

Harnessing Digital Transformation for Enhanced Teaching and Learning of Environmental Education in University of Port Harcourt, Nigeria.

Bell-Gam Roseline Soprinnye; Ovwromoh, Blessing Chinwe

University of Port Harcourt, Nigeria

DOI: <https://doi.org/10.51583/IJLTEMAS.2025.1408000205>

Received: 14 Sep 2025; Accepted: 21 Sep 2025; Published: 25 September

Abstract: Increasingly shifts in education into the digital age has challenged institutions of learning to rethink how learning is delivered especially in different fields including environmental education that demand both theoretical and practical engagement. This study explored how digital transformation can enhance teaching and learning in environmental education in the University of Port Harcourt. Using a descriptive survey method and a sample of 360 respondents comprising lecturers and students, the study examined levels of awareness, perceived benefits, and the challenges encountered in implementing digital tools. The findings revealed a high level of awareness about digital platforms such as Zoom, Google Classroom, and other learning management systems. However, actual usage was limited due to challenges like poor infrastructure, insufficient ICT training, and irregular power supply. Despite these setbacks, respondents acknowledged the value of digital learning in promoting flexibility, engagement, and access to resources. Based on the findings, the study recommends increased investment in digital infrastructure, consistent capacity building, and targeted motivation strategies to bridge the gap between digital awareness and practical implementation. If well harnessed, digital transformation can serve as a powerful tool to enrich environmental education and prepare students for solving real-world ecological problems.

Key-Words: Digital Transformation, Environmental Education, Digital Tools, Educational Technology, Teaching and Learning.

I. Introduction

Environmental education (EE) plays a vital role in equipping learners with the knowledge, skills, attitudes, and values necessary to address the pressing ecological issues of the 21st century. As global environmental challenges such as climate change, deforestation, pollution, and loss of biodiversity intensify, the need to reimagine and reinforce EE has never been more urgent (Tilbury, 2020). In response to this demand, higher education institutions, particularly in developing countries, are being called upon to explore innovative pedagogical approaches that not only enrich students' learning experiences but also promote environmental sustainability. Digital transformation represents one such avenue with enormous potential to reshape how environmental education is taught and learned in Nigerian institutions, especially at the University of Port Harcourt (UNIPORT).

Digital transformation in education refers to the integration of digital technologies into all aspects of teaching, learning, and educational management. This transformation encompasses the use of online learning platforms such as, virtual labs, simulations, big data, artificial intelligence (AI), augmented reality (AR), and mobile technologies to improve academic delivery and learner engagement (Selwyn, 2021). In the context of environmental education, these technologies can support interactive and experiential learning, real-time data collection, geographic visualisation, and collaborative problem-solving, which are crucial in cultivating a deep understanding of environmental systems and sustainable practices (Dede, 2014).

Environmental education is inherently interdisciplinary, experiential, and action-oriented. It thrives on fieldwork, data interpretation, and community-based projects. Traditional classroom approaches, which often rely on rote learning and passive instruction, are insufficient in delivering the kind of transformative environmental learning that today's students require (UNESCO, 2021). As such, embracing digital tools becomes essential in making learning more student-centered, participatory, and connected to real-world environmental issues.

Digital transformation provides a variety of tools that can enhance environmental education. For example, Geographic Information Systems (GIS) and remote sensing technologies allow students to collect and analyse environmental data relevant to their local contexts (Ferreira et al., 2024). Likewise, simulations and virtual reality (VR) environments enable learners to explore ecosystems, climate systems, and human-impact scenarios beyond physical boundaries (Shin et al., 2023; Markowitz et al., 2018). These innovations not only enrich instructional content but also foster critical thinking and systems-thinking competencies essential for environmental education (UNESCO, 2017).

University of Port Harcourt, as one of Nigeria's leading tertiary institutions, has made commendable efforts in adopting e-learning technologies. However, the implementation is uneven across faculties and departments, with environmental education still lagging in terms of curriculum digitisation, access to modern learning tools, and training for both students and instructors. Challenges such as limited infrastructure, inadequate digital literacy, resistance to change, and poor internet connectivity continue to hinder full-scale integration

Despite these challenges, there is a growing awareness of the need to harness digital tools to elevate the teaching and learning experience. The potential for integrating mobile learning, cloud-based collaboration, open educational resources (OERs), and data-driven decision-making is immense. These tools can help create adaptive learning paths, personalise content delivery, and enhance communication between lecturers and students.

