

## NAVIGATING DIGITAL COMPETENCE IN TVET EDUCATION: OVERCOMING CHALLENGES AND HARNESSING OPPORTUNITIES FOR INDUSTRY 4.0

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### ABSTRACT

The significance of digital skills in Technical and Vocational Education and Training (TVET) is increasing as technology plays a more prominent role in businesses and employment. This scoping review aims to address a knowledge gap suggesting that digital education requires adjustments in pedagogy and evaluation, necessitating instructor training and professional development. Thematic analysis was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Themes from Scopus repositories and Google Scholar were extracted and analysed using specific keywords related to digital literacy topics. After the search, a total of  $n = 16$  domains were initially identified and analysed comprehensively. Two themes emerged from the analysis: (1) Challenges, and (2) Strategies to overcome the digital competence challenges. The findings highlight a variety of approaches and technologies relevant to digital competency concerns. The review reveals gaps in the current literature and proposes future research directions to explore the potential and challenges associated with the benefits of training in TVET education. In conclusion, the thematic analysis provides valuable insights for educators, scholars, and policymakers to develop effective strategies for fostering digital proficiency in TVET programs. These strategies involve revising curriculum materials, enhancing instructor training, collaborating with researchers, and integrating digital competency into TVET programs.

**Keywords:** digital competence, digital skill, technical and vocational, Fourth Industrial Revolution, challenges, scoping review

### INTRODUCTION

The Fourth Industrial Revolution, characterized by the convergence of digital technologies, artificial intelligence, and automation, is fundamentally transforming industries and economies globally. As reliance on digital technologies grows across sectors, from manufacturing to healthcare, the need for digital competencies becomes increasingly critical to drive innovation and maintain competitiveness in a rapidly evolving marketplace. The Organization for Economic Cooperation and Development (OECD, 2018) emphasizes the essential nature of digital literacy for mental well-being in this era of digital transformation. Information and communication technology (ICT) is recognized as a significant factor in personal and professional development, particularly for students and educators. Cabero et al. (2020) highlights digital competence as a key skill that citizens, especially educators, must master to

meet future societal demands.

In this dynamic environment, Technical and Vocational Education and Training (TVET) institutions play a pivotal role in preparing the workforce for the transformations and opportunities presented by the Fourth Industrial Revolution (Rokeman & Kob, 2024). Integrating digital skills into TVET curricula is paramount to equipping students with the essential expertise and knowledge needed to succeed in today's dynamic workplaces. Digital competency encompasses a wide range of abilities, from fundamental digital literacy and data analysis to more specialized skills such as programming, cybersecurity, and proficiency in emerging technologies like the Internet of Things (IoT), blockchain, and cloud computing (Shatalova, 2023).

As stakeholders in TVET education navigate the implications of the Fourth Industrial Revolution, it is essential to explore the significance of digital competencies in shaping the future of TVET education. This literature review aims to delve into current research, best practices, challenges, and innovations concerning digital competencies within TVET education. Through fostering discourse and sharing insights from academia, industry, and government, this review seeks to enhance understanding and advocate for effective strategies in integrating digital competencies into TVET curricula.

