ijolii

Indonesian Journal Of Learning and instructional Innovation
Volume 4, Issue 01 (2026), pp. 112-124 | e-ISSN: 3025-8316
https://journal.uns.ac.id/ijolii | https://doi.org/10.20961/ijolii.v4i01.3677

Digital Learning in Vocational High Schools Practices: Insights from Teachers' Experiences

Mochamad Kamil Budiarto[1], Iwan Maulana[2], Khusnul Khotimah[3], Indri Yuli Widya Rulanti[4], Adhitya Amarulloh[5], Muhammad Yusron Lutfi[6]

[1,2,3,5,6] Universitas Negeri Surabaya, Surabaya, Indonesia
[4] SMK Negeri Poncol, Magetan, Indonesia
E-mail: [1]mochamadbudiarto@unesa.ac.id*, [2]iwanmaulana@unesa.ac.id, [3]khusnulhotimah@unesa.ac.id, [4]widyarulanty@gmail.com, [5]adhityaamarulloh@unesa.ac.id, [6]25112104064@mhs.unesa.ac.id
*Corresponding Author

Article History: Received: June 10, 2026; Accepted: June 30, 2026; Published: June 30, 2026

ABSTRACT

The swift advancement of digital technology and Industry 4.0 has heightened the significance of digital learning in vocational education, necessitating the integration of technology into the teaching and learning process inside schools. This study seeks to examine instructors' experiences in the deployment of digital learning and to determine the elements that facilitate and obstruct its execution. A qualitative case study was performed in a vocational high school, involving four teachers and two administrative and infrastructure personnel recruited via purposive sampling. Data were gathered via semi-structured interviews and observations, thereafter processed by theme analysis. Results demonstrate that digital learning is integrated across planning, instruction, and evaluation methodologies. Educators utilize several digital platforms and tools, including accessibility, user-friendliness, and pedagogical suitability. Despite the school's generally sufficient infrastructure, deficiencies in internet connectivity, device availability, and facility use persist as issues. Educators tackle these challenges using adaptive methods such customized instruction, gamification, peer-assisted learning, and the incorporation of AI literacy. The study indicates that the effective application of digital learning relies on the interplay among teacher practices, digital resources, infrastructural support, and teacher adaptability, hence enhancing the contextual comprehension of the digital learning ecosystem in vocational education.

Keywords: *Digital learning, AI-literacy, Vocational School, Teacher, Perspective.*

INTRODUCTION

Digital revolution is fundamentally altering education and work, influencing learning methodologies and requisite skills. Emerging technologies and Industry 4.0 have revolutionized company models, labor markets, and skill requirements, rendering digital literacy and competencies vital for employability and competitiveness. Educational institutions face pressure to modernize curricula, include digital tools, and equip learners for a knowledge-based, technology-driven economy (Dahalan et al., 2023)(Tan et al., 2024). Digital learning through platforms, simulations, MOOCs, and various technologies can improve flexibility, engagement, and learning results when integrated with effective pedagogy (Rêgo et al., 2023)(X. Zhang et al., 2024). This necessitates the ongoing enhancement of teachers' digital competencies, alongside

supportive leadership and institutional measures(Alenezi, 2023)(Ali et al., 2024). Digitalization is essential in Vocational Education and Training (VET) due to the strong connection between vocational programs and the swiftly evolving workplaces and industrial technology (Dahalan et al., 2023)(Sánchez-Prieto et al., 2021). Digital learning environments, encompassing e-learning platforms, simulations, gamification systems, and blended learning, facilitate the acquisition of 21st-century skills, including critical thinking, collaboration, and computational thinking, alongside job-specific competencies such as digital marketing (Noguera et al., 2024)(Savka et al., 2025). Studies indicate that the judicious integration of digital and online technologies can enhance academic performance, motivation, learning engagement, and satisfaction (Rêgo et al., 2023)(Savka et al., 2025). Simultaneously, numerous vocational education and training (VET) instructors and learners exhibit disparate digital competencies, and digital technologies remain inadequately incorporated into routine pedagogical practices (Dahalan et al., 2023)(Ali et al., 2024)(Hermans et al., 2024). This establishes a robust framework to assess and enhance digital learning competencies in students, with digital teaching and innovative leadership skills in staff, to provide high-quality and industry-relevant vocational education in the digital era.

The execution of digital learning is contingent upon teachers' classroom practices, the technologies they utilize, and the assistance they receive. Studies indicate that when educators possess positive dispositions, sufficient digital competencies, and substantial professional development, they create more interactive and student-centered lessons utilizing platforms, multimedia, and virtual reality or game-based tools to improve engagement and assessment (Akram et al., 2022)(Lomos et al., 2023). Effective pedagogical practices encompass customizing activities to align with learner attributes, employing problem-centered tasks, utilizing online assessments, implementing learning management systems (e.g., Google Classroom, Moodle), and leveraging digital simulations to elucidate intricate concepts and deliver prompt feedback (Nguyễn et al., 2022)(Lomos et al., 2023). Nonetheless, restricted digital proficiency, absence of training, and adverse or ambiguous attitudes of online education might hinder these activities, particularly when educators possess minimal prior experience with technology.