Given the urgency of environmental sustainability and the opportunities presented by digital transformation, this study aims to investigate how digital technologies can be harnessed to enhance the teaching and learning of environmental education at the University of Port Harcourt. By examining current practices, challenges, and potentials, the study seeks to provide empirical evidence and strategic recommendations for integrating digital tools into environmental education effectively

Statement of the Problem

Today's world is facing serious environmental challenges from climate change to rise in temperatures and flooding to pollution and the loss of biodiversity. To tackle these issues, there is a need for people who understand the environment and can make informed decisions to protect it becomes very necessary and that's where environmental education comes in. Environmental education plays a big role in shaping how young people think about the environment and how they act to safeguard it.

While digital transformation has revolutionised several sectors, its implementation in the academic sphere especially in disciplines like environmental education has not been fully explored or harnessed. Although platforms such as learning management systems (LMS), mobile learning apps, and digital simulation tools are available, there is minimal structured adoption of these tools in the environmental education curriculum at the University of Port Harcourt. This results in continued dependence on traditional, teacher-centered approaches that do not adequately support the development of critical thinking, data literacy, and real-world environmental problem-solving skills among students.

Moreover, the absence of a clear institutional framework for digital integration in environmental education has created disparities in access to learning tools, digital competence among lecturers and students, and content delivery quality. Infrastructural challenges such as inconsistent internet connectivity, inadequate training, and limited access to digital resources further deepen the gap. These issues not only hinder pedagogical innovation but also reduced students' engagement with contemporary environmental issues through digital lenses.

If left unaddressed, this gap risks producing graduates who are ill-prepared to apply digital solutions to environmental challenges in a technology-driven world. Therefore, there is a pressing need to explore how digital transformation can be systematically harnessed to improve the quality, relevance, and reach of environmental education at the University of Port Harcourt. This study seeks to address that gap by investigating the current practices, challenges, and opportunities surrounding the digitalisation of environmental education in the institution.

Research Objectives

The following are the research objectives:

1. To find out the level of awareness and usage of digital tools in teaching and learning environmental education in University of Port Harcourt.
2. To find out the benefits of using digital tools in the teaching and learning of environmental education in University of Port Harcourt.
3. To identify the challenges faced by lecturers and students in using digital tools for environmental education in University of Port Harcourt.
4. To explore the strategies to effectively implementing digital transformation to enhance teaching and learning environmental education in University of Port Harcourt.

Research Questions

1. What are the benefits of using digital tools in the teaching and learning of environmental education in University of Port Harcourt?
2. What are the challenges faced by both lecturers and students in using digital tools for environmental education at the University of Port Harcourt?
3. What strategies can be used to effectively implement the use of digital technologies in enhancing teaching and learning environmental education in University of Port Harcourt?

II. Literature Review

Students' Awareness Level of Digital Tools in Higher Education

Students' awareness of digital tools is a critical factor influencing the effectiveness of technology-enhanced learning in higher education. Awareness encompasses not only knowledge of the existence of these tools but also understanding their potential for

improving learning outcomes. In Nigerian universities, research indicates that while students are increasingly exposed to a range of digital platforms, their depth of awareness and ability to apply them effectively remains varied.

Ogolodom et al. (2022) found that many students in Nigerian universities became more familiar with digital learning tools during the COVID-19 pandemic due to the necessity of online classes. However, this exposure was often limited to basic tools such as video conferencing platforms and learning management systems, with less awareness of specialised applications relevant to specific disciplines. For instance, in environmental education, awareness of tools for geographic information systems (GIS), simulation software, and online environmental databases is still low among undergraduates.

Emma-Okon et al. (2024) noted that while students could navigate platforms such as Zoom, Google Classroom, and Microsoft Teams, there was limited understanding of advanced functionalities that could enhance interactivity and self-directed learning. This gap suggests that awareness is often surface-level, shaped more by immediate necessity than by intentional digital literacy training.

Furthermore, Adekoya et al. (2024) highlighted that socio-economic factors play a significant role in determining awareness levels. Students from urban and better-resourced backgrounds tend to be more familiar with a wider range of tools compared to those in rural or less technologically developed settings. This disparity underscores the need for structured digital skills training embedded within university curricula to ensure equitable competence and awareness.