## **LITERATURE REVIEW**

### **Digital Competencies in TVET Education**

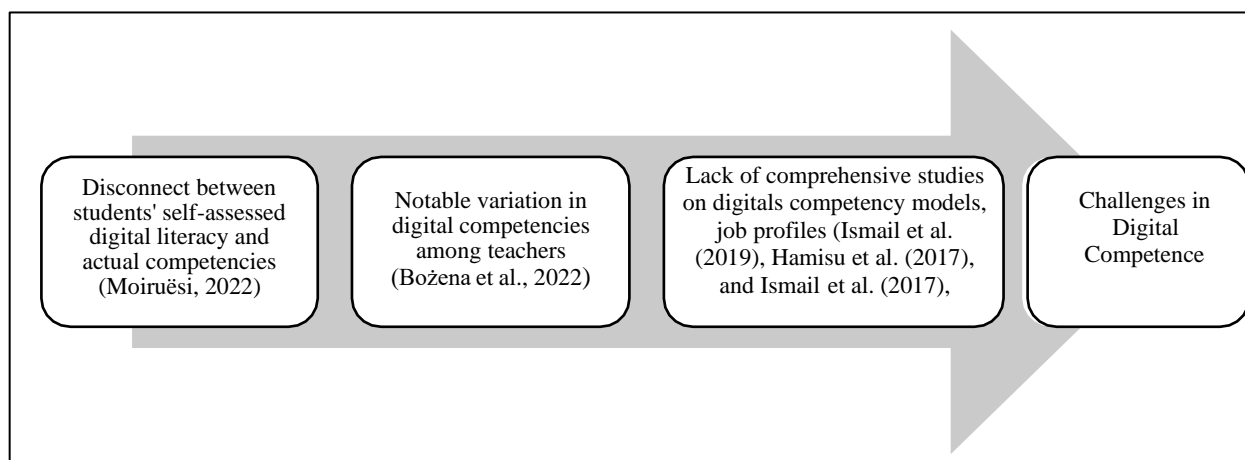
Digital competencies refer to the diverse array of skills, knowledge, and attitudes that empower individuals to effectively utilize and leverage digital technologies across various settings. Within the realm of Technical and Vocational Education and Training (TVET), digital competencies offer significant potential to enrich learning outcomes, stimulate innovation, and bolster employability (Varma & Malik, 2023). These competencies enable TVET graduates to adeptly navigate shifting job roles and industry requirements. In sectors like manufacturing, healthcare, and information technology, proficiency in digital technologies is increasingly viewed as a fundamental requirement for employment. TVET institutions that integrate digital competencies into their curricula are better positioned to address employer needs and equip students with a competitive advantage in the job market. Studies have shown that digital competencies among university students, particularly in education degrees, improves as they progress through their academic years, with online learning methods being more effective in promoting digital competency (Cepa-Rodríguez, & Murgiondo, 2024).

According to the European Union (EU), digital competence encompasses the ability to engage with digital technologies in a safe, critical, and responsible manner, encompassing their use for learning, work, and active participation in society. This encompasses skills such as literacy in information and data, collaboration and communication, understanding of media, creation of digital content (including coding), security (encompassing competencies in digital health and cybersecurity), awareness of intellectual property rights, problem-solving, and analytical thinking (Council of the European Union, 2018). Despite the potential advantages, the integration of digital competencies into TVET education presents challenges. Various factors hinder the effective implementation and adoption of digital technologies in the TVET environment (Sales et al., 2020).

The research gap in digital competence is multifaceted, encompassing demographic disparities, educational stages, and professional applications. One significant concern is the discrepancy between students' self-perceived digital literacy and their actual abilities, underscoring the need for interventions that foster self-awareness and metacognition in digital skills (Moiruësi, 2022). Furthermore, despite the increasing integration of digital tools and ICT in education, teachers' digital competencies vary considerably, influenced by factors like teaching experience and specific ICT domains (Božena et al., 2022). This highlights the need for tailored professional development programs. Additionally, TVET assessment necessitates incorporating Industrial Revolution 4.0 (IR 4.0) generic skills and career adaptability skills alongside technical skills, emphasizing a holistic approach to skill development in TVET subjects (Yusop et al., 2023). This need for a comprehensive approach to digital competency in Malaysia is echoed by local scholars, who identify a lack of comprehensive studies on digital

competency models, job profiles, and concerns regarding the competencies of TVET educators (Ismail et al., 2017; Hamisu et al., 2017; Ismail et al., 2019).

**Figure 1** Gaps in the Study



In primary education, the lack of comprehensive tools to assess digital competence at different stages further complicates the understanding of students' digital skills development. Collectively, these gaps highlight the need for a more nuanced and targeted approach to digital competence education, addressing specific demographic, educational, and professional needs to ensure that individuals are adequately prepared for the digital age.

### Research Questions

The primary objective of this evaluation is to perform a comprehensive review of the increasing challenges associated with the integration and incorporation of digital competencies related to the Technical and Vocational Education and Training (TVET) institutions. In light of the ongoing digital revolution causing significant changes and rearrangements on a global scale, TVET initiatives assume a crucial role in preparing the upcoming workforce with the essential competencies and expertise to excel in the technology-driven workplaces of the 21st century. The study aims to address the following research questions:

**Research Question 1:** What are the potential challenges associated with Digital Teaching Competence in Technical and Vocational Education and Training (TVET) education?