School infrastructure and organization are equally vital. The frequency and quality of teachers' use of digital platforms and resources are substantially influenced by the availability of stable, high-speed internet, adequate devices, up-to-date software, and technical support(Mintasih et al., 2024)(Woltran et al., 2022). Studies from Thailand and elsewhere show that a successful digital learning ecosystem relies on technology that supports learning, quality digital content, and a supportive learning environment. But these must be underpinned by clear policies, leadership vision, and adequate budgets for infrastructure and teacher development(Cirneanu & Moldoveanu, 2024)(Bitar & Davidovich, 2024)). The "relationship" between teachers, technology, and facilities is two-way: quality infrastructure and curated digital materials make for innovative pedagogy, but teachers' beliefs, expertise, and collaborative practices determine whether the available tools are truly integrated into everyday teaching (Stringer et al., 2022)(Kaimara et al., 2021). Overall success depends on teacher competencies and attitudes, robust infrastructure, institutional vision, and supportive policies. Barriers include lack of resources, unequal access and poor training.

The implementation of digital learning in education contexts has been widely studied in the literature, highlighting its potential to enhance learning flexibility, student engagement, and academic performance through the use of digital platforms, multimedia resources, simulations, and learning management systems (Rêgo et al., 2023)(Noguera et al., 2024). Further research has shown several benefits and problems of technology integration including the importance of teacher digital competency, professional development and institutional support in facilitating effective digital learning practices (Akram et al., 2022)(Alenezi, 2023). However, many of these

studies are mostly based on surveys to measure views, preparedness or acceptance of technology and so provide limited insights into the lived experiences and daily practices of teachers in adopting digital learning. Existing studies have highlighted the vital significance of digital technology in vocational education to prepare students for fast-changing industrial contexts, and to improve digital competence and job-specific competencies (Dahalan et al., 2023)(Wu & Zhong, 2025). Previous studies have addressed topics such as digital competences of students, learning outcomes, technology adoption and workforce preparedness in the context of vocational education (Wu & Zhong, 2025)(Rauseo et al., 2023). Nevertheless, little attention has been made to comprehend vocational teachers' experience of using digital learning in their daily teaching practices, especially with the availability of digital learning resources and institutional infrastructure support.

Furthermore, previous studies tend to examine digital learning practices, digital resources, teacher competencies, or infrastructure support as separate variables or isolated factors(Nguyễn et al., 2023)(Mintasih et al., 2024)(J. Zhang & Zhang, 2024). Although the literature acknowledges that the success of digital learning depends on the interaction between teachers, technology, and school support systems, few studies have explored these interrelated dimensions simultaneously within a single school context. Therefore, there is still a need for empirical research to examine how teachers implement digital learning, utilize digital learning resources and platforms, understand infrastructure support, and overcome implementation challenges in vocational education settings. Addressing this gap could provide a more comprehensive understanding of the digital learning ecosystem in vocational high schools and generate practical insights to strengthen digital learning implementation at the school level.

In light of this gap, a more contextual comprehension of digital learning implementation in vocational education is needed. Although prior research has yielded significant insights into technology integration, digital competency, and infrastructure readiness, there is a paucity of studies investigating the interplay of these variables within the daily teaching practices of vocational high school educators. Comprehending educators' perspectives is essential, as they are pivotal in converting technical resources and institutional support into significant learning opportunities for students. This study seeks to examine teachers' experiences in the deployment of digital learning in vocational high schools and to determine the elements that facilitate and obstruct its execution. This study aims to: (1) identify digital learning practices employed by educators; (2) analyze digital learning resources and technological platforms utilized in instructional activities; (3) assess the impact of school infrastructure on the facilitation of digital learning; and (4) examine the challenges encountered by educators and the adaptive strategies they employ in the implementation of digital learning.

METHODS

This study employed a qualitative case study methodology (Terrell, 2015). This method is particularly suitable as it enables researchers to comprehensively investigate a case within its real-world environment, taking into account multiple interconnected elements. Case studies offer academics an opportunity to directly capture teachers' perspectives, comprehend the intricacies of the digital learning process at vocational institutions, and elucidate the interplay of pedagogical methods, technology, and the educational setting.

