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# Enhancing Educational Outcomes through ICT: A Mixed-Methods and Machine Learning Study of Public Secondary Schools in Lagos

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## ABSTRACT

The integration of Information and Communication Technology (ICT) into teaching is increasingly being recognised as a critical driver of educational quality, yet its practical impact within Nigerian public secondary schools remains underexplored. This study investigates the availability of ICT infrastructure, teachers' competence, and the effectiveness of ICT tool utilisation across twelve public secondary schools in the Ibeju-Lekki Local Government Area, Lagos State. A total of 162 teachers participated, and data were collected using a structured four-point Likert-scale questionnaire. Descriptive statistics and Pearson Product–Moment Correlation were employed to examine the relationships among key variables. To complement the traditional analysis, a machine learning extension was introduced: a Random Forest Classifier was trained on the actual dataset to predict student academic performance levels—categorised as Low, Medium, and High—based on ICT-related teacher metrics. While the predictive model achieved modest classification accuracy (~30%), its integration demonstrates the potential of combining statistical inference with algorithmic modeling to offer both explanatory and predictive insights. The findings highlight the critical need for holistic policy and practice strategies that integrate infrastructure investment, teacher development, and data-driven planning to enhance the impact of ICT on educational outcomes.

**Keywords:** *ICT integration; machine learning; teacher competence; predictive modeling; student performance; Random Forest; public secondary schools*

## INTRODUCTION

Information and Communication Technology (ICT) has become a cornerstone of contemporary education. It has revolutionised how content is delivered, how learners engage with materials, and how schools operate at systemic levels. Globally, the integration of ICT into education is being driven by the need to equip learners with 21st-century skills, including digital literacy, critical thinking, and problem-solving capabilities (UNESCO, 2023; Alqahtani et al., 2023). The growing emphasis on student-centred learning has also prompted the adoption of ICT-based instructional strategies that support flexible, collaborative, and differentiated learning experiences.

ICT encompasses a wide array of digital tools and platforms—ranging from computers, tablets, and Internet connectivity to multimedia software, online learning management systems, and educational mobile applications. It supports not only academic instruction but also administrative tasks such as student data management, communication with parents, and performance analytics (Akinyemi, Adelana & Olurinola, 2022). Importantly, the availability of virtual learning environments (VLEs) has blurred traditional boundaries of time and space, allowing students to access learning content from virtually anywhere (Falore & Oredein, 2023). In this regard, ICT is increasingly seen not as a supplementary tool but as an essential infrastructure in education.

In light of these dynamics, it becomes crucial to examine ICT use in specific educational contexts to identify what works, what doesn't, and why. Lagos State - Nigeria's commercial and educational hub - presents a particularly interesting case due to its diversity and urban-rural divide. Within the state, Ibeju-Lekki Local Government Area offers a unique context where rapid development

coexists with infrastructural limitations. Understanding how ICT is being implemented in public secondary schools in this area can provide valuable insights for scaling up ICT integration in similar regions.

Therefore, this study investigates the impact of the effective use of ICT tools in teaching within public secondary schools in Ibeju-Lekki. It aims to assess the availability of ICT infrastructure, evaluate teachers' competence and readiness, and explore the implications of ICT use on teacher metrics of student academic performance. The findings will contribute to evidence-based policy and practice, helping to bridge the gap between technological possibilities and educational realities in Nigeria.

## LITERATURE REVIEW

### ICT Integration in Education

The successful integration of ICT into classroom practice depends significantly on how well teachers are prepared and supported to use these tools. Research has consistently demonstrated that teacher competence, self-efficacy, and attitudes toward technology are among the most critical determinants of whether ICT is effectively used in schools (Ikhlas & Rosa, 2023; Bingimlas, 2009). For ICT to enhance learning, it must be embedded within pedagogically sound frameworks that support active engagement, feedback, collaboration, and personalised instruction (Adedoyin & Soykan, 2020). This requires not just access to hardware and software, but also a systemic commitment to teacher professional development, infrastructure investment, and policy implementation.

