

Bridging the Digital Skills Gap: A Systematic Literature Review of Technology Adaptability in Vocational Education and Training

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ABSTRACT

As digital transformation accelerates across industries, vocational education and training (VET) institutions facing the challenge to equip learners with relevant technological competencies that suit the evolving workplace demands. This systematic literature review examines the critical intersection of digital skills development and technology adaptability within vocational education and training systems worldwide. The review analyzes peer-reviewed publications from the past decade that address technology integration, digital competence frameworks, and adaptability strategies specifically within vocational education and training contexts. Using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, a comprehensive search strategy across major educational databases, 12 studies met the inclusion criteria for detailed analysis. Findings reveal significant disparities in digital skills implementation across different technology used in VET systems, with particular challenges in connecting technology instruction and knowledge with workplace applications. This literature review identifies four key dimensions of successful technology adaptability in VET systems: institutional readiness, instructor digital competence, curriculum integration strategies, and industry-education partnerships. Results further indicate that effective technology adaptability in VET requires moving beyond basic digital literacy toward digital fluency aligns with the real occupational requirements. This research contributes to the development of vocational teachers' digital competencies, which current literature indicates often focuses on technical skills while neglecting critical aspects such as learning and workplace needs connectivity. Recommendations include developing more grounded, mixed-methods research approaches to address contextual factors in VET digitalization and creating adaptive frameworks that accommodate the diverse nature of vocational education systems internationally.

Keywords: digital skills, technology adaptability, technology adoption, systematic review, vocational education and training

INTRODUCTION

The digital transformation of industries worldwide has fundamentally altered skill requirements across occupational sectors, creating new demands for vocational education and training (VET) systems (Selvi et al., 2025; Würges & Aprea, 2024; Hernández-Serrano et al., 2025). As Parua & Yang (2024) emphasize, Industry 4.0 and Industry 5.0, characterized by AI, quantum technology, and 6G, are shifting from isolated technological advancements to interconnected clusters that redefine labor markets. Traditional approaches to vocational instruction face increasing pressure to evolve in response to rapidly changing technological landscapes that characterize modern workplaces as highlighted by Yusvana (2025), who notes that the skills gap between TVET graduates and employer demands widens due to rapid technological changes like AI and IoT (Stryzhak, 2023; Cazzaniga et al., 2024). This systematic literature review examines how VET institutions navigate the complex challenge of fostering technology adaptability while addressing widening digital skills gaps among students and instructors alike (Stryzhak, 2023; Riyanda et al., 2025; DeSanctis & Poole, 1994).

Vocational education occupies a unique position in educational ecosystems due to its direct connection to workplace practices and industry requirements (Parua & Yang, 2024; Lin & Pang, 2024). Unlike general

education, VET must respond quickly to technological disruptions within specific occupational contexts, making technology adaptability particularly crucial in these settings (Wintersberg & Pittich, 2025; Timotheou et al., 2023). The integration of digital competencies into vocational education represents not merely an enhancement of existing curricula but a fundamental reconsideration of how vocational knowledge is acquired, applied, and transferred processes aligning with UNESCO's (2022) call for structured integration of technology to enhance institutional efficiency and sustainable development across educational and workplace environments (Prasetya et al., 2025; Habibi et al., 2023; Parua & Yang, 2024)

Recent research has highlighted concerning disparities in digital skills implementation across VET systems internationally (Riyanda et al., 2025; Würges & Aprea 2024; Hernández-Serrano et al., 2025). As noted by Lahn & Berntsen (2023) examining vocational teachers' digital competencies, existing literature often demonstrates a narrow focus on technical skills with a lack of perspective on key issues about their digital competencies such as connectivity school/work, subject-specificity, and adaptive pedagogy (Riyanda et al., 2025; Hernández-Serrano et al., 2025). This disconnected between general digital competence frameworks and the specific requirements of vocational education contexts presents a significant barrier to effective technology integration (Lahn & Berntsen, 2023; Zhong & Juwaheer, 2024)

The present study addresses this research gap through a systematic analysis of literature examining technology adaptability specifically within vocational education settings (Prasetya et al., 2025; Ma et al., 2025; Huang 2025; Bödding et al., 2025). By synthesizing findings across diverse national contexts, institutional models, and occupational sectors, this review aims to identify effective strategies for enhancing digital skills development in ways that respond to the unique characteristics of vocational education and training (Wang et al., 2025; Butler et al., 2018; Beer & Mulder, 2020)