This study was performed at a vocational institution in the Magetan area that has adopted digital education via digital platforms, online learning materials, and technology-enhanced learning activities. This vocational institution was chosen due to its pertinent background for examining digital learning methodologies in vocational education, encompassing the application of digital technology and its supporting infrastructure. Participants were chosen by purposive

sampling to guarantee they possessed direct expertise and knowledge pertinent to the implementation of digital learning (Gill, 2020). The selection criterion mandated that teacher participants be actively engaged in digital learning activities, whilst administrative and infrastructural workers were chosen based on their roles in administering and supporting technological resources inside the school. The study involved five to six participants, comprising two vocational subject instructors, two general subject teachers, and one to two administrative or infrastructure staff members. The involvement of participants allowed the study to gather insights on digital learning methods, digital resources and platforms, infrastructure support, and implementation issues from both teaching and institutional viewpoints.

The data came from semi-structured interviews and observations. Participants' experiences, perceptions, and practices regarding digital learning implementation, including digital learning resources, technology platforms, infrastructure support, and teaching and learning challenges, were examined in semi-structured interviews. A customizable interview guide enables participants to comment on personal experiences while meeting study objectives. To supplement the interview data, observations were made of digital learning facilities, technology use in education, and the learning environment that supports digital learning in schools (Chand, 2025). Based on the study objectives and research questions, an interview guide and observation checklist were created. The teacher interview guide covered digital learning practices, tools and platforms, infrastructure support, and difficulties and adaption techniques. Administrative and infrastructure personnel interview guides stressed technical facilities and institutional support for digital learning. An observation checklist was utilized to assess the school's digital infrastructure, learning technologies, and learning environment in addition to interview data. Tables 1–3 show instrument characteristics and indicators.

Table 1. Interview Guide for Teachers

Aspect	**Indicators**
Digital Learning Practices	Planning of digital learning activities
	Implementation of digital learning practices
	Assessment and feedback in digital learning
Digital Learning Resources and Platforms	Types of digital platforms used
	Digital learning resources utilized
	Reasons for selecting digital resources and platforms
Infrastructure Support	Availability of digital learning facilities
	Accessibility of technology and internet resources
	Technical support provided by the school
Challenges and Adaptation Strategies	Technical challenges
	Pedagogical challenges
	Student-related challenges
	Adaptation strategies employed by teachers

Table 2. Interview Guide for Administrative/Infrastructure Staff

Aspect	**Indicators**
Infrastructure Support	Availability of ICT facilities
	Internet connectivity
	Availability of digital equipment
	Maintenance of technological facilities
School Support for Digital Learning	Technical support services
	Infrastructure development initiatives
	Challenges in infrastructure management

Table 3. Observation Checklist

Aspect	Indicators
Digital Infrastructure	Computer laboratory facilities
	Internet access
	Wi-Fi coverage
	Availability of digital devices
Learning Technology	Availability of LMS
	Use of learning applications
	Availability of digital learning resources
Learning Environment	Technology utilization in learning activities
	Accessibility of digital learning facilities

The collected data were analyzed using thematic analysis following Braun and Clarke's framework, which includes data introduction, initial coding, theme development, theme review, theme definition and naming, and report writing (Gihar, 2022). Through this process, recurring patterns related to digital learning practices, digital resources and platforms, infrastructure support, and implementation challenges were identified and interpreted. To ensure the reliability of the findings, credibility was established through triangulation of sources and methods, while reliability was supported by maintaining an audit trail throughout the research process. Confirmability was enhanced through peer review of thematic coding and interpretation, and transferability was achieved by providing rich descriptions of the research context, participants, and findings to enable readers to assess the applicability of the results in similar educational settings.

RESULTS AND DISCUSSION

Results

1. Digital Learning Practices in Vocational High Schools

Thematic analysis demonstrated that digital technology has been seamlessly incorporated into the learning process, encompassing planning, implementation, and assessment. Teachers develop technology-supported learning activities that are customized to their learning objectives, select suitable platforms, and prepare digital learning materials during the planning phase. Vocational educators frequently implemented project-based activities, digital tutorials, and specialized software to develop industry-oriented learning experiences, while general subject teachers prioritized interactive learning materials and digital content that promoted conceptual comprehension and student engagement. Free availability, accessibility, simplicity of use, and pedagogical appropriateness were the primary factors that influenced the selection of platforms among participants.

Blended learning became the predominant learning approach during the implementation phase. In order to facilitate communication, content delivery, learning activities, and assignment submission, educators integrated digital platforms with in-person instruction. Digital tools were implemented to facilitate student-centered learning by means of interactive explorations, project-based assignments, collaborative activities, and asynchronous learning opportunities. Observational data further verified that digital technology was consistently integrated into classroom practices through the use of learning management systems, online resources, and digital communication channels that extended teacher-student interactions beyond classroom hours. Assessment practices also extensively implemented digital technologies. Online exams, digital assignments, project evaluations, and e-portfolios are among the digital tools that educators employ for formative and summative assessment. These platforms support more individualized assessment practices, facilitate progress monitoring, and enable timely feedback. In addition, participants reported that they had modified their assessment strategies in response

to the emergence of new challenges associated with digital learning, such as the increased use of artificial intelligence tools by students and concerns regarding academic integrity. In general, the results suggest that digital learning is not restricted to the utilization of technology during instruction; rather, it has been integrated into the planning, teaching, and assessment processes.