**Research Question 2:** What strategies can be employed to overcome the barriers to digital competence in Technical and Vocational Education and Training (TVET) education?

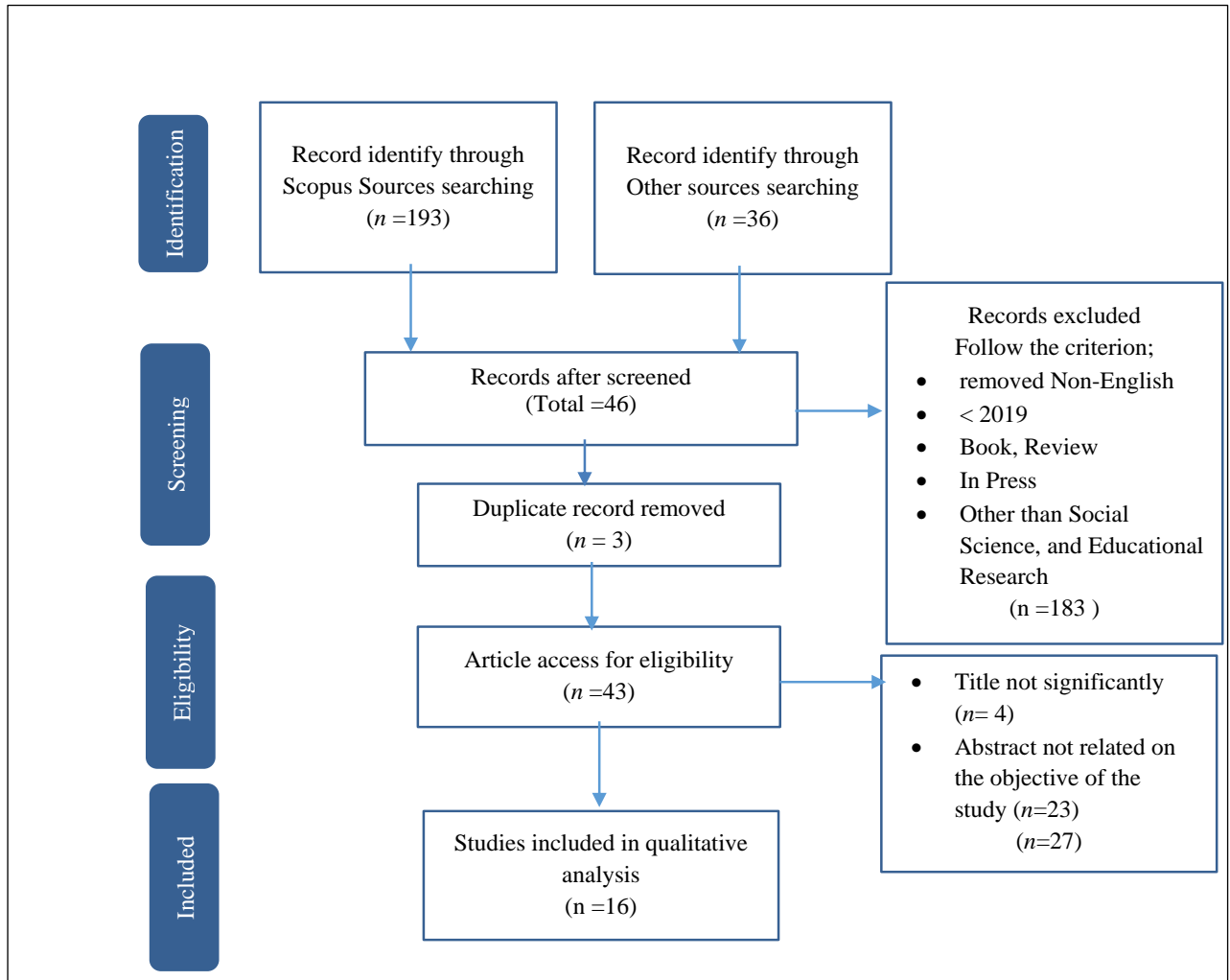
### METHODOLOGY

This section underscores the importance of thoroughly exploring the challenges and providing recommendations for the integration of digital skills among Technical and Vocational Education and Training (TVET) educators. The research methodology employed to address the formulated Research Questions (RQs) is outlined in the following section. The analysis is structured into two main parts: (1) potential and challenges, and (2) strategies can be employed to overcome the barriers to digital competence.