LITERATURE REVIEW

Conceptual Framework

The systematic review begins by establishing a conceptual framework that synthesizes multiple theoretical perspectives on technology adaptability within educational contexts (Cao et al., 2023; Routh et al., 2022; Ghosh & Ravichandran, 2024; Cigdem & Oncu, 2015). Drawing from both educational technology research and vocational pedagogy, this framework recognizes the distinctive characteristics of vocational education systems that differentiate them from general education when considering digital skills development (Parua & Yang, 2024; Lin & Pang, 2024). Technology adaptability in vocational education must balance generalized digital competencies with occupation-specific applications while maintaining strong connections between educational institutions and workplace environments (Cosa & Torelli, 2024; DeSanctis & Poole, 1994).

This integrated approach acknowledges that digital skills in vocational contexts extend beyond technical proficiency to encompass professional judgment, practical application, and industry-specific technological knowledge (Khademi-Vidra & Bakos, 2024; Zhong & Juwaheer, 2024). Current frameworks addressing teachers' digital competencies have predominantly emerged from general education contexts, potentially limiting their applicability to vocational settings (Mbambo & du Plessis, 2025; Iliescu et al., 2025). As noted in recent research, two decades of international research on the digital competencies of teachers have provided several frameworks for empirical studies and curriculum development. However, research publications addressing the needed digital competencies of vocational (VET) teachers are scarce (Mbambo & du Plessis, 2025; Habibi et al., 2023; Deschênes et al., 2024). This review addresses this gap by examining literature that specifically considers the unique requirements of technology adaptability in vocational education (Cosa & Torelli, 2024; Martin et al., 2020).

Digital Skills and Vocational Education

Digital skills represent a unit of capabilities rather than a sequence of competence (DeSanctis & Poole, 1994). Research distinguishes between fundamental digital literacy and more advanced digital fluency, with the latter being particularly critical in vocational contexts (Timotheou et al., 2023). Digital literacy is the basic level of digital skills, which includes the ability to use common digital devices, applications, and platforms, while digital

fluency is the advanced level of digital skills, which includes the ability to use digital tools and platforms to create, analyze, and manipulate information and content (Lin & Pang, 2024; Habibi et al., 2023; Ma et al., 2025; Wintersberg & Pittich, 2025).

Within vocational education specifically, digital skills must align with occupational requirements while remaining adaptable to technological evolution (Lin & Pang, 2024; Habibi et al., 2023; Martin et al., 2020). This creates tension between teaching current industry-standard technologies and fostering adaptability for future technological developments (Timotheou et al., 2023; Cosa & Torelli, 2024). Recent studies highlight that effective vocational education approaches this challenge by developing transferable technological competencies alongside occupation-specific applications, enabling graduates to navigate changing technological landscapes throughout their careers (Wintersberg & Pittich, 2025; Cosa & Torelli, 2024; Deschênes et al., 2024).

Technology Adaptability Frameworks

Existing research on technology adaptability in educational contexts has produced several influential frameworks, though few address the specific requirements of vocational education (Parua & Yang, 2024; Cosa & Torelli, 2024; DeSanctis & Poole, 1994). General education models typically emphasize pedagogical integration of technology, while business-oriented frameworks focus on organizational adaptation to technological change OECD (2021). Vocational education exists at the intersection of these domains, requiring frameworks that address both pedagogical concerns and workplace alignment (OECD, 2021; Lin & Pang, 2024; Lahn & Berntsen, 2023).

The review identifies significant gaps in current approaches to technology adaptability in VET contexts, particularly regarding the changing professional work of vocational teachers and background information about the national VET systems (Ogilvie & Kastelic, 2022; Sobkowich, 2025; Seida et al., 2024; Fejzić et al., 2023). Effective models must account for the institutional diversity of vocational education internationally while addressing the dual responsibilities of vocational educators to remain current with both pedagogical innovations and industry developments (Iliescu et al., 2025; Bol & Werfhorst, 2016).

METHODOLOGY

This study employed a systematic literature review methodology to comprehensively examine research addressing technology adaptability in vocational education and training contexts. The review process followed established Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for systematic reviews in educational research, incorporating both systematic search procedures and supplementary approaches to ensure comprehensive coverage of relevant literature.

