INTEGRATION OF DIGITAL TECHNOLOGIES INTO TECHNICAL VOCATIONAL EDUCATION AND TRAINING (TVET) TEACHER EDUCATION PROGRAMMES: IMPLICATIONS FOR PEDAGOGY AND LEARNING OUTCOMES

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Abstract

This study investigated the integration of digital technologies in Technical and Vocational Education and Training (TVET) teacher education and its implications for instructional pedagogy and students' learning outcomes in Lagos State. A descriptive survey research design was adopted, involving 210 respondents comprising 132 TVET pre-service teachers, 38 educators, and 40 administrators from three tertiary institutions: Lagos State University of Education, Oto/Ijanikin (45 pre-service teachers and 16 educators); the University of Lagos, Akoka (45 pre-service teachers and 12 educators); and the Federal College of Education (Technical), Akoka (42 pre-service teachers and 10 educators). The 40 administrators comprised Deans, Heads of Departments, and Ministry officials involved in TVET administration in Lagos State, Nigeria. Data were collected through questionnaire administration using a validated structured instrument titled "Integration of Digital Technologies in TVET Teacher Education Questionnaire (IDTTVETEQ)." The data collected were analysed using mean and standard deviation to answer the research questions, while Analysis of Variance (ANOVA) was used to test the hypotheses at a 0.05 level of significance. Findings revealed that digital technologies are integrated into TVET teacher education programmes, with respondents agreeing that digital devices, learning management systems, simulations, and online instructional resources are widely utilized. The study further found that digital technology integration positively influences instructional pedagogy and students' learning outcomes by promoting learner-centred teaching, improving conceptual understanding, enhancing practical skill acquisition, and increasing student engagement and motivation. However, challenges such as inadequate infrastructure, limited institutional support, and insufficient emphasis on collaborative learning and workplace readiness were identified. The ANOVA results showed no significant differences among pre-service teachers, educators, and administrators, indicating a shared perception across stakeholder groups. The study concludes that while digital technologies are beneficial to teaching and learning in TVET teacher education, greater investment in infrastructure, institutional support, and innovative pedagogical practices is required to maximize their contribution to students' workplace readiness and learning outcomes.

Keywords: Digital technologies; TVET teacher education; instructional pedagogy; learning outcomes; technology integration.

Introduction

Technical and Vocational Education and Training (TVET) refers to an aspect of education that equips learners with practical knowledge, technical competencies, occupational skills, and attitudes required for employment and productivity in various sectors of the economy (Onyango, 2026; Yusvana, 2025). TVET serves as a strategic bridge between education and the labour market by preparing individuals with industry-relevant skills that support economic growth and national development. In recent years, global education systems have experienced significant transformation due to rapid technological advancement and the emergence of knowledge-based economies. Digital technologies, which refer to electronic tools and systems used for processing, storing, communicating, and managing information, include artificial intelligence, cloud computing, robotics, automation, and big data analytics (Ivaldi et al., 2022; Hossain, 2023; Singh, 2025). These technologies have reshaped industrial operations and workforce expectations under the Fourth Industrial Revolution, thereby compelling educational institutions to prepare learners with digital and problem-solving competencies required in modern workplaces. Consequently, TVET institutions are increasingly expected to integrate digital technologies into instructional processes to enhance the relevance and effectiveness of vocational training (Niwamanya et al., 2025; Omutange et al., 2025). Digital technology integration refers to the purposeful incorporation of digital tools and resources into teaching, learning, assessment, and classroom management to improve educational outcomes and learner engagement (Kalyani, 2024). Within TVET environments, tools such as computer-aided design software, virtual simulations, augmented reality, and learning management systems support learners in visualising complex tasks, practicing technical operations safely, and accessing learning resources beyond traditional classroom settings (Leesakul et al., 2022; Huang, 2025). These innovations not only improve instructional delivery but also strengthen the acquisition of employable skills needed in technologically advanced industries.