In the Nigerian context, integrating ICT into public education presents both opportunities and challenges. While there has been noticeable progress in promoting digital literacy and expanding Internet access in urban areas, significant disparities persist across local government areas (Bakare & Olanrewaju, 2023). Many schools, especially those in under-resourced settings, still struggle with outdated or insufficient ICT infrastructure, erratic power supply, and limited Internet connectivity (George & Ige, 2022). Even when ICT tools are available, studies show they are often underutilised due to a lack of confidence or training among teachers (Yusuf et al., 2023).

Another pressing issue is the mismatch between teacher training and current technological demands. A large proportion of Nigerian educators were trained in traditional settings where ICT was not a component of pedagogical preparation (Ibrahim et al., 2021). As a result, many teachers have difficulty adapting their instructional methods to incorporate digital tools effectively. This disconnect poses a serious threat to efforts aimed at digitising public education and achieving equitable learning outcomes across the country. Furthermore, the existing national and state policies on ICT in education often lack effective implementation strategies and monitoring mechanisms.

Despite these challenges, there is evidence to suggest that when properly implemented, ICT can significantly improve learning outcomes. It facilitates immediate feedback, enhances student motivation, promotes collaboration, and supports differentiated instruction for learners with varied abilities (Alhassan & Adeyinka, 2020; Eze & Ani, 2022). Moreover, the development of students' digital competence is vital for employability in a rapidly evolving global economy. As such, governments and stakeholders are increasingly recognising the need for coordinated investments in infrastructure, training, and curriculum development that align with global best practices in digital education.

### Conceptual Perspectives on ICT Adoption in Education

The success of ICT integration is not solely a function of infrastructure or access but is deeply intertwined with teachers' pedagogical beliefs and capacity to integrate technology meaningfully. The Technological Pedagogical Content Knowledge (TPACK) framework, developed by Mishra and Koehler (2006), provides a useful lens to understand this dynamic. TPACK emphasises that effective technology integration occurs at the intersection of technological knowledge, pedagogical strategies, and content expertise. Teachers who possess strong TPACK are more likely to adapt digital tools in ways that enhance instructional effectiveness and student engagement.

In addition, the Technology Acceptance Model (TAM) (Davis, 1989) offers a behavioural perspective by highlighting two core factors - perceived usefulness and perceived ease of use - that influence a teacher's decision to adopt and consistently use ICT tools. Several studies in the Nigerian context, such as, Ibrahim & Shiring (2022) and Yusuf & Folorunso (2021), have shown that positive perceptions aligned with TAM principles predict greater adoption rates among educators.

These theoretical models provide explanatory depth for interpreting the study's findings: teachers with higher competence and proficiency are likely those who have achieved sufficient technological self-efficacy (TAM) and integrated ICT across pedagogical content areas (TPACK), enabling more effective utilisation in the classroom.

### Machine Learning in Education

In recent years, the application of machine learning in education has gained momentum, enabling researchers to uncover patterns in student behavior, predict learning outcomes, and personalise instruction. Baker & Inventado (2014) outlined the foundations of educational data mining (EDM), highlighting classification techniques such as decision trees and ensemble models in academic performance prediction. Romero & Ventura (2020) provided an extensive review of machine learning algorithms in learning analytics, noting the suitability of Random Forest for handling multidimensional educational data. These studies show that when used appropriately, machine learning can complement traditional methods by offering predictive insights that inform educational policy and intervention strategies.

Machine learning techniques have thus become increasingly important in education, particularly for predicting student performance based on instructional and contextual variables. Their use adds a valuable forward-looking lens to conventional correlation-based research and has growing relevance in contexts like Nigeria, where data-driven planning is essential for scaling access and improving quality.

## METHODOLOGY

This study adopted a descriptive survey research design, with a total of 162 teachers selected from 12 public secondary schools across Ibeju-Lekki Local Government Area of Lagos State using simple random sampling techniques. Data were collected using a self-structured questionnaire designed on a four-point Likert Scale, which captured variables such as ICT tool availability, teacher competence, proficiency, effective utilisation, and perceived impact on student academic performance.

The data collected were analysed using descriptive statistics (percentages for demographic data, mean and standard deviation for research questions) and inferential statistics. Specifically, the Pearson Product–Moment Correlation (PPMC) was used to test the relationships between ICT

availability, teacher competence, proficiency, effective utilisation, and teacher metrics of student academic performance.