Search Strategy and Selection Criteria

Table 1: Inclusion and Exclusion Criteria for Screening Article

Eligibility Criteria	Inclusion	Exclusion
Language	English	Other languages (non-English)
Year of Publication	2010-2025	Below 2010
Types of documents	Journal article	Literature review articles, proceedings, books (non-article)
Field of study	Vocational Education and Training	Other than Vocational Education and Training
Open Access	All	None

The literature search utilized multiple electronic databases including ERIC, Scopus, Web of Science, and education-specific repositories to identify peer-reviewed publications addressing technology adaptability in vocational education settings. The search strategy combined terms related to vocational education ("vocational

education," "VET," "vocational training," "TVET") with terms addressing digital skills and technology adaptability ("digital competence," "technology integration," "digital skills," "technology adaptability").

Initial searches yielded 377 potentially relevant publications. Following the removal of duplicates, 163 unique citations were screened based on title and abstract. Publications meeting initial relevance criteria underwent full-text review against detailed inclusion criteria: (1) focus on vocational education and training contexts; (2) substantive treatment of technology adaptability or digital skills development; (3) peer-reviewed and published between 2010-2025; and (4) available in English. This process identified 12 studies meeting all inclusion criteria for detailed analysis.

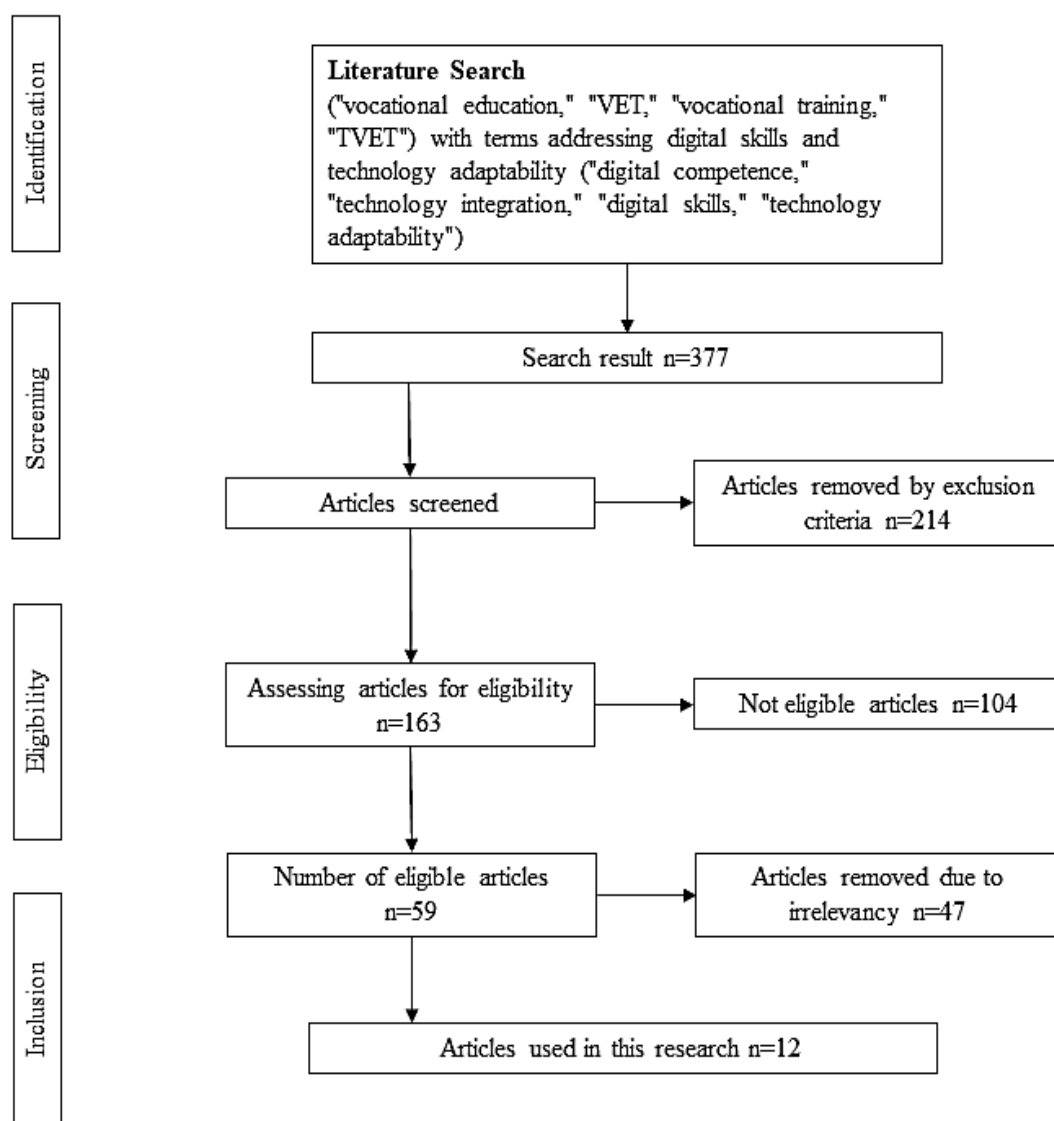


Figure 1: PRISMA model flow chart

Data Analysis Approach

The analytical approach combined descriptive analysis of literature characteristics with thematic synthesis of content (Creswell & Clark, 2017; Makwa et al., 2025; Bryman, 2016). For the descriptive analysis, publications were coded according to research methodology, geographical context, specific vocational sectors addressed, and conceptual frameworks employed (Creswell & Clark, 2017). The thematic synthesis utilized an iterative coding process to identify recurring themes, challenges, and recommended approaches to technology adaptability across the literature (Braun & Clarke, 2006; Li & Pilz, 2023).

This integrated approach aligns with recommendations from recent methodological literature suggesting that vocational education research benefits from more grounded research starting from case studies and qualitative data / mixed-methods research (Bryman, 2016; Teddlie & Tashakkori, 2009). By combining systematic procedures with interpretive synthesis, the methodology responds to the OECD's (2019) call for adaptive frameworks that harmonize global technological trends with localized vocational demands.

Table 2: 12 Reviewed Article Eligible for Screening

No.	Author	Title	Journal	Method	Research Focus
1.	Abromavičienė (2016)	Vocational Training Organization Preparation to Introduce Technology Enhanced Training and Learning	Vocational Training: Research And Realities	Quantitative, descriptive statistics	Assessing how well vocational training organizations are prepared to introduce Technology Enhanced Training and Learning (TEL) by evaluating its aspects
2.	Bacca et al. (2015)	Mobile Augmented Reality in Vocational Education and Training	Procedia Computer Science	Design-based approach	Exploring how mobile augmented reality can support vocational education by addressing diverse educational needs such as motivation, basic competence, and attention, thereby enhancing student engagement and learning outcomes