The primary aim is to investigate both the possibilities and barriers associated with embracing digital competencies in TVET education. To achieve this objective, a scoping review was conducted, along with a synthesis of relevant scholarly literature, to identify and examine key research themes. Furthermore, the segment outlines potential strategies to tackle the identified challenges and proposes

future research directions for scholars. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology, adapted from PRISMA 2009 (Moher et al., 2009), was utilized to guide this examination.

**Figure 2** Review Flow Chart (Adapted from PRISMA 2009)



The methodological approach adopted in this review adheres to the widely recognized standards for conducting Scoping Reviews. This framework provides comprehensive guidelines for evaluating and validating the rigor and accuracy of the review process, ensuring the inclusion of pertinent and essential details (Moher, 2009). An online database search was conducted using Scopus to identify relevant published articles due to its comprehensive coverage. Google Scholar was also utilized as it is known for being one of the largest scientific bibliographic databases globally, providing access to journals not widely indexed and various document types such as blogs, presentations, newspaper articles, working papers, and theses. While Google Scholar aggregates content from reputable academic sources, it also retrieves a larger number of citations and non-academic documents like patents. Consequently, initial results were filtered to address potential accuracy issues, necessitating a thorough examination of each retrieved record from the search (Haddaway et al., 2015).

## Identification

The research conducted a thorough review of available literature concerning the integration of digital competencies in Technical and Vocational Education and Training (TVET) during the identification phase. This process began with the identification of relevant keywords, which were further refined by exploring synonymous terms in thesauri, dictionaries, and prior studies. In constructing the search query, keywords with the widest array of alternatives were prioritized. For example, while "TVET" is predominantly used in Asia to refer to Technical and Vocational Education and Training, the acronym "VET" is utilized in certain European contexts as an alternative for Vocational Education and Training. This careful selection of terminology aimed to enhance the comprehensiveness of the literature review.

Furthermore, in several American countries, the term "Higher Vocational Education" is employed to specify and distinguish the level of TVET. Consequently, the search strategy incorporated variations such as "Technical Education" and "Vocational Education," alongside the keyword TVET, combined with phrases like "challenges" and "digital competence" to optimize the search outcomes. After identifying the pertinent terms, search queries were developed for the Scopus databases. This process resulted in the retrieval of 193 publications during the initial phase of the advanced search (refer to Table 1 for further details).

**Table 1** The search string used for the systematic review process

Databases	Keywords
Scopus	TITLE-ABS-KEY ("digital competence*" OR "challenges*" OR "lecturer*" OR "TVET" AND "technical and vocational") AND (LIMIT-TO (SUBJAREA, "SOC")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (PUBSTAGE, "final")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2023) OR LIMIT-TO (PUBYEAR, 2024))
Google Scholar	"digital competence" OR "challenges" OR "TVET" AND "technical and vocational"

## Screening

In the second section of the analysis, 229 articles were scrutinized in line with the predetermined criteria set by the researchers. Emphasis was placed on literature that functioned as the primary reservoir of pragmatic knowledge. As a result, works such as books, book series, meta-syntheses, meta-analyses, reviews, systematic reviews, and chapters were excluded from the analysis. The analysis specifically focused on articles published in the English language within the realms of social sciences and educational studies, restricted to a period of five years (2020-2024) to ensure pertinence. Consequently, 183 articles were disqualified based on the specified criteria outlined in Table 2. Moreover, duplicate articles were detected and deleted; among the initial selection of 46 articles, three were disregarded due to replication.