Table 4. Summary of Digital Learning Practices

Sub-theme	Initial Codes	Representative Excerpt	Source
Digital lesson planning	RPP_DIGITAL; VIDEO_TUTORIAL_MANDIRI; TEMPLATE_PROYEK	*"I prepare the RPP along with tutorial video links and check all lab devices before class"*	P1
Industry-aligned platform selection	TOOLS_RELEVAN_INDUSTRI; PLATFORM_GRATIS; OTONOMI_PEDAGOGIS	*"I deliberately choose tools actually used in the industry, not just educational tools"*	P2
Blended & flipped learning	BLENDED_LEARNING; FLIPPED_CLASSROOM; PROJECT_BASED	*"Students watch the tutorial at home first; class time is focused on practice and problem-solving"*	P1
Multimodal digital activities	PODCAST_PROJECT; KOLABORASI_DIGITAL; LITERASI_DIGITAL	*"Students script, record, edit, and publish their podcast on Spotify"*	P4
Digital formative assessment	QUIZIZZ; GITHUB_COMMIT_TRACKING; OTOMASI_PENILAIAN	*"Results go directly into an automatic spreadsheet"*	P1, P3
Differentiated digital feedback	FEEDBACK_24JAM; LOOM_VIDEO_PERSONAL; PEER_ASSESSMENT	*"I record a short explanation video and share it only with the student who needs it"*	P2
AI-adaptive assessment	GPTZERO; AI_LITERACY_KRITIS; PROSES_BUKAN_PRODUK	*"I now emphasize the writing process — draft, revision, and reflection"*	P4

2. Utilization of Digital Learning Resources and Technology Platforms

Interviews and classroom observations showed layered and autonomous platform adoption by teachers. Google Workspace for Education—Google Classroom, Google Meet, and Google Drive—was the institutional backbone of digital education, embraced by all four teachers. Beyond this shared ecosystem, platform selection varies by subject, demonstrating teachers' conscious efforts to match tools to their subjects. Vocational teachers used industry-standard tools. P1 simulated networks with Cisco Packet Tracer and GNS3, whereas P2 created an integrated development environment with GitHub, Replit, Discord, and VS Code Live Share to mimic software engineering practices. General subject teachers employed educational platforms: P3 used GeoGebra and Desmos for math visualizations and Khan Academy as an asynchronous resource, while P4 used Padlet, Canva, Audacity, and Anchor for literacy and creative production. Digital learning resources varied. Screencast recordings, PowerPoint-based video lectures, and YouTube tutorial videos were the main learning medium for all participants, supplemented with Khan Academy's selected open-access materials and subject-specific digital journals. A local server with 340 PDF modules, 120 video courses (~18GB), and 45 project templates, accessible via the school LAN, provided resistance against internet dependency. All observed classrooms used Google Classroom, not a school-owned or home-developed LMS.

The selection of platforms and resources was determined by three interconnected criteria consistently expressed by participants: student accessibility (particularly the availability of free versions), user-friendliness without necessitating extensive technical training, and congruence

with learning objectives—encompassing both vocational competency standards and disciplinary literacy aims. Institutional elements, including existing Google Workspace subscriptions in schools and the availability of GitHub Education Packs, enabled the adoption of certain platforms, but individual educators occasionally financed premium services independently in the absence of institutional backing.

Figure 1. Word Cloud Results

3. Infrastructure Support for Digital Learning

Classroom observations and interviews with teachers, administrative staff and infrastructure personnel show that the school has a digital infrastructure that is usually competent to support digital learning, although access and quality vary among learning contexts. The school has two computer laboratories, classroom projection equipment, an interactive multimedia room and a local digital repository of learning modules, instructional videos and project-based learning material. Two internet service providers and a fiber-optic network guarantee internet connectivity, giving stable access to digital platforms and online resources. But investigations showed variation in internet performance between sites, with laboratory spaces obtaining far higher connectivity than conventional classrooms, especially ones in older school buildings. Wi-Fi coverage is provided in most locations of the school, while certain places suffer lesser connectivity.

In addition to the physical infrastructure, the school provides organized technical and institutional assistance for the implementation of digital learning. The IT coordinator deals with technological problems and regular maintenance. Coordination between administrative staff and school leaders and technical staff allows planning of infrastructure and allocation of resources. The school also spends part of its operating budget on ICT development and employs free educational technology resources to enhance digital learning opportunities.