3.	Chang et al. (2013)	An augmented reality (AR)-based vocational task prompting system for people with cognitive impairments	Research in Developmental Disabilities	Single-case experimental	Exploring the potential of leveraging AR technology to enhance vocational job skills for individuals with cognitive impairments
4.	Cigdem & Oncu (2015)	E-assessment adaptation at a military vocational college: Student perceptions	Eurasia Journal of Mathematics, Science and Technology Education	Quantitative, Structural Equation Modeling (SEM)	Exploring an e-assessment method adaptation in a military vocational college and how the student perceptions of an e-assessment system
5.	Gekara & Nguyen (2018)	New technologies and the transformation of work and skills: a study of computerisation and automation of Australian container terminals	New Technology, Work and Employment	Qualitative, exploratory approach	Examining how the increased adoption of smart computer and robotic technologies is transforming work organization and workforce skills, shifting the traditional "wharfie" role to one embodied by highly educated, technologically adapt workers with strong soft and transferable skills

No.	Author	Title	Journal	Method	Research Focus
6.	Ghosh & Ravichandran (2024a)	Emerging Technologies in Vocational Education and Training	Journal of Digital Learning and Education	Qualitative, exploratory approach	Identified the transformative role of emerging technologies such as Virtual Reality (VR), Augmented Reality (AR), Artificial Intelligence (AI), Internet of Things (IoT) etc. in reshaping vocational pedagogy and skill development
7.	Hung Kee & Basher Rubel (2021)	Technology adaptation is on its way: The role of high involvement work practice	International Journal of Business Innovation and Research	Quantitative, Partial Least Squares (PLS)	Examining how High Involvement Work Practices (HIWP) influence the ability of employees to adapt to new technology
8.	Isharyani et al. (2024)	Retail technology adaptation in traditional retailers: A technology-to-performance chain perspective	Journal of Open Innovation: Technology, Market, and Complexity	Qualitative, case study approach	Examine the practical adaptations being made in the field (how traditional retailers adapt available technologies to suit their local operational needs) and also situates these adaptations within a theoretical framework (TPC) to understand their impact on overall business performance
9.	Papathanassiou et al. (2013)	Competencies development and self-assessment in maintenance management e-training	European Journal of Engineering Education	Mixed-method, design-based approach	Enhancing competency development and enabling technology adaptability through self-assessment for maintenance management by leveraging flexible, cost-effective e-learning solutions as an alternative to traditional training methods
10.	Parkinson & Mackay (2016)	The literacy practices of vocational training in Carpentry and Automotive Technology	Journal of Vocational Education and Training	Qualitative, social science approach	Investigating how technology adaptability enhancing vocational training through the literacy practices, specifically in Carpentry and Automotive Technology
11.	Reich et al. (2021a)	Using technology integration frameworks in vocational education and training	International Journal of Training Research	Qualitative, case study approach	Exploring the applicability and usefulness of Substitution Augmentation Modification Redefinition (SAMR) and the Technology Integration Matrix (TIM) integration frameworks in guiding the adoption of technology-enhanced and blended learning strategies in vocational education and training