To complement this traditional analysis, a machine learning model was also developed using the actual dataset. A Random Forest Classifier was employed to predict student academic performance levels—categorised as *Low*, *Medium*, and *High*—based on the four ICT-related teacher variables. The model was trained and evaluated using an 80/20 data split, and its performance was measured using standard metrics including precision, recall, F1-score, and accuracy. While the classifier achieved modest predictive accuracy (~30%), its inclusion underscores the potential of leveraging real-world educational data for predictive modeling. This hybrid approach strengthens the explanatory depth of the study and introduces a forward-looking, data-driven dimension to understanding ICT integration in public education.

## RESULTS

**Hypothesis 1:** Relationship between Availability of ICT Tools and Effective Utilisation of ICT Tools for Teaching

Table 1 presents the descriptive and inferential statistics assessing the relationship between the availability of ICT tools and their effective utilisation for teaching in public schools in Ibeju-Lekki Local Government Area.

***Table 1:*** *Pearson Correlation between Availability of ICT Tools and Effective Utilisation*

| **Variables** | **Mean** | **SD** | **N** | **df** | **r-cal.** | **r-crit.** | **p-value** | **Decision** |
|---|---|---|---|---|---|---|---|---|
| Availability of ICT Tools | 18.47 | 2.98 | | | | | | |
| Effective Utilisation of ICT | 13.72 | 2.66 | 162 | 160 | 0.41 | 0.138 | 0.002 | $H_{01}$ Rejected |

The Pearson correlation coefficient (r = 0.41, p = 0.002) indicates a moderate positive relationship between availability of ICT tools and their effective utilisation. As the calculated correlation exceeds the critical value (r-critical = 0.138) at df = 160 and $p < 0.05$, the null hypothesis is rejected. This suggests **a statistically significant association**: schools with greater availability of ICT resources are more likely to utilise them effectively in teaching.

**Hypothesis 2:** Relationship between Teachers' Competence and Effective Utilisation of ICT Tools for Teaching

Table 2 presents the analysis of the relationship between teachers' competence in the use of ICT tools and the extent to which these tools are effectively used in classroom instruction.

***Table 2:*** *Pearson Correlation between Teachers' ICT Competence and Effective Utilisation*

| **Variables** | **Mean** | **SD** | **N** | **df** | **r-cal.** | **r-crit.** | **p-value** | **Decision** |
|---|---|---|---|---|---|---|---|---|
| Teachers' ICT Competence | 20.18 | 2.41 | | | | | | |
| Effective Utilisation | 13.72 | 2.66 | 162 | 160 | 0.76 | 0.138 | 0.001 | $H_{02}$ Rejected |

The result reveals a strong positive correlation (r = 0.76, p = 0.001) between teachers' competence in ICT and its effective utilisation. Since the calculated r-value is substantially higher than the critical value and the p-value is less than 0.05, the null hypothesis is rejected. This finding implies a **significant relationship**: higher levels of teacher ICT competence are associated with greater effectiveness in the use of technology for teaching.

**Hypothesis 3: Relationship between Teachers' Proficiency in ICT Usage and Effective Utilisation of ICT Tools**

Table 3 presents data on the relationship between teachers' proficiency in ICT usage and how effectively these tools are applied in teaching.

***Table 3:*** *Pearson Correlation between Teachers' ICT Proficiency and Effective Utilisation*

| Variables | Mean | SD | N | df | r-cal. | r-crit. | p-value | Decision |
|---|---|---|---|---|---|---|---|---|
| Teachers' ICT Proficiency | 19.92 | 2.87 | | | | | | |
| Effective Utilisation | 13.72 | 2.66 | 162 | 160 | 0.48 | 0.138 | 0.003 | $H_{03}$ Rejected |

The analysis yields a moderate positive correlation (r = 0.48, p = 0.003), which is statistically significant at the 0.05 level. With the observed correlation greater than the critical value and a p-value below the threshold, the null hypothesis is rejected. This implies that teachers with higher proficiency in ICT usage tend to utilise ICT tools more effectively in their instructional practices.

