include insufficient digital infrastructure, inconsistent internet access, absence of skilled workers, and reluctance to change among educators (Kamba, 2019). Moreover, students from economically disadvantaged families have obstacles in obtaining digital equipment and internet connection, thereby restricting their involvement in e-learning programs (Oluwalola&Awodiji, 2019).

Empirical research has investigated the influence of e-learning on student learning outcomes, yielding diverse results. Kumar (2018) discovered that students participating in e-learning had superior self-directed learning and academic achievement relative to their counterparts in conventional classroom environments. Oladeji and Nuhu (2021) indicated that business education students employing e-learning technology demonstrated enhanced problem-solving capabilities and critical thinking abilities. Research by Ademiluyi (2020) found that the efficacy of e-learning depends on students' digital competencies and institutional support. Conversely, Walola and Awodiji (2019) discovered that although e-learning improved learning flexibility, students frequently faced challenges with motivation and self-discipline, adversely impacting their performance.

The digital divide continues to be a substantial obstacle to the adoption of e-learning in Southwestern Nigeria. The phrase "digital divide" denotes the disparity between persons with access to digital technologies and those without it. Kamba (2019) identifies socioeconomic gaps, insufficient ICT infrastructure, and restricted access to affordable internet services as factors contributing to the digital divide in Nigerian institutions. A study by Ayemhenre and Okolo (2019) revealed that pupils in urban regions possess superior access to digital learning materials than those in rural regions. Odugboye (2016) observed that colleges in Southwestern Nigeria encounter infrastructural difficulties, including inadequate energy supply and insufficient finance for e-learning programs. Overcoming these obstacles necessitates specific policy measures, investment in digital infrastructure, and capacity-building initiatives for educators and students (Umoru, 2023).

The use of e-learning and digital pedagogy in Nigerian institutions could revolutionize higher education by improving accessibility, engagement, and academic results. Nonetheless, other hurdles, such as technological obstacles and the digital divide, must be resolved to guarantee

the successful execution of digital learning projects. Future studies should concentrate on formulating sustainable solutions to close the digital divide and enhance the advantages of e-learning in Nigerian higher education institutions.

Methodology

This research used a descriptive survey approach to investigate the implementation of e-learning and digital pedagogy in Nigerian universities. The descriptive method is suitable for examining trends, difficulties, and effects of digital learning, as it facilitates the gathering of measurable data from a substantial population. This method offers insights into the perceptions and experiences of students and educators around the use of digital learning.

The study's target audience comprises students and teachers from specific universities in Southwestern Nigeria. These universities were selected based on their degree of involvement with e-learning platforms. The research examines students from many fields and professors engaged in digital instruction. The projected population comprises 5,000 students and 500 instructors within the designated institutions.

A multi-stage sampling method was utilized to choose participants for the study. The initial phase was the deliberate selection of universities that have implemented e-learning systems. The second stage employed stratified random sampling to classify respondents into students and lecturers. Proportionate sampling was employed to provide a sufficient representation of each group, involving 300 students and 100 instructors in the study.

Primary data was obtained via a standardized questionnaire and key informant interviews. The questionnaire included both closed and open-ended questions, addressing topics such as access to e-learning resources, digital literacy, encountered challenges, and perceived benefits. Interviews with key informants, including selected instructors and university administrators, were performed to obtain a comprehensive understanding of institutional policies and issues related to digital pedagogy.

The study instruments, specifically the questionnaire and interview guide, were evaluated by professionals in educational research and digital learning to confirm their validity. To evaluate the clarity and relevancy of the questions, a pilot study was executed, including 30 participants from a non-selected university. The questionnaire's reliability was evaluated using Cronbach's alpha coefficient, resulting in a score of 0.82, signifying strong internal consistency.

Quantitative data obtained from questionnaires was analyzed employing descriptive and inferential statistical methods. Descriptive statistics, including frequency distributions, means, and standard deviations, were employed to encapsulate the data. Inferential statistics, such as chi-square and regression analysis, were utilized to investigate the correlations among variables. Thematic analysis was conducted on qualitative data from interviews, categorizing responses into principal themes about the adoption of digital pedagogy.

The study received ethical approval from the appropriate institutional research ethics committee. Participants were apprised of the study's objective, and informed consent was secured prior to data collection. Responders' confidentiality and anonymity were guaranteed,

and participation was voluntary, allowing withdrawal at any point. Furthermore, the data was securely preserved and utilized exclusively for research reasons.

Results and Discussion

This chapter delineates the study's findings, emphasizing respondents' demographic attributes, the accessibility and utilization of e-learning technology, and the efficacy of digital pedagogy on educational achievements. The results are derived from data gathered from 300 students and 100 teachers at chosen universities in South-Western Nigeria, analyzed by descriptive and inferential statistics.