No.	Author	Title	Journal	Method	Research Focus
12.	Rubel et al. (2017)	Adapting technology: effect of high-involvement HRM and organisational trust	Behaviour and Information Technology	Quantitative, Partial Last Squares Structural Equation Modeling (PLS-SEM)	Examines how high-involvement human resource management (HIHRM) practices influence technology adaptation within organizations, with a specific focus on the mediating role of organizational trust

Research Question:

1. What technology is used in VET (Vocational Education and Training) in each article?
2. How do they manage to adapt to the technology they use?

FINDINGS

The systematic review reveals several key patterns in how technology adaptability manifests within vocational education and training contexts. Analysis of the selected literature identifies recurring themes regarding institutional approaches, pedagogical strategies, and systemic challenges in developing digital skills adaptability within VET systems internationally.

Table 3: Technology Used in VET and Technology Adaptability

No.	Literature	Technology Used in VET	Technology Adaptability
1.	Vocational Training Organisation Preparation to Introduce Technology Enhanced Training and Learning	Technology Enhanced Learning (TEL), examines ICT infrastructure, digital learning environments, online resources, and integrated training software.	Adaptability appears as the organization's capacity and readiness to systematically integrate TEL into their education processes. By evaluating quality criteria the study assesses how well the institution can align technological innovations with vocational training needs.
2.	Mobile Augmented Reality in Vocational Education and Training	A marker-based mobile augmented reality (AR) application named "Paint-cAR" is developed and deployed in a vocational training setting (specifically car maintenance).	The AR application is designed using inclusive frameworks (such as Universal Design for Learning) and a co-creation process. It adapted to diverse learner needs by providing real-time visual cues and corrective feedback, demonstrating how mobile AR can be seamlessly integrated into vocational training to cater to a range of competencies and special educational requirements.
3.	An augmented reality (AR)-based vocational task prompting system for people with cognitive impairments	An AR-based system delivers dynamic picture cues, monitors task execution, detects errors on the fly, and provides corrective prompts during vocational tasks.	The system is specifically adapted for individuals with cognitive impairments. Its design shows that by integrating real-time feedback and prompting to the user's performance, the technology can adjust to individual learning curves and enhance the acquisition and retention of job skills.

No.	Literature	Technology Used in VET	Technology Adaptability
4.	E-assessment adaptation at a military vocational college: Student perceptions	Digital e-assessment tools primarily online quizzes administered through an electronic platform are employed for evaluating student learning in a military vocational college.	Adaptability demonstrated through the examination of students' perceptions regarding the use of these digital tools. The study explores how e-assessment methods (supported by models like TAM2) are adjusted to fit the specific context and complexity of technical subjects, ensuring that the technology meets the pedagogical and operational needs of the military vocational environment.
5.	New technologies and the transformation of work and skills: a study of computerisation and automation of Australian container terminals	This research centers on the use of smart computer systems, robotics, and automation technologies that are transforming port operations at container terminals.	Discusses how these technologies reshape job roles by necessitating new skill sets. It highlights the emergence of a new "terminal worker" who must not only operate within high-tech computerized environments but also develop soft and transferable skills. This adaptive process reflects how work routines and training programs evolve in response to technological disruption.
6.	Emerging Technologies in Vocational Education and Training	A broad spectrum of emerging technologies is explored, including Virtual Reality (VR), Augmented Reality (AR), Artificial Intelligence (AI), Machine Learning (ML), the Internet of Things (IoT), Robotics, Automation, Big Data analytics, Blockchain, 3D printing, and Gamification.	Examines how these diverse innovations are progressively integrated into vocational pedagogy and training curriculums. It focuses on the need for educational programs to remain adapt to rapid technological changes while addressing challenges such as cost, access, and educator training.
7.	Technology adaptation is on its way: The role of high involvement work practice	This article centers on the adoption of information technology (IT) within organizations, especially in sectors like banking, where modern IT systems underpin work processes.	Adaptability is viewed from an organizational perspective. This study demonstrates that when employees experience high involvement work practices (through the knowledge sharing, decision participation, support, and training), they are better able to adjust to and adopt new technologies. In this way, personal and organizational processes facilitate a smoother adaptation to technological change.
8.	Retail technology adaptation in traditional retailers: A technology-to-performance chain perspective	The paper documents the adaptation of retail technologies such as traditional Point-of-Sale (PoS) systems (often integrated with printers and barcode scanners), mobile applications mimicking portable PoS (mPoS),	Technology adaptability appears in the way traditional retailers repurpose and combine the already existing technologies to fit local market conditions and resource constraints. This research shows that by modifying standard technology to suit their