Benefits of Digital Tools in Teaching and Learning Environmental Education

Digital tools are redefining the way environmental education is delivered in Nigerian universities by making learning more engaging, interactive, and adaptable. These technologies help both lecturers and students to connect environmental theory with real-world applications, creating an enriched and flexible learning environment. Thus, the benefits inherent are stated below:

Students Learn Better with Rich, Visual Content

When teaching environmental concepts such as climate change, deforestation, or waste management, tools like Geographic Information Systems (GIS), virtual labs, and interactive simulations allow students to visualise data and processes more clearly. Ubabuike and Ojechi (2025) is of the opinion that digital learning tools significantly improve student engagement and content retention meaning environmental science concepts are understood and remembered more effectively.

Teaching Becomes More Interactive and Collaborative

Digital platforms support real-time discussions, group projects, and interactive assessments, making environmental education less of a lecture-based process and more of a two-way learning process. Udeze and Adesola (2024) note that ICT tools help students actively participate in their learning, a crucial factor in tackling complex environmental issues that require teamwork and diverse perspectives.

Greater Flexibility in Teaching and Learning

Lecturers can adapt content delivery to different learning paces and styles, offering online modules, recorded lectures, and self-paced assignments. According to Oshodi (2022), digital tools provide opportunities for students to access learning materials anytime and anywhere, making it easier to balance studies with other commitments while ensuring continuity in learning.

Continuous Feedback to Support Learning

With online quizzes, project tracking tools, and instant grading systems, students can receive timely feedback that strengthens their understanding of environmental concepts. Uzorka and Odebiyi (2025) highlight that this not only maintains motivation but also helps lecturers adjust their teaching strategies to meet learning needs.

Challenges Faced by Lecturers and Students in Using Digital Tools for Environmental Education

The integration of digital tools into environmental education in Nigerian universities has introduced new opportunities for interactive learning, but it also presents significant challenges for both lecturers and students. These challenges are deeply tied to infrastructural limitations, socio-economic barriers, and gaps in digital competence.

For students, a major obstacle is the cost and availability of internet access. Ogolodom et al. (2022) found that many students struggle with financial constraints, lack of consistent internet connectivity, and limited mobile data, which hindered their ability to participate effectively in online learning. Such barriers are particularly impactful in environmental education, where interactive and media-rich content is often essential for understanding complex ecological concepts.

Lecturers also face considerable difficulties in delivering effective online instruction. According to Adekoya et al. (2024), educators in Nigerian universities are willing to adapt to e-learning but are constrained by unreliable power supply, poor internet connectivity, and inadequate institutional infrastructure. These issues reduce the effectiveness of live teaching sessions, delay feedback, and limit the use of advanced teaching tools such as simulations or real-time data analysis platforms often required in environmental science courses.

Moreover, both lecturers and students encounter skill-related challenges. Emma-Okon et al. (2024) highlight that limited training in the use of digital platforms, low motivation, and socio-economic disparities further widen the gap between those who can engage

with online tools and those who cannot. This affects environmental education particularly, as the subject often relies on practical fieldwork and laboratory sessions that are difficult to replicate virtually.

In sum, while digital tools have the potential to enhance environmental education in Nigerian universities, their successful adoption depends on addressing persistent infrastructural deficits, improving digital literacy for both lecturers and students, and ensuring equitable access to technological resources.

Strategies for Implementing Technologies to Enhance Teaching and Learning in Environmental Education

Integrating technology into environmental education offers opportunities to make learning more interactive, accessible, and impactful. However, successful implementation requires intentional strategies that address both technical and pedagogical needs. The following serves as strategies for the implementation:

Capacity Building and Digital Literacy Training

For technology integration to be effective, lecturers and students must possess the necessary skills to operate digital tools confidently. Adekoya et al. (2024) stress that training programmes should go beyond basic computer skills, focusing on environmental-specific technologies such as Geographic Information Systems (GIS), remote sensing tools, environmental modelling software, and virtual lab simulations.

Infrastructure Development

Robust digital infrastructure is the backbone of technology-enhanced learning. Ogolodom et al. (2022) identify poor internet connectivity and power instability as persistent barriers in Nigerian universities. Addressing these issues through improved broadband access, backup power solutions, and well-equipped digital laboratories can significantly boost the quality of environmental education delivery.