Demographic Characteristics of Respondents

The study captured responses from **students and lecturers** across various disciplines to assess their engagement with digital learning platforms. The demographic characteristics of respondents are summarized in Table 1.

Table 1: Demographic Characteristics of Respondents

Variable	**Students (n=300)**	**Lecturers (n=100)**	**Total (N=400)**	**Percentage (%)**
Gender				
Male	180	70	250	62.5%
Female	120	30	150	37.5%
Age Category				
18-25 years	190	5	195	48.8%
26-35 years	80	35	115	28.8%
36 and above	30	60	90	22.5%
Academic Level				
Undergraduate	250	-	250	62.5%
Postgraduate	50	100	150	37.5%

The findings indicate that 62.5% of participants were male, whilst 37.5% were female. The predominant age group among student participants was 18 to 25 years, including 190 out of 300 individuals (63.3%), whereas the majority of professors aged 36 and above accounted for 60 out of 100 (60%). This distribution indicates that younger students predominantly utilize e-learning technology, whilst lecturers involved in digital pedagogy are typically more seasoned faculty members.

Accessibility and Utilisation of E-Learning Technologies

The research evaluated the accessibility and usage of diverse e-learning platforms by students and instructors. Table 2 illustrates the accessibility and utilization frequency of several digital learning resources.

Table 2: Availability and Usage of E-Learning Technologies

E-Learning Technology	Availability (%)	Student Utilization (%)	Lecturer Utilization (%)
Learning Management Systems (LMS)	85%	70%	60%
Mobile Learning Apps	90%	75%	55%
Video Conferencing Tools (Zoom, Google Meet)	80%	72%	65%
Online Library Access	75%	60%	50%
Computer Labs	65%	50%	40%

Although numerous e-learning technologies are readily accessible in colleges in Southwestern Nigeria, their practical usage is comparatively limited. For instance, Learning Management Systems (LMS) are present in 85% of universities; nevertheless, only 70% of students and 60% of lecturers utilize them actively. Mobile learning applications are extensively accessible (90%) but are utilized more often by students (75%) than by lecturers (55%). The comparatively diminished utilization of computer laboratories (50% among students and 40% among lecturers) indicates that numerous students favor mobile-based learning, whilst instructors may require further training in the integration of digital technologies into their pedagogy.

Effectiveness of Digital Pedagogy on Educational Outcomes

The study assessed the effects of digital pedagogy by analyzing respondents' beliefs about the influence of e-learning tools on learning outcomes, such as comprehension, engagement, and accessibility.

Table 3: Perceived Impact of Digital Pedagogy on Learning Outcomes

Learning Outcome	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Improved understanding of concepts	55%	30%	10%	3%	2%
Increased student engagement	60%	25%	10%	3%	2%
Enhanced accessibility to learning resources	65%	20%	10%	3%	2%
Reduction in learning barriers	50%	30%	10%	7%	3%

The findings demonstrate that digital pedagogy positively influences learning outcomes. Specifically, 85% of respondents (Strongly Agree + Agree) indicated an improved understanding of concepts, thereby supporting the assertion that digital learning enhances

comprehension. The increase in student engagement (85%) indicates that interactive e-learning tools, including video conferencing and learning management systems, promote active learning. The accessibility of learning resources received the highest rating, with 65% of respondents strongly agreeing and 20% agreeing. Despite these advantages, 17% of respondents (Disagree + Strongly Disagree) contend that digital learning fails to diminish learning barriers, underscoring issues such as limited internet access, insufficient infrastructure, and gaps in digital literacy. The findings are consistent with current literature regarding e-learning adoption in developing countries, highlighting the necessity for policy interventions to enhance accessibility, training, and digital infrastructure in Nigerian universities.

The impact of digital pedagogy on educational outcomes.

Respondents were surveyed to evaluate the impact of digital pedagogy on learning outcomes. Table 3 summarizes their responses.

Table 3: Perceived Impact of Digital Pedagogy on Learning Outcomes

Learning Outcome	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
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Increased student engagement	60%	25%	10%	3%	2%
Enhanced accessibility to learning resources	65%	20%	10%	3%	2%
Reduction in learning barriers	50%	30%	10%	7%	3%

85% of participants (Strongly Agree + Agree) indicated an enhanced grasp of concepts, underscoring the efficacy of interactive digital tools in understanding. The elevated student engagement rate of 85% indicates that e-learning promotes active learning. The accessibility of resources received the highest rating (85%), underscoring the significance of digital platforms in enhancing educational inclusion. Nonetheless, 10% of respondents remained neutral, and 10% opposed the notion that digital pedagogy mitigates learning hurdles, highlighting issues such as internet connectivity, digital literacy, and infrastructural deficiencies.

Student Perspectives and Involvement with E-Learning Platforms

The study investigated student involvement with e-learning technologies to assess their interest, participation, and the problems encountered in digital learning settings.