On the whole, teachers said that the infrastructure available was sufficient to enable digital learning activities, especially for those with frequent access to computer laboratories and specialist software. But there are also certain hurdles, like a lack of quality facilities outside the lab setting, limits on lab time, intermittent internet connectivity in classrooms, and unequal access to personal digital devices by students. These findings imply that, despite the presence

of viable digital learning ecosystems in schools, the inequalities in infrastructure access continue to influence teachers' experiences and the practices of digital learning implementation.

Table 5. Thematic Coding Summary: Infrastructure Support for Digital Learning

Sub-theme	Initial Codes	Representative Excerpt	Source
Laboratory facilities & equipment	LAB_TERSEDIA; KETIDAKSETARAAN_KONDISI_LAB; PERANGKAT_USANG_LAB1; LAB2_BERFUNGSI_BAIK	*"Lab 1: 4 units non-functional, 8 frequently hang. Lab 2: all units active and in good condition"*	OBS
Internet connectivity & distribution	JARINGAN_FIBER_OPTIC; REDUNDANSI_INTERNET; DISPARITAS_KECEPATAN_INTERNET; WIFI_TIDAK_MERATA	*"Wi-Fi covers about 80% of the school, but there are still dead zones in the old building"*	P5, OBS
Local digital content repository	KONTEN_LOKAL_TERSEDIA; REPOSITORI_OFFLINE; VOLUME_KONTEN_SIGNIFIKAN	*"The local server is very useful when the internet is slow"*	P5
Technical support system	RESPONS_CEPAT_TEKNIS; SLA_INFORMAL; PEMELIHARAAN_BERKALA; SISTEM_IMAGING	*"Critical issues are resolved in 15 minutes; non-critical within 24 hours"*	P5
Institutional coordination & funding	KOORDINASI_ANTAR_UNIT; ALOKASI_BOS_TIK; KOLABORASI_STAKEHOLDER	*"Around 15–20% of BOS funds are allocated to ICT development"*	P6
Perceived adequacy — vocational teachers	KAPASITAS_PERANGKAT_CUKUP; GITHUB_EDUCATION_PACK; DUKUNGAN_SOFTWARE	*"The school was willing to subscribe to the GitHub Education Pack"*	P2
Perceived adequacy — general teachers	WIFI_TIDAK_STABIL_KELAS; HOTSPOT_PRIBADI; PROPOSAL_BELUM_DITINDAKLANJUTI	*"I often bring my own hotspot as a backup because the Wi-Fi in regular classrooms is not always stable"*	P3
Student access inequity	KESENJANGAN_AKSES_SISWA; KEPEMILIKAN_PERANGKAT_BERVARIASI; AKSES_LAB_TERBATAS	*"On average only 60–70% of students bring a device to regular classrooms"*	OBS

4. Challenges and Adaptation Strategies in Digital Learning

Teachers struggle with technical, pedagogical, and human resource issues. Technical issues include unreliable internet connectivity in conventional classrooms, limited access to high-performance devices, and unequal student ownership of personal digital devices, which hinder technology-enhanced learning. Teachers have trouble monitoring students' understanding and involvement in digital learning settings, especially with copy-paste, AI technologies, and digital competency levels. Some participants worried that overusing digital technologies could hurt pupils' core skills. HR issues were less prevalent but included insufficient structured professional development and the necessity for teachers to independently build their digital competencies and acquire new technical tools.

Teachers used several adaptations to overcome these obstacles. Offline learning materials, cloud-based and browser-accessible apps, and digital resource optimization solved technical issues. Teachers used differentiated instruction, supported kids with learning disabilities, and gave high-achieving students more challenging assignments. Gamification and peer-assisted learning are also utilized to engage students and provide learning support outside of class. Some teachers promote AI literacy and ethical usage of AI tools in response to the rise of AI in education. These findings imply that teachers are adapting to digital learning issues by integrating technology, pedagogy, and collaborative tactics to sustain relevant learning experiences.

The results of all four research questions suggest that digitally engaged instructors are operating within a structurally unequal institutional environment. Blended and reversed learning models are well-established, and digitally mediated assessment practices are becoming increasingly prevalent. Digital learning practices are sophisticated and pedagogically intentional. Industry-relevant and discipline-specific tools are selected primarily for pedagogical alignment and accessibility, while platform adoption is broad and differentiated by subject. The foundation of this adoption is Google Workspace. In laboratory contexts, infrastructure support is functionally adequate; however, it is severely restricted in regular classrooms due to the persistent barriers of uneven connectivity, device access, and scheduling. Teachers exhibit a significant adaptive capacity in overcoming these constraints by utilizing alternative solutions beyond the internet, differentiated learning, gamification, peer-to-peer learning structures, and the integration of emerging AI literacies. These strategies, in general, reflect a pragmatic and professionally autonomous response to the complex realities of implementing digital learning in a public vocational high school context.