**Hypothesis 4:** Relationship between Use of ICT for Teaching and teacher metrics on Student Academic Performance

Table 4 summarises the relationship between teachers' use of ICT for teaching and students' academic performance.

***Table 4:*** *Pearson Correlation between ICT Use and Student Academic Performance*

| Variables | Mean | SD | N | df | r-cal. | r-crit. | p-value | Decision |
|---|---|---|---|---|---|---|---|---|
| Use of ICT for Teaching | 19.92 | 2.87 | | | | | | |
| Student Academic Performance | 15.45 | 3.67 | 162 | 160 | 0.23 | 0.138 | 0.002 | $H_{04}$ Rejected |

The correlation analysis shows a weak but statistically significant positive relationship between use of ICT for teaching and student academic performance (r = 0.23, p = 0.002). Given that the r-calculated value exceeds the r-critical value and p < 0.05, the null hypothesis is rejected. This indicates a positive association, although modest, suggesting that increased ICT use in instruction is related to improved student academic outcomes.

**DISCUSSION**

The findings of this study collectively highlight the foundational and interconnected roles of ICT availability, teacher competence, and proficiency in shaping effective technology integration for teaching in public secondary schools.

First, the study established a moderate, statistically significant relationship between the availability of ICT tools and their effective utilisation ($r = 0.41$, $p = 0.002$). This finding substantiates global and local assertions that without access to hardware and digital resources, pedagogical ICT adoption is nearly impossible (UNESCO, 2023; Alqahtani et al., 2023). The result affirms the work of Bello & Agbo (2023), who observed that ICT availability directly affects usage levels in Lagos State schools. Similar findings have emerged from studies conducted in comparable urban districts, indicating that infrastructure is a precondition for successful ICT integration.

Second, a strong and statistically significant correlation was observed between teachers' ICT competence and their effective utilisation of technology ($r = 0.76$, $p = 0.001$). This aligns with recent empirical studies by Baytar et al. (2023) and Yusuf et al. (2023), which report that teachers' digital competence is the strongest predictor of meaningful ICT integration in Nigerian classrooms. This supports the broader claim that teacher training and capacity-building programmes are central to digital education reform (Khan, 2025).

The third hypothesis revealed a moderate positive relationship between teachers' proficiency in ICT usage and effective classroom integration ($r = 0.48$, $p = 0.003$). This result supports prior findings by Adegbija, Fakeye & Bakare (2020) and Enoch et al. (2023), who noted that the frequency and depth of ICT tool usage significantly influenced how confidently teachers incorporated these tools into pedagogy. Proficiency, distinct from general competence, reflects active engagement with technology over time and underlines the importance of practical, hands-on training rather than theoretical exposure alone.

Lastly, the study found a significant but weak correlation between the use of ICT for teaching and student academic performance ($r = 0.23$, $p = 0.002$). This confirms studies such as Adedoyin & Soykan (2020) and Eze & Ani (2022), which suggested that ICT can enhance learning outcomes when paired with appropriate pedagogy. However, the modest strength of the relationship suggests that ICT is not a silver bullet. Other factors such as, curriculum relevance; classroom management; and learner motivation; moderate the effects of ICT usage on performance.

While previous studies such as Adekunle, Adepoju & Abdullahi (2015) have shown mixed or non-significant results regarding ICT and academic achievement, the growing evidence base, especially post the COVID-19 pandemic, reinforces the value of digital learning environments in enhancing engagement and expanding access to resources (Abdi & Abdi, 2025; UNESCO, 2023)

**Model Performance Interpretation**

While the Random Forest Classifier achieved a classification accuracy of approximately 30%, this performance should be interpreted in light of the task complexity and data structure. The dataset categorised student academic performance into three roughly balanced classes — Low, Medium, and High; meaning that random guessing would yield a baseline accuracy of approximately 33%. Therefore, the model's current performance is close to, but slightly below, the chance level, indicating limited predictive power with the available features.

However, the machine learning model offers more than just accuracy. The feature importance analysis revealed that teacher competence and effective utilisation of ICT tools were the strongest predictors of student performance classification, followed by ICT availability and proficiency. This insight aligns with the correlational analysis and reinforces the model's interpretive value, even if its predictive accuracy remains modest.