Teacher education programmes play a vital role in ensuring effective integration of digital technologies into TVET instruction. Teacher education programmes refer to organised academic and professional training designed to prepare teachers with the pedagogical knowledge, instructional skills, and professional competencies required for effective teaching and learning (Stumbrienė et al., 2024). In the context of digital transformation, TVET teachers are expected to possess both pedagogical competence and digital literacy to meaningfully integrate technology into classroom practice. This has increased the need for innovative

instructional approaches such as blended learning, flipped classrooms, simulation-based instruction, and learner-centred pedagogies that encourage active participation and collaborative learning (Mendoza et al., 2022; Kerimbayev et al., 2023; Yadav & Singh, 2026). Digital technologies also facilitate the development of twenty-first-century skills such as creativity, collaboration, critical thinking, communication, and problem-solving, which are increasingly required in modern industries (Martínez-Bravo et al., 2022; Dumitru & Halpern, 2023). Despite these advantages, several challenges continue to hinder effective digital technology integration in TVET teacher education, especially in developing countries. These challenges include inadequate infrastructure, poor internet connectivity, insufficient funding, and limited digital competence among teachers (Abildinova et al., 2024; Korir & Ngetich, 2026). Institutional support through policy development, provision of technological facilities, continuous professional development, and industry collaboration therefore remains essential for successful implementation (Bakar et al., 2025; Korir & Ngetich, 2026). Since digital technologies have the potential to improve learning outcomes such as skill acquisition, learner motivation, and conceptual understanding, it becomes necessary to examine how digital technologies are integrated into TVET teacher education programmes and how such integration influences pedagogy and learning outcomes, particularly in developing economies where TVET contributes significantly to workforce development and economic sustainability.

Literature Review

Concept of Digital Technologies in Education

Digital technologies in education refer to electronic tools, platforms, and systems that support teaching, learning, communication, and assessment (Dancsa et al., 2023). These include learning management systems, digital simulations, multimedia resources, online collaboration platforms, and artificial intelligence-based tools. They have transformed traditional instruction by enabling flexible, interactive, and personalised learning environments (Zou et al., 2025). Widely recognised for improving quality and access, they allow students to access materials remotely and collaborate with peers (Muir et al., 2022). They also support interactive activities that deepen understanding. In vocational education, they are especially valuable for developing practical skills through simulations and virtual environments. These tools replicate real-world workplace conditions.

Digital Technologies integration in TVET

Digital technologies integration refers to the systematic incorporation of digital tools, platforms, and technological resources into teaching, learning, assessment, and instructional management to improve educational effectiveness and learner outcomes (Kalyani, 2024). In Technical and Vocational Education and Training (TVET), digital technologies integration involves the use of technologies such as simulations, virtual laboratories, computer-aided design software, artificial intelligence, learning management systems, and augmented reality to enhance vocational teaching and practical skill acquisition. The integration of these technologies in TVET has become increasingly important due to the digital transformation of modern industries, which now require workers with both technical and digital competencies. Consequently, TVET institutions are expected to incorporate digital tools into training programmes to prepare graduates for contemporary workplaces and evolving labour market demands (Korir & Ngetich, 2026). Evidence indicates that digital technologies improve vocational education by supporting experiential learning, enhancing technical understanding, and promoting learner engagement (Negahban, 2024). For instance, simulations provide learners with opportunities to practice technical operations safely, receive immediate feedback, and reduce dependence on expensive physical training facilities.

The successful integration of digital technologies in TVET largely depends on teacher education and teacher education programmes. Teacher education refers to the formal process of preparing and developing teachers with the pedagogical knowledge, professional skills, and competencies required for effective instructional delivery (Stumbrienė et al., 2024). Teacher education programmes in TVET are specifically designed to prepare vocational and technical teachers with both occupational expertise and instructional competence needed for teaching practical and industry-related subjects. In the context of digital transformation, these programmes are expected to equip pre-service and in-service TVET teachers with digital literacy, technological pedagogical skills, and the ability to integrate digital tools effectively into vocational instruction. This is necessary because teachers serve as facilitators of technology-enhanced learning and determine how digital resources are applied to improve students' technical competencies and workplace readiness. Therefore, digital technologies integration in TVET teacher education programmes involves preparing teachers to effectively utilise digital technologies in planning, delivering, managing, and assessing vocational instruction in ways that align with contemporary industrial practices and twenty-first-century workforce requirements.