Discussion

The results of this study suggest that digital learning in vocational high schools has evolved beyond the mere use of instrumental technology, becoming a systematically integrated aspect of teachers' pedagogical practices throughout the entire learning cycle, including planning, implementation, and assessment. This is consistent with the findings of Akram et al. (2022), who demonstrated that educators who have a positive attitude toward digital technology are more likely to create interactive and student-centered courses by utilizing digital and multimedia platforms for instruction and feedback. The uniform implementation of blended learning among all participants is consistent with the findings of Nguyễn et al. (2022), who identified blended models as a learning framework that is becoming increasingly prevalent in digitally mature school environments. This framework facilitates the integration of asynchronous digital activities with face-to-face engagement. The capacity of teachers to intentionally integrate digital tools into subject-specific pedagogical approaches is a critical factor in the sustained digital integration at the classroom level, as demonstrated by the varying platform choices of vocational and general subject teachers in this study (Lomos et al., 2023). These results substantiate the argument Alenezi (2023) that a genuine digital transformation necessitates a transition from the perception of technology as a complement to the perception of it as an essential component of the learning process. This suggests that digital learning has become an essential aspect of everyday pedagogical practice in vocational high schools, with significant implications for teacher professional development, curriculum design, and institutional support.

In this study, teachers' platform selection was consistently influenced by three pragmatic criteria: accessibility, simplicity of use, and pedagogical appropriateness, rather than the sophistication or novelty of the technology. This pattern is consistent with the findings of Dahalan et al. (2023), who discovered that the deliberate alignment of technological tools with job competency standards and authentic workplace practices is a defining characteristic of effective digital integration in vocational education. This orientation is reflected in the adoption

of industry-standard tools by vocational instructors, who position digital platforms not only as teaching aids but also as simulated professional environments that connect classroom learning and industry expectations. Examples of such tools include GitHub, Cisco Packet Tracer, and Replit. These findings are in accordance with Barboutidis & Stiakakis (2023), who contend that vocational educators are increasingly anticipated to act as intermediaries between the evolving industry technologies and classroom pedagogy, which requires the selection of tools that emulate real-world digital workflows. In contrast, general subject teachers prioritized platforms that facilitate conceptual visualization and creative production, such as GeoGebra, Desmos, Canva, and Audacity. This distinction is consistent with the perspective of Rauseo et al. (2023), who underscored the significance of aligning digital resources with the epistemic requirements of specific subject areas rather than implementing uniform technological solutions across disciplines. This study's discovery that the selection of context-appropriate tools promotes meaningful digital integration was further supported by the fact that student engagement and learning outcomes were more strongly correlated with the pedagogical coherence of platform use than with technological complexity (Noguera et al., 2024). Collectively, these results indicate that educators serve as instructional designers, making deliberate and context-sensitive decisions regarding the integration of technology that are consistent with the unique learning characteristics and competency requirements of general academic and vocational subjects.

Despite the school's relatively adequate digital infrastructure, which included computer laboratories, internet connectivity, and digital learning resources, the results indicate that infrastructure alone does not ensure the equitable or effective implementation of digital learning. The capacity of teachers to conduct technology-intensive learning activities outside the laboratory environment was restricted by the uneven Wi-Fi coverage, unequal pupil access to digital devices, and differences in internet performance across classrooms. These results corroborate prior research that underscores the significance of infrastructure quality and equitable access in determining the efficacy of digital learning (Nguyễn et al., 2023)(Mintasih et al., 2024). However, the mere presence of facilities does not necessarily result in meaningful pedagogical integration (Woltran et al., 2022)(J. Zhang & Zhang, 2024). This study emphasizes the adaptive capacity of instructors as a critical factor in the implementation of digital learning. Teachers devised a variety of strategies in response to technical, pedagogical, and resource-related limitations, such as the integration of AI literacy, differentiated learning, gamification, peer-assisted learning, and offline learning repositories. These results bolster the argument that sustainable digital learning is contingent upon the active participation of instructors, adaptive skills, and pedagogical flexibility, in addition to the provision of technology (Kaimara et al., 2021)(Stringer et al., 2022). Thus, the interaction between institutional support and instructors' ability to creatively transform available resources into meaningful learning opportunities appears to be a determining factor in the success of digital learning in vocational education.