Adoption of Blended Learning Models

Blending face-to-face teaching with online platforms ensures flexibility and supports diverse learning needs. Emma-Okon et al. (2024) note that hybrid approaches help maintain interaction while providing access to rich multimedia resources. In environmental education, this may include combining physical fieldwork with virtual ecosystem tours or satellite image analysis.

Integration of Open Educational Resources (OER)

Leveraging OER platforms allows access to up-to-date environmental datasets, case studies, and research publications. This promotes self-directed learning and ensures students engage with real-world environmental data, fostering analytical and problem-solving skills.

Institutional and Industry Partnerships

Collaboration with environmental agencies, tech companies, and research organisations can provide access to specialised tools, training, and datasets. Such partnerships enhance students' exposure to real-world applications of technology in environmental problem-solving.

III. Methodology

This study adopted the descriptive survey research design. This design was chosen because it enables the collection and analysis of data from a sample population in order to describe, explain, and interpret existing conditions.

The target population and sample size for this study consist of 360 students and lecturers involved in Environmental Education at the University of Port Harcourt. These individuals were selected because they are directly involved in teaching and learning processes that may be impacted by digital transformation. The primary instrument for data collection was a structured questionnaire developed by the researcher. The reliability of the instrument was done and a reliability coefficient of 0.88 was obtained, indicating that the instrument was internally consistent and reliable for data collection. Data collected from the questionnaire were analysed using descriptive statistics such as mean scores and standard deviation

IV. Results

Research Question1. what is the level of awareness and usage of digital tools in teaching and learning of environmental education in University of Port Harcourt?

Table 1: Mean responses on the awareness and usage digital tools in University of Port Harcourt (n = 360)

S/N	Questionnaire Item	VHE4	HE3	LE 2	VLE1	(X)	Std.Dev	Decision
1	I am aware of digital tools (e.g., LMS, Zoom, Google Classroom) used in teaching.	170	130	40	20	3.25	0.79	High Level

2	I frequently use digital platforms for learning or instruction.	80	110	120	50	2.36	0.98	Low Level
3	My department provides access to relevant digital resources.	70	90	130	70	2.19	1.01	Low Level
4	I receive training or orientation on how to use digital tools effectively.	65	95	120	80	2.18	1.00	Low Level
5	I receive training or orientation on how to use digital tools effectively	80	110	120	50	2.36	0.98	Low Level

Criterion Mean: 2.50

Data in Table 1 shows the mean responses of the respondents on the extent digital technologies are used in the teaching and learning of environmental education in University of Port Harcourt. From the analysis done, it can be seen that only 1 out of 5 stipulated items were agreed with. This therefore shows that digital technologies are not adequately used in the teaching and learning of environmental education, as students are only aware of LMS, Zoom and Google Classroom.

Research Question 2. What are the benefits of using digital tools in the teaching and learning of environmental education in University of Port Harcourt?

Table 2: Mean responses on the benefits of using digital tools in teaching and learning environmental education in University of Port Harcourt? (n = 360)

S/N	Questionnaire Item	SA 4	A 3	D 2	SD 1	(X)	Std.Dev	Decision
6	Digital tools make teaching more interactive and engaging.	160	130	50	20	3.19	0.83	Agree
7	Students learn faster and retain more when digital content is used.	150	120	60	30	3.08	0.88	Agree
8	Digital platforms improve students' access to relevant learning materials.	140	120	70	30	3.03	0.90	Agree
9	Digital learning allows for more flexibility in teaching and learning schedules.	130	110	80	40	2.94	0.95	Agree
10	Integration of technology helps in achieving better learning outcomes.	125	115	85	35	2.92	0.96	Agree

Criterion Mean: 2.50

Data in Table 2 shows the mean responses of the respondents on the benefits of using digital tools in the teaching and learning of environmental education in University of Port Harcourt. From the analysis done, it can be seen that all the 5 items are above the criterion mean of 2.5, which means that digital tools make teaching more interactive and engaging, students learn faster, digital platforms improve students access to relevant learning materials and integration helps in achieving better learning outcomes.

Research Question3: What are the challenges faced by both lecturers and students in using digital tools for environmental education at the University of Port Harcourt?