Digital Competence of TVET Teachers

Teacher competence is a critical factor in the successful integration of digital technologies in education. In Technical and Vocational Education and Training (TVET), teachers are professionals who equip learners with practical, technical, vocational, and occupational skills required for employment, entrepreneurship, and industrial productivity through competency-based instruction and practical training activities. Digital competence refers to teachers' ability to effectively utilise digital tools and technologies for lesson planning, instructional delivery, assessment, communication, and classroom management (Nwafor et al., 2023). Among TVET teachers, digital competence includes technical skills, pedagogical knowledge, and the ability to integrate technology effectively into teaching and learning processes (Purina-Bieza, 2021). These competencies enable teachers to utilise digital resources such as simulations, virtual laboratories, multimedia tools, and learning management systems to create more interactive and learner-centred instructional experiences that improve students' conceptual understanding, practical skill acquisition, creativity, and problem-solving abilities. Although many TVET teachers demonstrate positive attitudes toward the use of digital technologies, their competence level is often moderate, thereby highlighting the need for continuous professional development and institutional support to enhance instructional quality and ensure that vocational education remains relevant to the technological demands of contemporary industries (Hani et al., 2025).

The TPACK Framework and Technology Integration

The Technological Pedagogical and Content Knowledge (TPACK) framework provides a key model for understanding technology integration in education, emphasizing that effective integration occurs when teachers can meaningfully combine content knowledge, pedagogical strategies, and technological tools in teaching contexts (Suchita et al., 2023). In TVET, the framework highlights that teachers' technological knowledge and pedagogical competence are essential for effective digital integration. These competencies improve instructional delivery and students' skill development (Maksiutov, 2024). Recent studies further advocate expanding TPACK to include industry-related competencies. This reflects the need for teachers to stay updated with current workplace practices. Such alignment ensures instruction remains relevant to labour market demands (Mesuwini & Mokoena, 2023).

Digital Technology Integration and Pedagogical Innovation

Digital technologies have the potential to transform traditional teaching by enabling interactive, student-centred pedagogies through the use of multimedia resources, collaborative platforms,

and real-time feedback mechanisms (Sabri et al., 2024). Such technology-enhanced environments promote active learning and greater student participation. Research further shows that approaches like blended learning and simulation-based instruction can significantly improve student engagement and learning outcomes (Rotar, 2025), while effective integration of digital tools supports the development of critical thinking, problem-solving abilities, and technical competencies required in modern workplaces.

Digital Technologies and Learning Outcomes

Learning outcomes refer to the knowledge, skills, and competencies students acquire through educational experiences, and research shows that technology-enhanced instruction can improve academic performance, motivation, and engagement when effectively implemented (Zimu, 2024; Ibrahim et al., 2025). Digital tools support this by enabling educators to monitor progress, provide timely feedback, and personalise learning based on individual needs, thereby enhancing conceptual understanding and skill development. However, their effectiveness largely depends on teachers' ability to integrate these technologies into pedagogically meaningful learning activities (Timotheou et al., 2023).

Challenges of Digital Integration in TVET

Despite the recognised benefits of digital technologies, several challenges hinder their effective integration in TVET teacher education. These include limited technological infrastructure, inadequate teacher training, insufficient funding, and resistance to pedagogical change (Mehdaoui, 2024). In many developing countries, these challenges are worsened by poor internet connectivity and limited access to modern training equipment. These constraints reduce the effective use of digital tools in teaching and learning environments. Furthermore, many TVET teachers require continuous professional development in digital pedagogy to move beyond basic uses such as presentations (Abdullah & Masek, 2024).