Overall, the findings of this study indicate that the implementation of digital learning in vocational high schools cannot be adequately understood through a single factor. Rather, the evidence points to an interconnected ecosystem in which infrastructure support, digital resources and platforms, teaching practices, teacher adaptation strategies, and institutional support operate as interconnected elements. When one component is hampered, as seen in cases of uneven connectivity or device access, the effectiveness of the broader system depends on compensatory mechanisms elsewhere, particularly teacher adaptability. This systemic interdependence extends and contextualizes existing digital integration frameworks by demonstrating that in resource-diverse public-school environments, the coherence of the overall ecosystem is more important than the strength of any individual component. Thus, this study provides a context-based conceptual explanation of the implementation of digital learning in vocational education, highlighting the dynamic interactions between teachers, technology, and institutional conditions as mechanisms shaping a functional digital learning ecosystem.

CONCLUSION

This investigation demonstrates that the integration of digital learning into vocational high schools has become an essential component of the daily learning process, encompassing the planning, implementation, and evaluation phases. Teachers employ a variety of digital learning platforms and resources in a strategic manner, determining their suitability for learning objectives, simplicity of use, and accessibility. While schools have provided infrastructure support that is relatively adequate, there are still a number of obstacles that are associated with the equitable use of digital facilities, the availability of devices, and the accessibility of the internet in different learning environments. The research results also suggest that the implementation of digital learning is not necessarily impeded by technical, pedagogical, or human resource challenges. Rather, educators exhibit a high level of adaptive capacity by incorporating artificial intelligence literacy, gamification, peer-based learning, differentiated learning, and alternative learning resources into the learning process. This study demonstrates that the success of digital learning in vocational education is not solely influenced by the availability of technology, but rather by the dynamic interaction between teachers' pedagogical practices, digital resources, infrastructure support, and their adaptability in creating meaningful learning experiences. These results suggest that the digital learning ecosystem in vocational schools must be holistically strengthened by enhancing the digital competencies of instructors, ensuring equal access to infrastructure, and establishing school policies that encourage technology-based learning innovation.

CONFLICT OF INTEREST

The authors declare there are no conflict of interest.

REFERENCES

Akram, H., Abdelrady, A. H., Al-Adwan, A. S., & Ramzan, M. (2022). Teachers' Perceptions of Technology Integration in Teaching-Learning Practices: A Systematic Review. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.920317

Alenezi, M. (2023). Digital Learning and Digital Institution in Higher Education. *Education Sciences*, *13*(1), 88. https://doi.org/10.3390/educsci13010088

Ali, W., Rahman, A., & Karsidi, R. (2024). Sustainable Skill Development in Pakistan: Bridging Gaps in Vocational and Technical Education Policy – A Systematic Literature Review. *Society*. https://doi.org/10.33019/society.v12i2.734

Barboutidis, G., & Stiakakis, E. (2023). Identifying the Factors to Enhance Digital Competence of Students at Vocational Training Institutes. *Technology, Knowledge and Learning*, *28*, 613–650. https://doi.org/10.1007/s10758-023-09641-1

Bitar, N., & Davidovich, N. (2024). Transforming Pedagogy: The Digital Revolution in Higher Education. *Education Sciences*. https://doi.org/10.3390/educsci14080811

Chand, S. P. (2025). Methods of Data Collection in Qualitative Research: Interviews, Focus Groups, Observations, and Document Analysis. *Advances in Educational Research and Evaluation*, *6*(1), 303–317. https://doi.org/10.25082/AERE.2025.01.001

Cirneanu, A.-L., & Moldoveanu, C.-E. (2024). Use of Digital Technology in Integrated Mathematics Education. *Applied System Innovation*, *7*(4), 66. https://doi.org/10.3390/asi7040066

Dahalan, F., Alias, N., & Shaharom, M. (2023). Gamification and Game Based Learning for Vocational Education and Training: A Systematic Literature Review. *Education and*

Information Technologies, 1–39. https://doi.org/10.1007/s10639-022-11548-w

Gihar, R. (2022). Research Paradigms: Qualitative, Quantitative and Mixed Method. *International Journal of Science and Research (IJSR)*, *11*(10), 444–447. https://doi.org/10.21275/SR221010141739

Gill, S. L. (2020). Qualitative Sampling Methods. *Journal of Human Lactation*, *36*(4). https://doi.org/10.1177/0890334420949218

Hermans, S., Neutens, T., Wyffels, F., & Van Petegem, P. (2024). Empowering Vocational Students: A Research-Based Framework for Computational Thinking Integration. *Education Sciences*. https://doi.org/10.3390/educsci14020206

Kaimara, P., Fokides, E., Oikonomou, A., & Deliyannis, I. (2021). Potential Barriers to the Implementation of Digital Game-Based Learning in the Classroom: Pre-service Teachers' Views. *Technology, Knowledge and Learning*, *26*, 825–844. https://doi.org/10.1007/s10758-021-09512-7