Table 3: Mean responses on the challenges faced by both lecturers and students in using digital tools for environmental education at the University of Port Harcourt? (n = 360)

S/N	Questionnaire Item	SA 4	A 3	D 2	SD 1	(X)	Std.Dev	Decision
11	Lack of adequate digital infrastructure (e.g., internet, devices) affects implementation.	180	120	40	20	3.28	0.81	Agree
12	There is insufficient ICT training for lecturers and students.	160	130	50	20	3.19	0.83	Agree

13	Power supply issues hinder effective use of digital tools.	155	125	55	25	3.14	0.87	Agree
14	There is low motivation among staff to adopt digital tools.	100	120	90	50	2.67	1.01	Agree
15	Technical support is not always available when needed.	110	115	85	50	2.70	0.99	Agree

Criterion Mean: 2.50

Data in Table 3 shows the mean responses of the respondents on the challenges faced by both lecturers and students in using digital tools for environmental education at the University of Port Harcourt. From the analysis done, it can be seen that all the items raised were above the criterion mean of 2.5. This therefore shows that digital technologies are not adequately used in the teaching and learning of environmental education, as students are only aware of LMS, Zoom and Google

Classroom.

Research Question 4. What strategies can be used to effectively implement the use of digital technologies in enhancing teaching and learning environmental education in University of Port Harcourt?

Table 4: Mean responses on the strategies that can be used to effectively implement the use of digital technologies in enhancing teaching and learning environmental education in University of Port Harcourt? (n = 360)

S/N	Questionnaire Item	SA 4	A 3	D 2	SD 1	(X)	Std.Dev	Decicion
16	Training and capacity building. Lecturers and students should receive regular training on the use of digital tools.	140	120	70	30	3.03	0.90	Agree
17	Curriculum integration. Digital technologies should be integrated into environmental education curriculum at all levels.	170	130	40	20	3.25	0.79	Agree
18	Technical support system. The university should provide technical support to lecturers and students.	180	120	40	20	3.28	0.81	Agree
19	Collaborations and partnerships. partnerships with environmental agencies and technology providers can help improve access to relevant digitals tools and training.	110	115	85	50	2.70	0.99	Agree
20	A combination of traditional classroom teaching and online learning enhances the delivery of environmental education.	125	115	85	35	2.92	0.96	Agree

Criterion Mean: 2.50

Data in Table 4 shows the means response of the respondents on the strategies that can be used to effectively implement the use of digital technologies in enhancing teaching and learning environmental education in University of Port Harcourt. The criterion means in all the item raised are above 2.5, which implies that the respondent agreed to the fact that training and capacity building, curriculum integration, technical support system, collaboration and partnership and a combination of traditional classroom teaching and online learning are all strategies that can be used to implement the use of digital strategies in environmental education.

V. Discussion of Findings

This study investigated the role of digital transformation in enhancing teaching and learning in Environmental Education at the University of Port Harcourt. The discussion of findings is organised around the three research questions.

Awareness and Usage of Digital Technologies

Finding from the first research question revealed a high level of awareness of digital tools such as Zoom, Google Classroom, and Learning Management Systems. Respondents also strongly agreed that digital tools enhance teaching and learning outcomes. However, actual usage of digital platforms, access to digital resources and training opportunities scored significantly lower. This indicates that while awareness exists, practical integration and support for usage remain low.

These results align with studies such as Ogolodom et al. (2022) who found that many students in Nigerian universities became more familiar with digital learning tools during the COVID-19 pandemic due to the necessity of online classes. Also, Emma-Okon et al. (2024) noted that while students could navigate platforms such as Zoom, Google Classroom, and Microsoft Teams, there was limited understanding of advanced functionalities that could enhance interactivity and self-directed learning. These shows that many institutions in Nigeria show enthusiasm for digital transformation but face challenges in resource usage. The implication is that while lecturers and students understand the importance of digital tools, they may lack the capacity or institutional support to implement them effectively.

Benefits of Digital Tools in Teaching and Learning

The second research question focused on the benefits of digital tools in terms of teaching and learning. All five items in this category showed moderate mean scores indicating that respondents generally acknowledge the value of digital tools in improving student engagement, flexibility, access to resources and helps in achieving better learning outcomes.

This supports the findings of Oshodi (2022) who states that digital tools provide opportunities for students to access learning materials anytime and anywhere, making it easier to balance studies with other commitments while ensuring continuity in learning. Also, Ubabuike and Ojechi (2025) supports the findings by stating that digital learning tools significantly improve student engagement and content retention meaning environmental science concepts are understood and remembered more effectively.