**Table 2** Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Literature type	Journal (Article)	Book, Review
Language	English	Non-English
Subject Area	Social Science, Educational Research	Besides Social Science, Educational Research / Others
Timeline	2020 – 2024	< 2019
Publication Stage	Final	In Press

## **Eligibility**

The third stage of the screening process involved a comprehensive review of 43 articles, meticulously scrutinizing their titles and key findings for alignment with the established inclusion criteria and relevance to the study's objectives. This meticulous review led to the exclusion of twenty-seven reports (n=27) due to their empirical data failing to meet the study's criteria. Specifically, these reports either contained irrelevant titles or their abstracts did not align with the study's primary focus. Consequently, only 16 articles were deemed suitable for further evaluation.

## **Data Abstraction and Analysis**

This study involved an examination and synthesis of various research designs, including mixed methods, qualitative, and quantitative approaches, through an integrative analysis as part of the assessment strategy. The primary aim was to identify relevant topics and subtopics, commencing with data collection to serve as a foundation for theme development. Figure 3 illustrates the authors' thorough review of 16 articles to extract relevant assertions related to the subjects under investigation. Recent significant works addressing digital competency in TVET education, particularly challenges and recommendations, were critically evaluated. The research outcomes and methodologies from all studies were meticulously analysed.

Subsequently, the authors collaborated with co-authors to delineate themes based on the data within the study's framework. A comprehensive log was maintained throughout the data analysis process to document analyses, perspectives, inquiries, and insights to facilitate data interpretation. Any discrepancies in theme formulation were discussed among the authors, leading to final adjustments to enhance thematic coherence. To validate the findings, two experts—one specializing in higher education and the other in TVET education—participated in the analytical selection process. This expert review ensured that each subtheme was coherent, relevant, and appropriately aligned with the study's context.

## **RESEARCH FINDINGS**

Data extraction was conducted to facilitate the comparison of literature meeting the predetermined criteria. This procedure entailed the extraction of data from the tools utilized in the study based on established categories, encompassing obstacles and suggestions concerning digital proficiency in TVET education. These categories were merged to offer a more distinct synopsis conducive to meaningful comparisons. After several screening phases, a total of 16 articles were chosen, consisting of 12 sourced from the Scopus repository and four from Google Scholar. The selected articles encompassed various publication years: two in 2024, four in 2023, eight in 2022, one in 2021, and one in 2020. The articles were classified based on themes that corresponded to the research objectives, specifically addressing the challenges related to the incorporation of digital skills in TVET education and providing relevant strategies that can be employed to overcome the barriers to digital competence (see Table 3 for more details).

**Table 3** The research article findings are based on the proposed search criterion

<b>Authors</b>	<b>Title</b>	<b>Methods</b>	<b>Main Findings</b>
Mesuwini, J., & Mokoena, S. (2024)	Exploring online teaching and learning challenges for the technical and vocational education and training lecturer	Qualitative	This research explored the challenges faced by educators in Technical and Vocational Education and Training (TVET) institutions during the shift to online instruction. While the transition to virtual teaching offered benefits, educators encountered significant obstacles, including technical difficulties, low engagement levels, and limited student participation due to poor internet connectivity and lack of access to digital devices.

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Storey, V. A., & Wagner, A. (2024)	Integrating Artificial Intelligence (AI) Into Adult Education: Opportunities, Challenges, and Future Directions	Qualitative	This paper reviews the integration of Artificial Intelligence (AI) in adult education, highlighting its potential benefits and challenges. It analyses AI innovations such as Large Language Models (LLM), Machine Learning (ML), Virtual Reality (VR), and Data Learning Analytics (DLA) in educational contexts. Focusing on adult learners and instructors, the research identifies advantages like personalized learning experiences and improved support, alongside challenges related to data privacy and ethical concerns.
Sephokgole, R. D., Makgato, M., & Khoza, S. (2023)	Innovative Strategies for Integrating Technology into Agricultural Programmes at Technical and Vocational Colleges	Qualitative	Innovative strategies for integrating technology into these programs were examined through interviews, document analysis, and thematic analysis. Participants were knowledgeable about these strategies, which aligned with the Kotlik-Redmann (2003) framework, encompassing technology integration, experimentation, development, and assessment.
Razali, S. S., Ismail, A., Ahmad, M. F., Hassan, W. A. S. W., & Hashim, S. (2023)	Validation of Multimedia Elements Based on Art Context Toward Technical and Vocational Education in the 21st-Century	Qualitative	This study identifies key factors that improve teaching and learning through multimedia. Utilizing the Fuzzy Delphi Technique, data were collected from experts in multimedia design and teaching, who validated the effectiveness of multimedia methods. Future research should explore broader applications of multimedia in TVET to better prepare students for 21st-century challenges.