The modest performance highlights the limitations of relying solely on teacher-side ICT metrics to predict academic outcomes, suggesting the need for more granular, multi-dimensional datasets. Future models may benefit from incorporating additional variables such as subject area, student

engagement levels, socio-economic context, school leadership support, and classroom interaction data to significantly improve predictive accuracy and reliability.

**Limitations of the Study**

Despite the valuable insights this study offers on ICT integration and predictive modeling in public secondary schools, certain limitations must be acknowledged.

First, the sample was drawn from twelve schools within a single local government area (Ibeju-Lekki), which, while diverse, may not fully represent the broader spectrum of Nigerian public secondary schools. Regional disparities in infrastructure, teacher training, and policy enforcement could influence the generalisability of the findings.

Second, the data on student academic performance were based on teacher perceptions rather than direct assessment scores or centralised academic records. While teacher evaluations are informative, they may carry subjective biases or lack uniformity in assessment criteria.

Third, the machine learning model employed (Random Forest Classifier) was trained on a relatively small dataset (n = 162), which limits its predictive power and increases the risk of overfitting. Although the model achieved moderate interpretive value through feature importance analysis, its classification accuracy (~30%) fell slightly below the baseline for random guessing (33% for balanced classes). Larger and more diverse datasets would be needed to improve model performance.

Additionally, the study focused exclusively on teacher-related ICT variables and did not include learner-level data such as motivation, engagement, or digital access outside school. These factors are known to influence both ICT usage and academic outcomes and could be considered in future studies to build more robust predictive models.

**CONCLUSION**

This study has demonstrated that the integration of ICT into teaching practices in public secondary schools in Ibeju-Lekki Local Government Area is significantly influenced by interrelated factors: the availability of ICT infrastructure, teacher competence, and the practical proficiency of educators. These variables were found to be positively and significantly associated with the effective utilisation of ICT tools in the classroom.

Although the correlation between ICT uses and student academic performance was modest, it was statistically significant, suggesting that ICT, when effectively integrated into instruction, can contribute to improved learning outcomes. However, this effect is mediated by contextual variables such as pedagogical quality, curriculum alignment, and professional support systems.

Beyond correlation analysis, this study also employed predictive modeling using a Random Forest Classifier trained on the actual dataset. The model aimed to classify student performance outcomes based on ICT-related teacher factors. While the classifier achieved a predictive accuracy of approximately 30%, its integration represents a methodological advancement by introducing computational intelligence into educational research. The use of real-world data for prediction offers a shift from descriptive to actionable analytics—supporting forward-looking educational planning and resource allocation.

Future research should expand on this approach by incorporating a broader set of predictive features, such as subject area differences, classroom size, frequency of ICT training, and school-level contextual variables. This would help enhance model accuracy and allow stakeholders to better anticipate and address barriers to effective ICT integration.

## RECOMMENDATIONS

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

1. **Targeted Professional Development**: Government and school authorities should regularly organise workshops, seminars, and in-service training focused on ICT pedagogical integration, not just technical know-how. These should be embedded into ongoing teacher development cycles.

2. **Enforce and Monitor ICT Policy Implementation**: Ministries of Education and school boards should actively implement the national ICT in education policy. This includes setting clear expectations, monitoring usage, and offering incentives for technology integration.

3. **Compulsory Digital Literacy Curriculum**: School management should ensure that digital literacy is integrated across subjects, with computer education made a core part of the curriculum from early secondary levels to encourage both teachers and students to engage consistently with technology.

4. **Equitable Infrastructure Provision**: State and local governments, in partnership with private sector stakeholders, should ensure that all secondary schools are equipped with adequate ICT infrastructure, including computers, projectors, and reliable internet access, with provisions for regular maintenance.

5. **Sustainability and Local Ownership**: School ICT committees should be empowered to coordinate localised efforts, monitor usage, and drive context-relevant innovation. Schools must also receive technical support staff to maintain equipment and assist teachers.

6. **Further Research and Monitoring:** Longitudinal and mixed-method research is encouraged to explore how ICT affects learning trajectories over time, as well as how variables such as socio-economic status, teacher experience, and digital culture impact implementation success.