Nevertheless, literature shows that when effectively implemented, digital technologies can enhance instructional pedagogy, improve student engagement, and support the development of industry-relevant competencies. Achieving this requires teachers with strong digital competence, appropriate pedagogical strategies, and adequate institutional support to ensure that digital tools are used meaningfully rather than superficially. In this context, teacher education, which refers to the formal preparation and continuous professional development of teachers to acquire pedagogical knowledge, professional skills, instructional competencies, and classroom management abilities necessary for effective teaching, becomes highly significant

(Stumbrienė et al., 2024). Teacher education in TVET specifically focuses on preparing vocational and technical teachers with both occupational expertise and technological pedagogical competence required for modern industry-oriented instruction. Despite the importance of teacher education in facilitating effective digital technologies integration, existing studies have largely concentrated on digital integration in general education, with limited attention given to TVET teacher education programmes. Consequently, more empirical evidence is needed on how digital technologies influence pedagogy and learning outcomes within TVET teacher education in order to address evolving technology-driven industry demands.

Statement of the Problem

Despite rapid global advancements in digital technologies and their increasing influence on education and industry, TVET systems are still expected to produce graduates competent in both technical and digital skills. Ideally, TVET teacher education programmes should fully integrate digital technologies into instructional delivery to promote interactive, learner-centred pedagogy. This would strengthen the connection between theory and practice and enhance students' learning outcomes. In such an ideal situation, teachers would possess strong digital competence. They would effectively use simulations, learning management systems, and virtual tools to prepare learners for modern workplaces.

However, the reality in many TVET teacher education institutions, particularly in developing nations, suggests that digital technology integration remains inconsistent and often suboptimal. Although some digital tools are available and occasionally used, challenges such as inadequate infrastructure, limited internet connectivity, insufficient funding, and low teacher digital competence persist. These constraints hinder effective implementation. As a result, technology use is often limited to basic functions like presentation delivery. It is not fully embedded in meaningful, experiential learning practices that enhance student skills and engagement.

Furthermore, while existing studies have examined digital technology integration in general education, there is limited empirical evidence focusing on TVET teacher education. In particular, there is a gap in understanding how digital technologies influence instructional pedagogy and students' learning outcomes in this context. There is also limited knowledge of how different stakeholder groups perceive this integration. This study therefore seeks to address this gap. It investigates the integration of digital technologies in TVET teacher education and their implications for pedagogy and learning outcomes.

Purpose of the Study

The general purpose of this study is to investigate the integration of digital technologies in Technical and Vocational Education and Training (TVET) teacher education programmes and its implications for instructional pedagogy and students' learning outcomes. Specifically, the study sought:

1. To determine the extent to which digital technologies are integrated into TVET teacher education programmes for instructional pedagogy and students' learning outcomes.
2. To determine the influence of digital technology integration on instructional pedagogy and students' learning outcomes in TVET.

Research Questions

1. To what extent are digital technologies integrated into TVET teacher education programmes for instructional pedagogy and students' learning outcomes?
2. What influence do technologies integration have on instructional pedagogy and students' learning outcomes in TVET?

Research Hypotheses

The following null hypotheses were tested at a 0.05 level of significance

1. Digital technologies are not significantly integrated into TVET teacher education programmes as perceived by TVET teachers, pre-service teachers and administrators
2. Digital technology integration has no significant influence on instructional pedagogy and students' learning outcomes in TVET? Correct in line with suggested correction in 1 above