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<b>Authors</b>	<b>Title</b>	<b>Methods</b>	<b>Main Findings</b>
Richard, G. S., Joseph, A., Elikem K., & Edem, B. K (2023)	Technology Integration in Technical and Vocational Education and Training (TVET): The Role of the Art Teacher	Quantitative	The findings underscore the significance of teachers' technological expertise, pedagogical skills, and art content knowledge for effective technology integration in TVET.
Jamil, M. R. M., Hasyim, A. T. M., Othman, M. S., Ahmad, A. M., Noh, N. R. M., & Kamal, M. F. M. (2023)	Digital Pedagogy Policy in Technical and Vocational Education and Training (TVET) in Malaysia: Fuzzy Delphi Approach	Qualitative	Digital platforms are increasingly adopted in vocational colleges in Malaysia as an alternative to traditional methods, yet student outcomes remain unsatisfactory. The results indicated unanimous consensus (100%) that digital platforms could effectively address two keys objectives for enhancing TVET education.
Razak, A. N. A., Noordin, M. K., & Khanan, M. F. A. (2022)	Digital Learning in Technical and Vocational Education and Training (TVET) In Public University, Malaysia	Quantitative	Findings reveal that while lecturers possess moderate knowledge of online teaching and high proficiency in digital learning, adequate infrastructure remains lacking. The study identifies a gap in knowledge and highlights the need for improved digital learning infrastructure in TVET.
Soeprijanto, S., Diamah, A., & Rusmono, R. (2022)	The effect of digital literacy, self-awareness, and career planning on engineering and vocational teacher education students' learning achievement	Quantitative	The study explores how technology integration enhances teaching and learning in Technical and Vocational Education and Training (TVET). The research shows a significant link between teachers' knowledge and their engagement in TVET. Teachers' technological, pedagogical, and subject-specific knowledge play a vital role in integrating technology into TVET practices.
Bastaki, J., & Charles, L. (2022)	The Privilege to Work: Syrian Refugees in Jordan, Technical and Vocational Education Training, and the Remote Work Loophole	Qualitative	Despite the goal of supporting formal employment, many refugees prefer informal work even after completing TVET training. A key finding is that the most successful TVET programs incorporate digital skills training, which allows refugees to access remote work opportunities and navigate local employment challenges.
Chiloane G.M.; De Jager T.; Mokgosi P. (2022)	TVET Engineering Lecturers' Perceptions on the Application of Technology Tools in Teaching and Learning in South Africa	Qualitative	Teaching and learning in TVET colleges are being transformed by technology. They often lack the skills and knowledge to effectively use technology, which negatively impacts their teaching. Lecturers also struggle to integrate technology into their lessons due to inadequate support.