Challenges in Implementing Digital Transformation

For the third research question, the analysis identified several moderate to severe challenges impeding digital transformation. Notably, inadequate infrastructure insufficient ICT training and erratic power supply were ranked as the most pressing issues. These were followed by low motivation to adopt digital tools and limited technical support.

These findings are consistent with the work of Ogolodom et al. (2022) who found that many students struggle with financial constraints, lack of consistent internet connectivity, and limited mobile data, which hinder their ability to participate effectively in online learning. Also, Adekoya et al. (2024), confirmed that educators in Nigerian universities are willing to adapt to e-learning but are constrained by unreliable power supply, poor internet connectivity, and inadequate institutional infrastructure. These issues reduced the effectiveness of live teaching sessions, delayed feedbacks, and limiting the use of advanced teaching tools such as simulations or real-time data analysis platforms often required in environmental science courses. Without addressing these core structural challenges, digital transformation will likely remain a superficial effort rather than a deeply integrated solution in environmental education.

Strategies to effectively implement the use of digital technologies

Finding from the fourth research question indicates that there are several strategies that could be used in implementing digital technologies in the teaching and learning of environmental education in University of Port-Harcourt and they include training and capacity building, curriculum integration, technical support system, collaboration and partnership and a combination of traditional classroom teaching and online learning. For example, National open University of Nigeria (NOUN) built a full featured online learning platform, mobile access, course video and network of study centers to support students

This is in line with the works of Adekoya et al. (2024) who is of the opinion that training programmes should go beyond basic computer skills but rather focus on environmental-specific technologies such as Geographic Information Systems (GIS), remote sensing tools, environmental modelling software, and virtual lab simulations and also Emma-Okon et al. (2024) who note that hybrid approaches help maintain interaction while providing access to rich multimedia resources that combining online and the traditional method of teaching. Ahmadu Bello University, Zaria Distance Learning Programme have employed a visual learning environment (LMS), Webinar, Structured course ware, discussion forum and blended components to enhance teaching and learning

Overall, while the awareness and perceived benefits of digital transformation are encouraging, practical usage is hindered by real challenges such as training gaps, infrastructure deficits, and technical constraints. This suggests a need for strategic investment in digital capacity building, including staff development, infrastructure upgrades, and policy reform to fully harness the benefits of digital education in the University of Port Harcourt.

VI. Conclusion

This study examined how digital transformation can enhance teaching and learning in Environmental Education at the University of Port Harcourt. The findings revealed a promising level of awareness and acknowledgment of the benefits of digital tools among both students and lecturers. However, the study also uncovered significant gaps in practical usage, access to digital resources, training, and institutional support.

While respondents generally agreed that digital tools can make teaching more engaging and improve learning outcomes, the persistent challenges such as poor infrastructure, inadequate ICT training, and unreliable power supply limit the full realisation of these benefits. These findings point to a digital divide between awareness and actual implementation. Digital transformation holds great potential to revolutionise environmental education, but to unlock this potential, strategic actions must be taken. It is not enough

to introduce digital tools; universities must provide the necessary training, infrastructure, and motivation to ensure these tools are effectively used.

VII. Recommendations

Based on the findings of the study, the following recommendations are proposed:

1. Management of Nigerian institutions of learning must invest in digital infrastructural upgrade i.e. reliable internet access, modern computers, digital classrooms, and power backup systems, especially within faculties that teach environmental education.
2. The Institutions of Learning should organise continuous ICT training for both staff and students regularly on the effective use of digital tools and platforms. Workshops, seminars, and hands-on training sessions should be institutionalised to build digital confidence and competence.
3. The Management of Higher Institutions should motivate and incentivise Digital Adoption; such as recognition, digital teaching grants, or workload adjustments to encourage lecturers to adopt and innovate with digital technologies in their teaching.
4. Develop Policy and Strategic Framework: University management should create a clear digital transformation policy tailored to the needs of Environmental Education with periodic monitoring and evaluation to ensure accountability.