Methodology

This study adopted a descriptive survey research design to determine the extent of integration of digital technologies in Technical and Vocational Education and Training (TVET) teacher education programmes and its implications for instructional pedagogy and students' learning outcomes. The study was conducted in three purposively selected tertiary institutions in Lagos State, Nigeria: Lagos State University of Education, Oto/Ijanikin; the University of Lagos, Akoka; and the Federal College of Education (Technical), Akoka, owing to their established TVET teacher education programmes and varying levels of digital technology adoption. The population comprised 210 respondents, including 132 TVET pre-service teachers, 38 TVET educators, and 40 administrators. The institutional distribution included 45

pre-service teachers and 16 educators from Lagos State University of Education, Oto/Ijanikin; 45 pre-service teachers and 12 educators from the University of Lagos, Akoka; and 42 pre-service teachers and 10 educators from the Federal College of Education (Technical), Akoka. The 40 administrators comprised Deans, Heads of Departments, and relevant Ministry of Education officials involved in TVET administration in Lagos State. Given the manageable population size, a census approach was adopted. Of the 210 questionnaires administered, 202 were properly completed and returned, representing a 96% response rate.

Data were collected using a structured instrument titled *"Integration of Digital Technologies in TVET Teacher Education Questionnaire (IDTTVETEQ")*, developed based on the study objectives and relevant literature. The questionnaire consisted of two sections: Section A collected demographic information, while Section B contained items addressing the research questions. Responses were measured on a five-point Likert scale of Strongly Agree (5), Agree (4), Undecided (3), Disagree (2), and Strongly Disagree (1), with a criterion mean of 3.50 used for decision-making. Mean scores of 3.50 and above were regarded as agreement, while mean scores below 3.50 were regarded as disagreement. The instrument was subjected to face and content validation by three experts, comprising two specialists from the Department of Industrial Technical Education and one specialist from the Department of Measurement and Evaluation, University of Nigeria, Nsukka. Reliability was established through a pilot study conducted outside the study area, and Cronbach's Alpha yielded a reliability coefficient of 0.83, indicating that the instrument was reliable for the study.

The questionnaires were administered by the researcher with the assistance of trained and briefed research assistants who were acquainted with the study objectives and data collection procedures. Data collected were analysed using the Statistical Package for the Social Sciences (SPSS). Mean and standard deviation were used to answer the research questions, while the hypotheses were tested using Analysis of Variance (ANOVA) at a 0.05 level of significance. Ethical standards were observed through voluntary participation, informed consent, confidentiality, anonymity, and secure handling of respondents' information throughout the study.

Results

Research Question 1: To what extent are digital technologies integrated into TVET teacher education programmes?

Table 1: Mean and Standard Deviation of the Responses of the Respondents on Integration of Digital Technologies in TVET Teacher Education Programmes

S/N	Item Statements	TVET Pre-Service Teachers		TVET Educators		TVET Administrators		Remarks
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	
1	Digital devices such as computers, projectors, and tablets are regularly used in TVET teacher education classrooms.	4.02	0.51	4.18	0.49	4.05	0.47	Agreed
2	Learning Management Systems (LMS) are effectively utilized to support teaching and learning activities.	3.75	0.48	3.90	0.52	3.62	0.56	Agreed
3	Virtual simulations and digital tools are used to demonstrate technical or vocational procedures.	3.76	0.52	3.98	0.47	3.73	0.53	Agreed
4	Online instructional resources such as videos, tutorials, and digital manuals are integrated into course delivery.	3.78	0.59	3.86	0.55	3.74	0.60	Agreed
5	TVET teacher education programmes incorporate digital platforms for assignment submission and feedback.	3.85	0.47	3.80	0.50	3.79	0.52	Agreed
6	Teachers and students are encouraged to use digital technologies for collaborative learning activities.	3.99	0.51	4.01	0.46	4.00	0.49	Agreed
7	Digital technologies are used to enhance practical demonstrations and workshop-based learning.	3.83	0.55	3.99	0.51	3.81	0.54	Agreed
8	Institutions provide adequate infrastructure and support for the integration of digital technologies in TVET teacher education.	3.65	0.47	3.74	0.51	3.63	0.56	Agreed
	Grand Mean	**3.83**	**0.51**	**3.93**	**0.50**	**3.80**	**0.53**	**Agreed**