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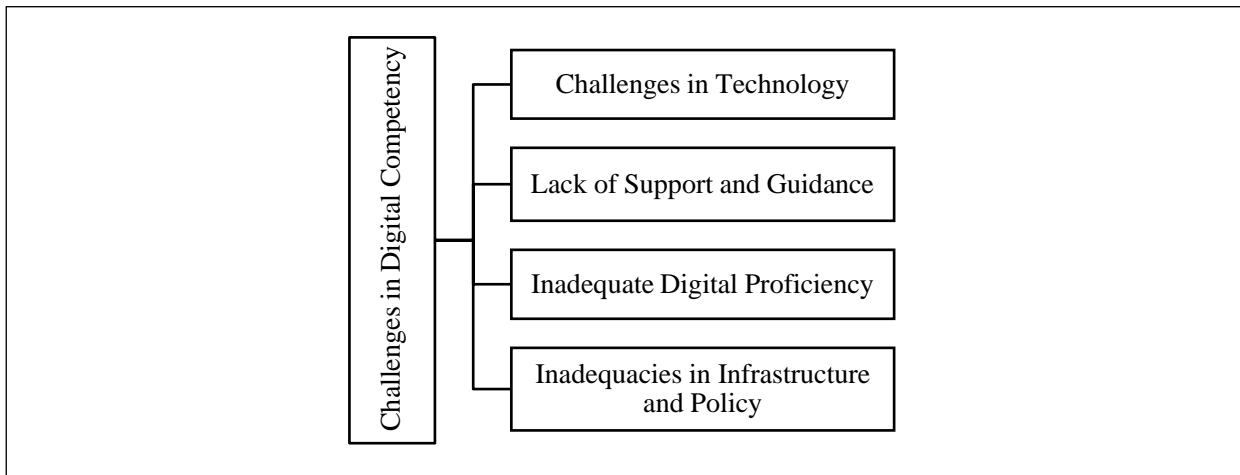
<b>Authors</b>	<b>Title</b>	<b>Methods</b>	<b>Main Findings</b>
Aina, A. Y., & Ogegbo, A. A. (2022)	Investigating TVET collegeeducators' experiences while transitioning from the traditional classroom to the virtual classroom during theCOVID-19 pandemic	Qualitative	Utilizing a case study approach with seven urban TVET educators, the research identified significant challenges, including inadequateunderstanding of virtual teaching, limited training, insufficient online resources, and lack of support. Despite these challenges, positive outcomes were observed, such as enhanced communication skills and the adoption of new teaching methods.
Saienko, V., Kurysh, N., & Siliutina, I. (2022)	Digital Competence of Higher Education Applicants: New Opportunities and Challenges for Future Education	Quantitative	Findings indicate that many students possess insufficient digital competence; despite having access to digital resources, their mastery remains low. The study highlights the critical need for enhanced training to improve digital competence in education.
Karani, A. O., & Mary, W. M. (2022)	Challenges and prospects of online instruction of vocational subjects by TVET institutions in Kenya due to covid-19	Qualitative	Findings reveal challenges such as digital imbalance, lackof competencies, and limited virtual resources, yet the shift to online learning has also created opportunities for the use of electronic devices and platforms, despite access limitations.
Foreman-Brown, G., Fitzpatrick, E., & Twyford, K. (2022)	Reimagining teacher identity in the post-Covid- 19 university: becoming digitally savvy, reflective in practice, collaborative, and relational	Qualitative	Teachers faced heightened demands for professional adaptation, resulting in a notable shift toward relational pedagogies and student- centered approaches. While the move to online teaching presented challenges, it also offered opportunities to enhance relationality and resource access. Successful online education necessitates specific pedagogical practices and methods to cultivate effective relational connections.
Salleh, S. M., Musa, J., Jaidin, J.H., & Shahrill, M. (2021)	Development of TVET teachers' beliefs about technology enriched instruction through professional development workshops: Application of the technology acceptance model	Quantitative	The study examines the impact of perceived technology usefulness, ease of use, and self-efficacy on teachers' intentions. To facilitate this exploration, a series of workshops on technology-enhanced instruction were conducted for TVET teachers. Data analysis revealed a significant influence of perceived technology usefulness, ease of use, and self-efficacy on teachers' intentions to utilize technology in their classrooms.
Owais, A., Alabidi, S., Hatamleh, Z., & Hussein, E. (2020)	Technical and vocational education and training in the UAE	Quantitative	The findings indicate a positive correlation between teachers' use of technology, their training, and access to technology in relation to the mission of TVET institutions. The study highlights critical factors influencing teacher training and technology integration in TVET.