Table 4: Student Engagement with E-Learning Platforms

Engagement Factor	Always (%)	Frequently (%)	Occasionally (%)	Rarely (%)	Never (%)

Active participation in online discussions	40%	35%	15%	7%	3%
Completion of online assignments	50%	30%	10%	7%	3%
Interaction with lecturers via e-learning platforms	35%	40%	15%	5%	5%
Usage of online learning resources	45%	35%	12%	5%	3%

85% of participants (Strongly Agree + Agree) indicated enhanced grasp of concepts, underscoring the efficacy of interactive digital tools in understanding. The elevated student engagement rate of 85% indicates that e-learning promotes active learning. The accessibility of resources received the highest rating (85%), underscoring the significance of digital platforms in enhancing educational inclusion. Nonetheless, 10% of respondents remained neutral, and 10% opposed the notion that digital pedagogy mitigates learning hurdles, highlighting issues such as internet connectivity, digital literacy, and infrastructural deficiencies.

Student Perspectives and Involvement with E-Learning Platforms

The study investigated student involvement with e-learning technologies to assess their interest, participation, and the problems encountered in digital learning settings.

75% of students actively participate in online conversations, whereas 22% participate only occasionally or infrequently, indicating that some students struggle with motivation or digital learning adaptation. 80% consistently complete tasks, demonstrating great academic engagement through digital channels. Interaction with lecturers is strong (75%), although 10% rarely or never interact, highlighting the need for faculty-student engagement measures. The use of online resources is at 80%, suggesting widespread acceptability but emphasizing the need for enhanced digital resource availability.

Institutional Support and Challenges for Digital Learning

Institutional support is crucial for e-learning uptake. This study looked at the quality of institutional assistance and the issues that students and professors encounter.

Table 5: Institutional Support for Digital Learning

Support Factor	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Provision of e-learning infrastructure	45%	35%	10%	7%	3%
Availability of technical support	40%	30%	15%	10%	5%
Training for lecturers	35%	30%	20%	10%	5%

and students					
Internet accessibility support	30%	25%	20%	15%	10%

30% of those polled disagreed that institutions provide appropriate digital infrastructure. 25% of students and teachers reported insufficient technical assistance, making troubleshooting difficult. 15% of respondents believed that training options were inadequate, harming educators' and students' digital competency. 25% disagreed that institutions provide adequate internet access, citing connectivity issues as a significant impediment.

Hypothesis Testing

To statistically validate the findings, the study tested the hypothesis:

H_0: There is no significant relationship between digital pedagogy and student learning outcomes.

H_1: There is a significant relationship between digital pedagogy and student learning outcomes.

Table 6: Chi-Square Test Results

Variable	**Chi-Square (χ^2)**	**p-value**	**Decision**
Digital pedagogy vs. Learning Outcomes	18.45	0.002	Reject H_0
Digital pedagogy vs. Student Engagement	14.62	0.005	Reject H_0

The p-values (0.002 and 0.005) being below 0.05 leads to the rejection of the null hypothesis (H_0), indicating that digital pedagogy has a significant effect on student learning outcomes and engagement. The significant correlation indicates that universities ought to persist in their investment in digital learning, while simultaneously tackling infrastructure and technical challenges.

Discussion of Findings

This study's findings offer important insights regarding the adoption, utilisation, and effectiveness of digital pedagogy in universities located in South-Western Nigeria. This analysis examines significant trends, challenges, and implications for educational policy and practice.

The demographic analysis reveals that younger students (18–25 years) constitute the main users of e-learning platforms, whereas lecturers aged 36 and older exhibit reduced levels of engagement. This is consistent with Adedayo's (2016) study, which identified that the digital literacy levels of older faculty members influence their readiness to incorporate e-learning technologies into their teaching practices. The variation in digital skills indicates a necessity for specialised training initiatives to address generational differences and improve faculty interaction with digital resources.

Although e-learning tools like Learning Management Systems and mobile learning applications exhibit high availability rates of 85% and 90%, respectively, their actual utilisation remains comparatively low, especially among lecturers. This aligns with Ajayi's

(2019) findings, which indicate that despite the expansion of digital infrastructure in Nigerian universities, faculty adoption is suboptimal, attributed to insufficient training and resistance to technological change. The reduced utilisation of computer labs, with 50% of students and 40% of lecturers engaging, suggests a transition to mobile-based learning. This trend is corroborated by Oyeleke et al. (2020), who highlighted the increasing dependence on mobile learning applications among Nigerian students. This trend highlights the necessity of optimising mobile learning resources and ensuring the usability of digital platforms for educators.