No.	Literature	Technology Used in VET	Technology Adaptability
		and adapted Electronic Data Capture (EDC) devices.	operational needs, retailers can achieve an effective task-technology fit that enhances performance even in resource-constrained environments.
9.	Competencies development and self-assessment in maintenance management e-training	E-learning toolkit designed for maintenance management. The toolkit is built upon an open-source Learning Management System and incorporates online courses, self-assessment tests, and interactive learning modules.	Technology adaptability is occurred by how its self-assessment and modular design allow learners to follow individualized learning paths, thereby accommodating time constraints and diverse skill levels while standardizing competency evaluation across the sector.
10.	The literacy practices of vocational training in Carpentry and Automotive Technology	This research examines the literacy practices, how trainees interact with complex technical texts such as building standards, specifications, codes, and manufacturer instructions.	Adaptability is reflected in how vocational education evolves to support the specific literacy needs of tradespeople. By investigating the specialized language and practices, this article illustrates how vocational training adapts to convey and maintain technical knowledge that crucial for professional practice.
11.	Using technology integration frameworks in vocational education and training	This article explores technology integration frameworks, specifically SAMR (Substitution, Augmentation, Modification, Redefinition) and TIM (Technology Integration Matrix) as a tools to guide the incorporation of digital resources within vocational learning environments.	By applying these frameworks to an Australian Defence Force Vocational College, this research demonstrates how educators can assess and improve the degree to which technology is blended into courses. It shows that when educators systematically adopt such frameworks, they can more effectively adapt technology to fit the unique, practical requirements of vocational education.
12.	Adapting technology: effect of high-involvement HRM and organisational trust	This study examines the adopt of general information technologies within private banking. While the specific systems are not detailed, the focus is on the digital tools used in day-to-day banking operations.	This paper explores technology adaptability at the intersection of human resource practices and technology adoption. The findings claimed that high-involvement HRM practices, supported by organisational trust, significantly foster a culture in which employees are more willing and able to adapt to incoming technological changes. This mediation effect emphasizes the role of supportive work environments in the successful integration of new digital tools.

Institutional Factors in Technology Adaptability

Institutional readiness emerges as a critical factor in determining effective technology adaptability within vocational education settings (Abromavičienė, 2016; Reich et al., 2021; Cigdem & Oncu, 2015; Ghosh &

Ravichandran, 2024; Bacca et al., 2015). The literature consistently identifies several institutional characteristics associated with successful digital skills development, including: (1) strategic leadership commitment to digital transformation; (2) adequate technological infrastructure and support systems; (3) professional development opportunities for instructors; and (4) organizational cultures that encourage experimentation and innovation (Lee, 2024; Duci et al., 2024; Rama et al., 2024; Hashim et al., 2023; Inamorato dos Santos et al., 2023).

Studies examining institutional barriers to technology adoption highlight significant disparities between public and private VET providers, with public institutions often facing greater constraints due to funding limitations, administrative procedures, and outdated equipment (Guintard et al., 2024; Utami et al., 2025; Rahman et al., 2023). Successful institutions demonstrate capacity to develop partnerships that overcome resource limitations through industry collaboration, sharing of technological resources, and development of digital learning communities that extend beyond institutional boundaries (Valdés et al., 2021; Timotheou et al., 2023; Audrin et al., 2024).