## REFERENCES

Abdi, A. S. and Abdi, I. A. (2025). Factors affecting school teacher's knowledge, attitude and integration of ict in education in mogadishu, somalia.. https://doi.org/10.21203/rs.3.rs-6096621/v1

Adedoyin, O. B. & Soykan, E. (2020) 'Covid-19 pandemic and online learning: the challenges and opportunities', *Interactive Learning Environments*, pp. 1–13. https://doi.org/10.1080/10494820.2020.1813180

Adegbija, M. V., Fakeye, D. O. & Bakare, R. A. (2020) 'An assessment of the use of mobile learning (m-learning) tools in teaching English language in senior secondary schools in Ibadan', *KIU Journal of Social Sciences*, vol. 6, no. 1, pp. 101–107.

Adekunle, S. E., Adepoju, S. A., & Abdullahi, M. B. (2015). Perception of students on computer utilization and academic performance in the north-central geopolitical zone of Nigeria. *International Journal of Modern Education and Computer Science*, vol. 7, no. 4, pp. 53-60. https://doi.org/10.5815/ijmecs.2015.04.06

Aderonmu, M. O. & Ejeba, D. (2020) 'Smart education in Nigeria: Challenges and prospects, *International Journal of Engineering and Management Research*, vol. 10, no. 3, pp. 1–8.

Adukaite, A., van Zyl, I. & Cantoni, L. (2017) 'The role of digital technology in tourism education: A case study of South African secondary schools', *Journal of Hospitality, Leisure, Sport & Tourism Education*, vol. 21, pp. 15–26. https://doi.org/10.1016/j.jhlste.2017.07.001

Akinyemi, A. L., Adelana, O. P. & Olurinola, O. D. (2022) 'Use of infographics as teaching and learning tools: Survey of pre-service teachers' knowledge and readiness in a Nigerian university', *Journal of ICT in Education*, vol. 9, no. 1, pp. 117–130. https://doi.org/10.37134/jictie.vol9.1.10

Alhassan, A. A., & Adeyinka, A. (2020). Information and communication technology for enhanced learning outcomes in education: An analysis of teacher professional development. *Journal of Computer Assisted Learning,* vol. 36, no. 3, pp.482–498. https://doi.org/10.1111/jcal.12442

Alqahtani, A. S., Rajab, L. D. & Alshahrani, F. M. (2023) 'Digital learning in the 21st century: A global perspective', *Education and Information Technologies*, vol. 28, no. 2, pp. 1753–1771. https://doi.org/10.1007/s10639-023-11394-4

Bakare, O. O. & Olanrewaju, O. J. (2023) 'Teachers' attitude and utilization of ICT integration in Social Studies teaching in Ile-Ife upper basic schools', *Ilorin Journal of Education*, vol. 42, no. 2, pp. 52–59.

Baker, R. S. J. d. & Inventado, P. S. (2014) 'Educational data mining and learning analytics', in Larusson, J. A. & White, B. (eds.) *Learning Analytics: From Research to Practice*. New York: Springer, pp. 61–75. https://doi.org/10.1007/978-1-4614-3305-7_4

Baytar, E. M., Elyacoubi, H., Saqri, N., & Ouchaouka, L. (2023). Teachers' sense of competence in terms of ICT use: the case of secondary school teachers. *Research in Learning Technology*, vol. 31. https://doi.org/10.25304/rlt.v31.2874

Bello, A. O., & Agbo, J. (2023). Assessing ICT strategy implementation in education: A review of current practices. *International Journal of Learning and Teaching in Higher Education, 23*(1), 11–29. https://doi.org/10.1007/s40561-022-00300-5

Bingimlas, K. (2009). Barriers to the successful integration of ICT in teaching and learning environments: a review of the literature. *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 5, no. 3. https://doi.org/10.12973/ejmste/75275

Davis, F. D. (1989) 'Perceived usefulness, perceived ease of use, and user acceptance of information technology', *MIS Quarterly*, vol. 13, no. 3, pp. 319–340. https://doi.org/10.2307/249008

Enoch, L. C., Abraham, R. M. & Singaram, V. S. (2023): Factors That Enhance and Hinder the Retention and Transfer of Online Pre-Clinical Skills Training to Facilitate Blended Learning, *Advances in Medical Education and Practice*, vol. 14, pp. 919-936. https://doi.org/10.2147/AMEP.S398376

Eze, M. O., & Ani, O. E. (2022). Challenges and opportunities for ICT integration in education: A study of the Sub-Saharan African context. *International Journal of Education and Development using Information and Communication Technology,* vol. 18, no. 2, pp. 41–58.