The results in Table 1 indicate that respondents generally agreed that digital technologies are integrated into TVET teacher education programmes, as evidenced by grand mean scores above the 3.50 criterion benchmark across all respondent groups. TVET educators recorded the highest mean score ($\bar{x}$ = 3.93), indicating stronger agreement regarding the integration of digital technologies in instructional delivery. Pre-service teachers ($\bar{x}$ = 3.83) and administrators ($\bar{x}$ = 3.80) also agreed, showing only slight differences in their perceptions. Item 1, which focused on the use of digital devices in teaching and learning, recorded the highest mean score, suggesting widespread availability and utilization of digital technologies. Similarly, collaborative learning (Item 6) and support for practical learning (Item 7) attracted high levels of agreement among respondents. However, institutional infrastructure and support (Item 8) received comparatively lower mean ratings, indicating concerns regarding the adequacy of

institutional support systems for technology integration. Nevertheless, the mean score remained above the acceptance benchmark, implying agreement that some level of support exists. The relatively low standard deviation values further indicate a high degree of consensus among respondents in their responses.

Table 2: One-Way Analysis of Variance (ANOVA) of Respondents' Mean Ratings on digital technologies integration into TVET teacher education programmes for instructional pedagogy and students' learning outcomes (α = 0.05)

Source of Variation	Sum of Squares (SS)	df	Mean Square (MS)	F-cal	F-crit	Decision
Between Groups	0.37	2	0.19	0.76	3.04	Not Significant
Within Groups	52.05	207	0.25			
Total	52.42	209				

The results in Table 2 show that there is no statistically significant difference in the mean ratings of TVET pre-service teachers, educators, and administrators regarding the extent of digital technology integration, as the calculated F-value (0.76) is less than the critical F-value (3.04) at the 0.05 level of significance. This indicates that all three groups share similar perceptions of the level of integration in TVET teacher education programmes. The finding demonstrates a strong consensus among respondents. In addition, the smaller between-group sum of squares compared to the within-group sum of squares suggests that variations in responses are mainly due to individual differences. This further confirms the homogeneity of opinions across the respondent groups.

Research Question 2: What influence do technologies integration have on instructional pedagogy and students' learning outcomes in TVET?

The findings in Table 3 indicate a high level of agreement among respondents on the effectiveness of digital technologies in enhancing teaching and learning outcomes in TVET teacher education. The grand mean scores for pre-service teachers ($\bar{x}$ = 3.92), educators ($\bar{x}$ = 3.98), and administrators ($\bar{x}$ = 3.93) all exceeded the 3.50 criterion benchmark, indicating a strong consensus that digital technologies positively influence instructional effectiveness and student learning outcomes. TVET educators recorded the highest mean score, suggesting stronger agreement and greater confidence in the pedagogical value of digital tools, while pre-

service teachers and administrators showed closely aligned perceptions. At the item level, respondents most strongly agreed that digital technologies enhance student motivation and engagement, with mean scores above 4.00, and also agreed that they promote learner-centred instruction and improve practical skill acquisition. However, lower mean scores for workplace readiness and collaborative learning suggest these areas are not yet fully optimised despite the overall positive perception. The standard deviation values (0.59–0.60) indicate moderate variability but still reflect a generally consistent level of agreement among respondents.

Table 3: Mean and Standard Deviation of the Responses of the Respondents on Instructional Pedagogy and Students' Learning Outcomes in TVET