Pedagogical Approaches to Digital Skills Development

The literature reveals diverse pedagogical approaches to fostering technology adaptability, with significant variation across different vocational sectors and national contexts (Hung Kee & Basher Rubel, 2021; Gekara & Nguyen, 2018; Isharyani et al., 2024). Effective approaches generally share certain characteristics: they emphasize authentic workplace applications, incorporate project-based learning methodologies, and develop both technical proficiency and adaptive mindsets (Parkinson & Mackay, 2016; Rubel et al., 2017; Papathanassiou et al., 2013). Rather than treating digital skills as isolated competencies, successful programs integrate them throughout vocational curricula in ways that reflect their application in corresponding workplace environments (Chang et al., 2013; Reich et al., 2021; Bacca et al., 2015).

As noted in recent research on student learning adaptability, educational approaches that combine "attitude, knowledge, digital skills, and adaptability" produce stronger outcomes than those focusing exclusively on technical skills development (Rashid et al., 2024; Nour A., 2019). Studies examining pedagogical innovation in VET contexts emphasize the importance of balancing structured instruction with opportunities for self-directed exploration of technological applications, particularly in rapidly evolving technical fields (Messina Dahlberg & Gustavsson, 2025; Akinsulie et al., 2024).

Digital Competencies of Vocational Educators

A significant portion of the literature addresses the critical role of vocational educators in facilitating technology adaptability among students (Cigdem & Oncu, 2015; Bacca et al., 2015; Reich et al., 2021). Research consistently identifies teacher digital competence as a limiting factor in VET technology integration, with many studies noting gaps between instructor capabilities and workplace technological requirements (Lee, 2024; Ghosh & Ravichandran, 2024). This challenge is particularly acute in vocational education due to the dual professional identities of many VET instructors as both educators and industry practitioners (Duci et al., 2024; Rama et al., 2024; Hashim et al., 2023).

Several studies highlight the inadequacy of general digital competence frameworks when applied to vocational educators. As one research synthesis notes, vocational teachers require specific digital competencies related to "connectivity school/work, subject-specificity, and adaptive pedagogy" (Hashim et al., 2023; Barliana et al., 2020). Effective professional development approaches for vocational educators combine technical skills development with pedagogical application and industry-specific technological knowledge, recognizing the complex interplay between these domains in vocational instruction (Stefanowicz-Kocoł, 2024; Zervas & Stiakakis, 2024; Michelotto & Joia, 2024).

Bridging Education-Workplace Technology Gaps

The distinctive characteristic of vocational education-its direct connection to workplace practice-creates both opportunities and challenges for technology adaptability. Literature examining this education-workplace interface identifies persistent gaps between technological applications in educational settings and corresponding workplace environments (Parkinson & Mackay, 2016; Hung Kee & Basher Rubel, 2021; Rubel et al., 2017).

These disparities result from multiple factors: resource limitations in educational institutions, rapid technological change in industry settings, and structural barriers to workplace-education collaboration (Yusvana, 2025; Tee et al., 2024; Wintersberg & Pittich, 2025).

Successful approaches to bridging these gaps incorporate several strategies: work-integrated learning models that expose students to workplace technologies; industry partnerships that facilitate technology sharing and knowledge transfer; and curriculum designs that emphasize technological principles alongside specific applications (Timotheou et al., 2023; Habibi et al., 2023; Lahn & Berntsen, 2023). The literature suggests that developing technology adaptability, rather than proficiency with specific tools, better prepares vocational students for workplace success in rapidly evolving technical environments (Prasetya et al., 2025; Zhong & Juwaheer, 2024; Bødning et al., 2025).

DISCUSSION

Integration of Findings with Existing Frameworks

The systematic review findings both complement and challenge existing frameworks for understanding technology adaptation in educational contexts (Lahn & Berntsen, 2023; Butler et al., 2018). While general educational technology models provide valuable insights regarding pedagogical integration of digital tools, they often fail to address the distinctive characteristics of vocational education-particularly its direct connection to workplace practices and the dual professional identities of many vocational instructors (Riyanda et al., 2025; Cao et al., 2023). Similarly, frameworks addressing workplace digital transformation provide limited guidance for educational contexts with their distinct institutional structures and pedagogical requirements (Deschênes et al., 2024; Sobkowich, 2025; Lee, 2024).

The findings suggest that effective technology adaptability in vocational education requires integrated frameworks that address multiple dimensions: institutional capacity, pedagogical approaches, instructor capabilities, and workplace alignment (Reich et al., 2021; Ghosh & Ravichandran, 2024). Such integrated approaches remain underdeveloped in current literature, with most studies focusing on isolated aspects of the technology adaptability challenge rather than comprehensive models reflecting the complexity of vocational education ecosystems (Huang, 2025; Gao & Mohamad, 2025).