References

1. Adekoya, A. O., Adesegun, O. A., Adekoya, A. O., Abolurin, O. O., Ehioghae, O., Idowu, A. O., & Ogunlesi, T. A. (2024). Integrating e-learning into the educational framework for undergraduate medical training: a Nigerian survey on trainers' perception and readiness. *Pan African Medical Journal*, 49(50). <https://doi.org/10.11604/pamj.2024.49.50.42398>
2. Brooks, D. C. and M. McCormack. (2020) Driving Digital Transformation in Higher Education. Educause.
3. Dede, C. (2014). The Role of Digital Technologies in Deeper Learning. Students at the center: Deeper Learning Research Series. Jobs for the Future.
4. Emma-Okon, B., Tombs, M., Akomolafe, R., & Ayannuga, O. (2024). Teaching pre-clinical medical students remotely in Nigeria post COVID-19 pandemic: can past experiences shape future directions? *BMC Medical Education*, 24(515). <https://doi.org/10.1186/s12909-024-05508-w>
5. Ferreira, C. M., Oliveira, I. M., & Pires, A. (2024). Enhancing Earth and Environmental Science undergraduate students' skills through GIS. *Education Sciences*, 14(9), 1026. <https://doi.org/10.3390/educsci14091026>
6. Hajj-Hassan, M., Chaker, R., and Cederqvist, A. M. (2004). Environmental Education: A systematic Review on the Use of Digital Tools for Fostering Sustainability Awareness. *Sustainability*. 16(9) 3733. <https://doi.org/10.3390/su16093733>
7. Markowitz, D. M., Laha, R., Perone, B. P., Pea, R. D., & Bailenson, J. N. (2018). Immersive virtual reality field trips facilitate learning about climate change. *Frontiers in Psychology*, 9, 2364. <https://doi.org/10.3389/fpsyg.2018.02364>
8. Ogolodom, M. P., Mbaba, A. N., Okpaleke, M. S., Chukwueze, I. O., Okankwu, E. A., Joseph, D. Z., & Orevaoghene, O. E. (2022). Online learning in Nigerian universities during the COVID-19 pandemic: the experiences of nursing and radiography undergraduate students. *Journal of Radiology Nursing*, 42(1), 128–135. <https://doi.org/10.1016/j.jradnu.2022.08.012>
9. Oshodi, I. K. (2022). A review of the impact of Education Technology in developing countries: A case study of Nigeria. DOI: 10.13140/RG.2.2.10596.30084. Retrieved from <https://www.researchgate.net/publication/357814372>. A review of the impact of Education Technology in developing countries. A case study of Nigeria.
10. Selwyn, N. (2021). *Education and Technology: Key Issues and Debates* (2nd ed.). Bloomsbury Academic *International Review of Education*. DOI:10.1007/s1159-022-09971-9
11. Shin, D., Jung, S., Kim, C., & Lee, H. (2023). Designing immersive virtual reality simulation for environmental education. *Electronics*, 12(2), 315. <https://doi.org/10.3390/electronics12020315>
12. Tilbury, D. (2020). Reorienting higher education for sustainable development: Imperatives and priorities. *Journal of Environmental Studies and Sciences*, 10(3), 157-168. <https://doi.org/10.1007/s13412-020-00591-4>
13. Ubabuike, J. C., & Ojechi, P. C. (2025). The impact of digital learning tools on students' engagement and retention in public secondary schools in Anambra State, Nigeria. *International Journal of Education Research and Scientific Development*, 8(1), 115–125. DOI: 10.59795/ijersd.v8i1.252. Retrieved from <https://ijersd.net/index.php/IJRES/article/view/252>
14. Udeze, A. N., & Adesola, T. A. (2024). Learning Technologies: Its Role and Challenges on Students' Learning in Nigeria. *International Journal of Library Science and Educational Research*, 4(8). Retrieved from <https://cambridgeresearchpub.com/ijlser/article/view/280>
15. Uzorka, A., & Odebiyi, O. A. (2025). Impact of Digital Learning Tools on Student Engagement and Achievement. *Journal of Digital Learning and Distance Education*. DOI: 10.56778/jdlde.v4i1.511. Retrieved from <https://rjupublisher.com/ojs/index.php/JDLDE/article/view/511>
16. UNESCO. (2017). *Education for Sustainable Development Goals: Learning objectives*. UNESCO Publishing. <https://unesdoc.unesco.org/ark:/48223/pf0000247444>
17. UNESCO. (2021). *Education for Sustainable Development: A roadmap*. United Nations Educational, Scientific and Cultural Organization. <https://unesdoc.unesco.org/ark:/48223/pf0000374802>