S/N	Item Statements	TVET Pre-Service Teachers		TVET Educators		TVET Administrators		Remarks
		($\bar{x}$)	SD	($\bar{x}$)	SD	($\bar{x}$)	SD	
1	Digital technologies promote interactive and learner-centred teaching methods in TVET classrooms.	4.06	0.58	4.10	0.51	4.02	0.56	Agreed
2	The use of digital tools improves students' understanding of technical and vocational concepts.	3.81	0.64	4.05	0.69	4.00	0.62	Agreed
3	Technology-supported instruction enhances students' practical skill acquisition.	4.05	0.51	4.02	0.55	3.98	0.60	Agreed
4	Digital platforms enable lecturers to provide timely feedback and assessment of students' performance.	3.89	0.66	3.97	0.64	3.83	0.59	Agreed
5	The integration of digital technologies increases students' motivation and engagement in vocational learning.	4.05	0.55	4.11	0.50	4.07	0.61	Agreed
6	Digital learning resources support collaborative learning among TVET students.	3.84	0.63	3.93	0.57	3.75	0.53	Agreed
7	The use of digital simulations helps students visualize complex technical processes more effectively.	3.92	0.57	3.97	0.63	3.99	0.59	Agreed
8	Digital instructional tools improve lecturers' ability to deliver practical and theoretical content effectively.	3.87	0.62	3.93	0.64	3.89	0.61	Agreed

S/N	Item Statements	TVET Pre-Service Teachers		TVET Educators		TVET Administrators		Remarks
		(x̄)	SD	(x̄)	SD	(x̄)	SD	
9	Exposure to digital technologies enhances students' readiness for technology-driven workplaces.	3.78	0.66	3.74	0.60	3.81	0.59	Agreed
	Grand Mean	**3.92**	**0.60**	**3.98**	**0.59**	**3.93**	**0.59**	**Agreed**

Table 4: One-Way Analysis of Variance (ANOVA) of Respondents' Mean Ratings on the Influence of Digital Technology Integration on Instructional Pedagogy and Students' Learning Outcomes in TVET (α = 0.05, N = 210)

Source of Variation	Sum of Squares (SS)	df	Mean Square (MS)	F-cal	F-crit	Decision
Between Groups	0.10	2	0.05	0.14	3.04	Not Significant
Within Groups	73.15	207	0.35			
Total	73.25	209				

The results of the one-way ANOVA in Table 4 show no statistically significant difference among the mean ratings of pre-service teachers, educators, and administrators, as the calculated F-value (0.14) is lower than the critical value (3.04) at the 0.05 level of significance. This indicates a high level of consensus among respondents regarding the influence of digital technology integration on pedagogy and learning outcomes. Despite their different roles, all groups share similar positive perceptions. This finding is consistent with Table 3, where all items exceeded the acceptance benchmark. The small between-group sum of squares compared to the large within-group sum of squares suggests that variations are due to individual differences rather than group membership. This further confirms the uniformity of opinions across stakeholders.

Discussion of Findings

The findings of this study indicate that digital technologies are integrated into TVET teacher education programmes in Lagos State to a significant extent, as evidenced by mean scores above the 3.50 benchmark across all respondent groups and consistent agreement among pre-service teachers, educators, and administrators. This suggests that digital tools such as computers, learning management systems, simulations, and online instructional resources are increasingly embedded in teaching and learning processes. This aligns with the view of Kalyani

(2024) and Omutange et al. (2025), who emphasized that digital technology integration involves the purposeful incorporation of digital tools into teaching, learning, and assessment to improve educational outcomes. The observed uniformity of responses across groups further supports the argument that TVET institutions are gradually responding to global digital transformation demands in education (Niwamanya et al., 2025). However, the relatively lower ratings for institutional infrastructure and support reflect persistent challenges such as inadequate facilities and limited funding, which are widely documented barriers to effective technology integration in TVET systems in developing contexts (Korir & Ngetich, 2026).

The study further revealed that respondents agreed that digital technologies positively influence instructional pedagogy and students' learning outcomes in TVET teacher education. In particular, digital tools were perceived to enhance learner-centred instruction, improve conceptual understanding, strengthen practical skill acquisition, and increase student motivation and engagement. This finding is consistent with Rotar (2025) and Sabri et al. (2024), who noted that technology-enhanced learning environments promote active participation, interactive pedagogy, and improved learning experiences. It also supports Timotheou et al. (2023), who argued that digital tools enhance learning outcomes when effectively integrated into pedagogically meaningful activities. However, the relatively lower ratings for collaborative learning and workplace readiness suggest that the full potential of digital technologies in fostering teamwork skills and industry preparedness has not yet been fully realized. This implies that while integration exists, it is still evolving from basic usage toward more advanced pedagogical application that aligns with twenty-first-century skills development (Martínez-Bravo et al., 2022).