Contextual Factors in Technology Adaptability

The review highlights the significant influence of contextual factors on technology adaptability in vocational education (Habibi et al., 2023; Cattaneo et al., 2022). National policy environments, funding models, and institutional structures create diverse conditions for technology integration across different vocational education systems. This contextual diversity challenges attempts to develop universal frameworks or best practices for technology adaptability in VET settings (Choi & Lim, 2017; Borges do Nascimento et al., 2023).

As noted in research examining digital competence frameworks, the literature often neglects contextual issues, for example, the changing professional work of vocational teachers and background information about the national VET systems (George et al., 2022; Lahn & Berntsen, 2023). Effective approaches to technology adaptability must recognize and respond to these contextual factors, balancing general principles with context-sensitive implementation strategies that accommodate the distinctive characteristics of specific vocational education environments (Choi & Lim, 2017; Cattaneo et al., 2022).

Future Directions for Research and Practice

The systematic review identifies several promising directions for future research and practice in fostering technology adaptability within vocational education settings. These include:

1. Development of vocational-specific digital competence frameworks that address the distinctive requirements of different occupational sectors while maintaining sufficient flexibility to accommodate technological evolution (Pan & Filippova, 2024; Habibi et al., 2023; Gekara & Nguyen, 2018).

2. Exploration of innovative workplace-education partnership models that facilitate technology knowledge transfer and shared resource utilization (Ghosh & Ravichandran, 2024; Reich et al., 2021).
3. Investigation of pedagogical approaches that develop adaptive technological capabilities rather than tool-specific skills, better preparing vocational students for continuously evolving workplace environments (Pan & Filippova, 2024; Parkinson & Mackay, 2016; Habibi et al., 2023).
4. Examination of professional development models that address the complex requirements of vocational educators navigating dual professional identities while maintaining currency with technological developments (Lahn & Berntsen, 2023; Wang et al., 2025; Zhong & Juwaheer, 2024) .

The literature increasingly points toward more grounded research starting from case studies and qualitative data / mixed-methods research as particularly valuable in understanding the complex interplay of factors influencing technology adaptability in vocational contexts (Chang et al., 2013; Papathanassiou et al., 2013; Reich et al., 2021). Such approaches offer potential to develop more nuanced understanding of how technological change manifests across diverse vocational education settings (Mbambo & du Plessis, 2025; Tee et al., 2024; Yusvana, 2025).

CONCLUSION

This systematic literature review has examined the complex challenge of fostering technology adaptability within vocational education and training systems (Cattaneo et al., 2022; Li & Pilz, 2023; OECD, 2023). The analysis reveals that effective approaches to bridging digital skills gaps in vocational education extend beyond technical training to encompass institutional transformation, pedagogical innovation, and strengthened workplace-education connections (Braun & Clarke, 2006; Bryman, 2016; Creswell & Clark, 2017; Teddlie & Tashakkori, 2009). The distinctive characteristics of vocational education-its direct alignment with workplace practices, diverse occupational contexts, and connections to industry-create both unique challenges and opportunities for developing technological adaptability among students and instructors (Lahn & Berntsen, 2023; Roll & Ifenthaler, 2021).

The findings highlight the inadequacy of general digital competence frameworks when applied to vocational education contexts without adaptation to their specific requirements (Borges do Nascimento et al., 2023; Lahn & Berntsen, 2023; Pan & Filippova, 2024). Effective approaches recognize the need for both general digital fluency and occupation-specific technological applications, developing adaptable capabilities that prepare vocational graduates to navigate continuously evolving workplace technologies (Anh et al., 2024; Audrin et al., 2024; Rashid et al., 2024; Utami et al., 2025). Such approaches require institutional environments that support technological innovation, instructors with appropriate digital competencies, and strong connections between educational and workplace settings (Michelotto & Joia, 2024; Rama et al., 2024; Zervas & Stiakakis, 2024).

Future development of technology adaptability in vocational education will require more contextualized approaches that respond to the diversity of vocational education systems internationally while addressing common challenges in connecting educational technology with workplace applications (Duci et al., 2024; Rama et al., 2024). By fostering adaptability rather than narrow technical proficiency, vocational education can better fulfill its mission of preparing students for success in rapidly evolving occupational environments shaped by ongoing technological transformation (Anh et al., 2024; Rashid et al., 2024; Utami et al., 2025).

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