Falore, J. O. & Oredein, A. O. (2023) 'Digital teachers' competence, virtual classroom management and secondary school students' attitude during COVID-19 in Lagos State', *Lead City University Journal of Education*, vol. 2, no. 2, pp. 93–104.

George, A. P. & Ige, N. A. (2022) 'Availability of ICT resources and utilization in Lagos State basic schools', *International Journal of Academic Multidisciplinary Research*, vol. 6, no. 12, pp. 198–207.

Griffin, P. & Care, E. (2015) *Assessment and Teaching of 21st Century Skills: Methods and Approach*. Dordrecht: Springer. https://doi.org/10.1007/978-94-017-9395-7

Griffin, P., Care, E. & McGaw, B. (2012) *Assessment and Teaching of 21st Century Skills*. Dordrecht: Springer. https://doi.org/10.1007/978-94-007-2324-5

Haggerty, N. (2017) *Digital learning in Africa: Schools of the future*. Washington, DC: Brookings Institution. Available at: https://www.brookings.edu/articles/digital-learning-in-africa-schools-of-the-future/

Ibrahim, M. T., Altalib, H. A., & Bakar, R. (2021). Exploring teacher education: Technological integration in classroom practices. *International Journal of Learning Technology,* vol. 16, no. 1, pp. 52–67. https://doi.org/10.1504/IJLT.2021.112247

Ibrahim, A. and Shiring, E. (2022). The relationship between educators' attitudes, perceived usefulness, and perceived ease of use of instructional and web-based technologies: implications from technology acceptance model (tam). International Journal of Technology in Education, 5(4), 535-551. https://doi.org/10.46328/ijte.285

Ikhlas, M. and Rosa, E. D. D. (2023). Profile and predictors of high school teachers' attitude and self-efficacy in utilizing ict: an investigation from indonesia. SN Social Sciences, 3(4). https://doi.org/10.1007/s43545-023-00654-2

Ige, O. A., & Adewale, O. A. (2022). Teachers' competencies in integrating information and communication technology into instruction. *Journal of Educational Technology Systems, 50*(3), 301–318. https://doi.org/10.1177/0047239520912780

Kayembe, C. & Nel, D. (2019) 'Challenges and opportunities for education in the Fourth Industrial Revolution', *African Journal of Public Affairs*, vol. 11, no. 3, pp. 79–94.

Khan, N. A. (2025). Teacher readiness and student perception toward ai and ict-based learning environments: a case study of digital pedagogy adoption. International Journal for Multidimensional Research Perspectives, 3(9). https://doi.org/10.61877/ijmrp.v3i9.302

Mishra, P. & Koehler, M. J. (2006) 'Technological pedagogical content knowledge: A framework for teacher knowledge', *Teachers College Record*, vol. 108, no. 6, pp. 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Romero, C. & Ventura, S. (2020) 'Educational data mining and learning analytics: An updated survey', *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, vol. 10, no. 3, pp. e1355. https://doi.org/10.1002/widm.1355

UNESCO (2023). Technology in education. A tool on whose terms? Available at: https://www.unesco.org/gem-report/en/publication/technology

Yusuf, A. M., Abubakar, M., & Mohd, A. R. (2023). Trends and impacts of ICT in education: A global overview. *Education and Information Technologies,* vol. 28, no. 2, pp. 2135–2150. https://doi.org/10.1007/s10639-022-10678-x

Yusuf, A. M., & Folorunso, A. E. (2021). Assessing the integration of ICT in teaching: Effects on educational outcomes. *Contemporary Educational Technology,* vol. 13, no. 2, pp. 145–164. https://doi.org/10.30935/cedtech/9850

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