Lomos, C., Luyten, H., & Tieck, S. (2023). Implementing ICT in classroom practice: what else matters besides the ICT infrastructure? *Large-Scale Assessments in Education*, *11*. https://doi.org/10.1186/s40536-022-00144-6

Mintasih, D., Sukiman, S., & Purnama, S. (2024). Integration of Digital Technology in Islamic Religious Education Learning: A Qualitative Study on Teachers' Competence and Implementation Models in Secondary Schools. *Jurnal Pendidikan Islam*. https://doi.org/10.14421/jpi.2024.131.85-96

Nguyễn, L., Kanjug, I., Lowatcharin, G., Manakul, T., Poonpon, K., Sarakorn, W., Somabut, A., Srisawasdi, N., Traiyarach, S., & Tuamsuk, K. (2022). How teachers manage their classroom in the digital learning environment – experiences from the University Smart Learning Project. *Heliyon*, *8*. https://doi.org/10.1016/j.heliyon.2022.e10817

Nguyễn, L., Kanjug, I., Lowatcharin, G., Manakul, T., Poonpon, K., Sarakorn, W., Somabut, A., Srisawasdi, N., Traiyarach, S., & Tuamsuk, K. (2023). Digital Learning Ecosystem for Classroom Teaching in Thailand High Schools. *SAGE Open*, *13*. https://doi.org/10.1177/21582440231158303

Noguera, I., Barrientos, D., Torres-Sánchez, M., & Pineda-Herrero, P. (2024). Exploring Pedagogical and Digital Practices in Vocational Education and Training: Comparing Teacher and Student Perspectives. *Education Sciences*, *14*(7), 734. https://doi.org/10.3390/educsci14070734

Rauseo, M., Harder, A., Glassey-Previdoli, D., Cattaneo, A., Schumann, S., & Imboden, S. (2023). Correction: Same, but Different? Digital Transformation in Swiss Vocational Schools from the Perspectives of School Management and Teachers. *Technology, Knowledge and Learning*, *28*, 429. https://doi.org/10.1007/s10758-022-09638-2

Rêgo, B. S., Lourenço, D., Moreira, F., & Pereira, C. S. (2023). Digital transformation, skills and education: A systematic literature review. *Industry and Higher Education*, *38*, 336–349. https://doi.org/10.1177/09504222231208969

Sánchez-Prieto, J., Trujillo-Torres, J. M., Gómez-García, M., & Gómez-García, G. (2021). Incident Factors in the Sustainable Development of Digital Teaching Competence in Dual Vocational Education and Training Teachers. *European Journal of Investigation in Health, Psychology and Education*, *11*(3), 758–769. https://doi.org/10.3390/ejihpe11030054

Savka, I., Yakymovych, T., Ruziak, T., Kozlovskyi, P.-V., Turchyn, I., & Holiiad, I. (2025). Future

Teachers' Digital Skills Development Through Professional and Vocational Training in Informal Education. *The New Educational Review*. https://doi.org/10.15804/tner.2025.79.1.13

Stringer, L., Lee, K., Sturm, S., & Giacaman, N. (2022). A systematic review of primary school teachers' experiences with digital technologies curricula. *Education and Information Technologies*, *27*, 12585–12607. https://doi.org/10.1007/s10639-022-11127-z

Tan, X., Lin, X., & Zhuang, R. (2024). Development and validation of a secondary vocational school students' digital learning competence scale. *Smart Learning Environments*, *11*. https://doi.org/10.1186/s40561-024-00325-6

Terrell, S. (2015). Mixed-Methods Research Methodologies. *The Qualitative Report*, *17*, 254–280. https://consensus.app/papers/mixedmethods-research-methodologies-terrell/2efe0a9295765c4dba7a18773a672406/

Woltran, F., Lindner, K., Dzojic, T., & Schwab, S. (2022). Will–Skill–Tool Components as Key Factors for Digital Media Implementation in Education: Austrian Teachers' Experiences with Digital Forms of Instruction during the COVID-19 Pandemic. *Electronics*. https://doi.org/10.3390/electronics11121805

Wu, W., & Zhong, Z. (2025). Teachers' Enactment of Digital Transformation in Technical and Vocational Education and Training in China: An Activity Theory Perspective. *Journal of Education and Learning*. https://doi.org/10.5539/jel.v15n1p113

Zhang, J., & Zhang, Z. (2024). AI in teacher education: Unlocking new dimensions in teaching support, inclusive learning, and digital literacy. *J. Comput. Assist. Learn.*, *40*, 1871–1885. https://doi.org/10.1111/jcal.12988

Zhang, X., Qian, W., & Chen, C.-K. (2024). The effect of digital technology usage on higher vocational student satisfaction: the mediating role of learning experience and learning engagement. *Frontiers in Education*. https://doi.org/10.3389/feduc.2024.1508119