The findings indicate that digital pedagogy has a beneficial impact on student learning outcomes. A notable percentage of participants (85%) indicated enhanced conceptual understanding and engagement via digital platforms. This finding aligns with the research conducted by Adebayo and Olufemi (2018), which demonstrated that interactive digital tools improve student participation and understanding. Nonetheless, the study identified challenges, with 17% of respondents indicating that digital learning does not substantially mitigate learning barriers. Issues related to internet access, gaps in digital literacy, and deficiencies in infrastructure, as highlighted by Adediran et al. (2021), contribute to these limitations.

Engagement metrics indicate that 75% of students actively participate in online discussions and 80% consistently complete assignments; however, a significant 22% engage only occasionally or infrequently. This indicates variability in motivation and adaptability to digital learning among students. Ogunleye et al. (2017) similarly identified digital distractions and challenges in self-regulation as significant barriers to participation in online learning. Moreover, 80% of students regularly utilise online learning resources, while the 20% who do not highlight a necessity for enhanced accessibility and awareness of existing digital tools.

Institutional support is essential for the effective implementation of digital pedagogy. The study indicates that although 80% of respondents recognise the availability of e-learning infrastructure, challenges remain in technical support, with 25% reporting inadequacy, and internet accessibility, also at 25% inadequacy. The findings corroborate Olaniyi (2020), who emphasised that insufficient internet infrastructure in Nigerian universities undermines the efficacy of digital learning initiatives. Addressing these gaps through policy reforms and enhanced investment in digital infrastructure is crucial for the sustainable adoption of e-learning.

The results of the hypothesis test indicate a significant relationship between digital pedagogy and student learning outcomes ($\chi^2 = 18.45$, $p = 0.002$) as well as student engagement ($\chi^2 = 14.62$, $p = 0.005$). The findings support Adedayo's (2016) assertion that effective digital pedagogy improves educational outcomes and engagement. Statistical validation indicates that universities should persist in investing in digital learning strategies while mitigating existing barriers via faculty training, improved technical support, and enhanced infrastructure development.

This study highlights the beneficial effects of digital pedagogy on learning outcomes and student engagement within universities in South-Western Nigeria. Challenges including

internet accessibility, deficiencies in technical support, and gaps in digital literacy must be addressed to optimise the advantages of e-learning. Future research should prioritise longitudinal studies to evaluate the long-term impacts of digital learning interventions and investigate methods for enhancing digital competency among lecturers. Recommendations for policy include the implementation of targeted training programs for faculty, enhanced investment in digital infrastructure, and the formulation of inclusive e-learning policies to address the digital divide.

Summary of Findings

This research analysed the use of renewable energy in water purification systems, specifically targeting remote or off-grid regions in Delta State, Nigeria. The results indicate that renewable energy sources, especially solar and wind energy provide sustainable options for powering water purification systems. The research identified significant challenges, such as elevated initial costs, insufficient technical expertise, and variable government policies that influence the adoption of these technologies.

The study examined the effectiveness of different renewable energy-based water purification methods, including solar distillation, photovoltaic-powered reverse osmosis, and ultraviolet purification. The findings demonstrate that these methods substantially enhance water quality, decrease reliance on fossil fuels, and improve access to clean drinking water in rural areas. Furthermore, socioeconomic factors, including income levels, education, and community awareness, were identified as influencing the adoption rate of these systems.

The study identified deficiencies in policy and emphasised the necessity for increased engagement from both government and private sectors to advance the utilisation of renewable energy in water purification. Collaboration among stakeholders, financial incentives, and heightened investment in research and development are essential for securing long-term success in the sector.

Conclusion

The research indicates that renewable energy technologies offer a feasible and sustainable approach to water purification in remote or off-grid regions of Delta State. The long-term advantages of adopting these technologies surpass the challenges posed by barriers such as cost and insufficient technical expertise. The study highlights the necessity of a multi-stakeholder approach that includes government agencies, private sector entities, and local communities to promote broader adoption.

Addressing these challenges and utilising available resources will enable Nigeria to improve access to clean water, promote environmental sustainability, and enhance public health outcomes. Innovative financing models, capacity-building programs, and supportive policies are essential for scaling the implementation of renewable energy-powered water purification systems.

Recommendation

i. The government ought to implement subsidies, tax incentives, and grants to promote investment in renewable energy-powered water purification systems.

ii. Training programs must be developed to provide local communities with essential technical skills for the operation and maintenance of renewable energy systems.
iii. It is essential to promote collaboration among government entities, the private sector, and international organisations to enhance investment and innovation within the sector.
iv. Educational campaigns are necessary to inform rural communities about the advantages and functioning of renewable energy-powered water purification systems.
v. Ongoing research and innovation must be promoted to improve the efficiency, cost-effectiveness, and adaptability of renewable energy technologies in water purification.
vi. A structured framework is necessary for monitoring and evaluating the performance of renewable energy water purification projects to ensure sustainability and facilitate impact assessment.

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