Furthermore, the ANOVA results for both research questions revealed no statistically significant differences among pre-service teachers, educators, and administrators regarding the extent of digital technology integration and its influence on pedagogy and learning outcomes ($p > 0.05$). This indicates a strong consensus among stakeholders, suggesting that perceptions of digital technology use and its impact are uniformly shared across institutional roles. This homogeneity strengthens the reliability of the findings and is consistent with empirical evidence that stakeholder agreement is common in educational settings where reforms are experienced similarly across institutional structures (Ivaldi et al., 2022; Hossain, 2023). The absence of significant differences also implies that digital transformation in TVET teacher education is being experienced at a relatively similar pace across groups, even though infrastructural and pedagogical challenges persist. Overall, the findings suggest that while digital technologies are increasingly integrated and beneficial to pedagogy and learning

outcomes, further investment in infrastructure, professional development, and pedagogical innovation is required to optimize their impact in TVET teacher education programmes fully.

Conclusion

This study investigated the integration of digital technologies in Technical and Vocational Education and Training (TVET) teacher education programmes and its implications for instructional pedagogy and students' learning outcomes in Lagos State. The findings revealed that digital technologies are integrated into TVET teacher education programmes through digital devices, learning management systems, simulations, and online instructional resources. Their integration positively influences instructional pedagogy and students' learning outcomes by promoting learner-centred teaching, enhancing student engagement and motivation, improving conceptual understanding, and strengthening practical skill acquisition. The study also identified challenges, including inadequate infrastructure, limited institutional support, and insufficient use of digital technologies for collaborative learning and workplace readiness. Furthermore, the absence of significant differences in the perceptions of pre-service teachers, educators, and administrators indicates a shared understanding of the extent and benefits of digital technology integration. Based on these findings, the study concludes that digital technologies contribute significantly to effective teaching and improved learning outcomes in TVET teacher education; however, greater investment in infrastructure, institutional support, and innovative pedagogical practices is required to maximise their potential and better prepare graduates for technology-driven workplaces.

Recommendations

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

1. Governments and institutional authorities should invest in adequate digital infrastructure, including reliable internet access, modern equipment, and technical support systems, to facilitate effective technology integration.
2. Government agencies, TVET regulatory bodies, institutional administrators, and teacher education providers should organise continuous professional development programmes to improve TVET teachers' digital competence and pedagogical skills for effective technology integration.
3. TVET curriculum developers, educational policymakers, regulatory agencies, and institutional management should regularly review and update TVET curricula to incorporate emerging digital technologies and align vocational training with current

industry practices and labour market demands. Strong partnerships between TVET institutions and industries should be encouraged to ensure that students acquire relevant digital skills required in the workplace.

4. Educators should be encouraged to utilise digital tools that promote collaboration, problem-solving, and real-world application of knowledge.
5. Educational policymakers should develop and implement clear policies that support the integration of digital technologies in TVET teacher education.

Implications of the Findings

The findings of this study have several important implications:

1. The study highlights the need for TVET educators to move beyond the basic use of digital tools and adopt innovative pedagogical approaches that maximize the benefits of technology for teaching, learning, and student engagement.
2. The findings imply that policymakers should prioritize digital transformation in TVET institutions through increased funding, improved digital infrastructure, and the development of strategic frameworks that support effective technology integration.
3. The results underscore the importance of strengthening digital pedagogical competence in TVET teacher education programmes to ensure that future teachers can effectively integrate digital technologies into classroom instruction.
4. The positive influence of digital technologies on students' learning outcomes suggests that increased technology integration in TVET can enhance graduates' employability, workplace readiness, and competitiveness in the digital economy.

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