## DISCUSSIONS

### **Research Question 1: What are the potential challenges associated with Digital Teaching Competence in Technical and Vocational Education and Training (TVET) education?**

The review highlights the significant challenges encountered by lecturers in Technical and Vocational Education and Training (TVET) in navigating digital competency as outlined in Figure 3. A main issue is the technical difficulties faced by lecturers can be categorized into the following themes:

**Figure 3** Challenges in Digital Competency



#### **a) Challenges in Technology**

The research findings reveal significant technological difficulties that hinder the integration of digital competencies in Technical and Vocational Education and Training (TVET). A primary concern is the connectivity issues and software glitches that disrupt the teaching and learning process in online environments (Chiloane et al., 2022; Aina & Ogegbo, 2022). These technical challenges can severely impact the efficacy of digital learning, undermining the seamless delivery of course content and activities.

Furthermore, the study highlights the issue of inadequate technology, limited internet access, and frequent power outages, leading to significant challenges with access and equity among TVET lecturers and students (Chiloane et al., 2022; Mesuwini & Mokoena, 2024). These disparities in technological resources and infrastructure underscore the pressing need to address the technology access gaps across the student population. Failure to do so can perpetuate educational inequalities and hinder the effective integration of digital competencies, which are increasingly crucial for success in modern, technology-driven workplaces. Managing these fundamental technological constraints is a key step in empowering Technical and Vocational Education and Training (TVET) institutions to effectively exploit the benefits offered by digital technologies and competencies.

#### **b) Lack of Support and Guidance**

The research findings also highlight the lack of support and guidance available to lecturers in TVET institutions, hindering their ability to effectively navigate the integration of digital competencies. The study indicates that lecturers face limited practical online support, suggesting a significant gap in the assistance and guidance provided to them in utilizing digital platforms and tools effectively (Storey & Wagner, 2024). This lack of support places a considerable burden on lecturers, who are tasked with transitioning to technology-driven teaching methods without the necessary training and resources.

Moreover, the research involving the lack of interaction and support from management and students themselves in the digitalized learning environment (Karani et al., 2022). This deficiency presents obstacles in maintaining student engagement and addressing their individual learning needs. The absence of a collaborative and supportive digital ecosystem can hinder the successful

implementation of digital competencies, as lecturers struggle to foster meaningful interactions and cater to the diverse learning requirements of their students. Addressing these support and guidance gaps is crucial in empowering TVET lecturers to effectively integrate digital skills and technologies into their teaching practices, ultimately enhancing the learning experiences and outcomes for TVET students.

### **c) Inadequate Digital Proficiency**

The research findings also reveal a concerning lack of digital expertise among TVET lecturers, which significantly impacts their ability to effectively integrate technology into their teaching practices. The study indicates that lecturers often lack sufficient technology skills and knowledge, hindering their capacity to seamlessly incorporate digital tools and platforms into their instructional approaches (Saienko et al., 2022). This skills gap presents a significant challenge, as lecturers struggle to navigate the complexities of digital learning environments and maximize the potential of technology-driven pedagogies.

Furthermore, the research highlights the broader inadequacies in the technology skills required to master digital competency within TVET institutions. This finding underscores the critical importance of providing continuous professional development opportunities for lecturers to enhance their proficiency in online learning methods and emerging technologies (Saienko et al., 2022). Without the necessary digital expertise, lecturers are unable to effectively model and impart the digital skills and literacies that are increasingly essential for TVET students to succeed in the technology-driven workplaces of the future. Addressing the skills gaps and fostering ongoing professional development are paramount in empowering TVET lecturers to confidently and effectively integrate digital competencies into their teaching practices.

### **d) Inadequacies in Infrastructure and Policy**

The findings indicate a significant lack of investments in technology infrastructure, which is essential for supporting effective digital learning in Technical and Vocational Education and Training (TVET) institutions. This inadequacy is evident as institutions struggle to provide the necessary resources and technological tools that facilitate an optimal learning environment (Razak et al., 2022; Aina & Ogegbo, 2022; Karani et al., 2022; García-Morales et al., 2021). Insufficient infrastructure not only hampers the effective utilization of digital platforms but also restricts lecturers and students from fully engaging with the technological tools that are crucial for modern educational practices.

Additionally, the absence of coherent policies and frameworks further complicates the integration of technology into TVET education. Such policies are vital for ensuring quality education and guiding the effective incorporation of digital competencies within the curriculum (Razali et al., 2023; Soeprijanto et al., 2022; Aina & Ogegbo, 2022). Without clear guidelines, institutions may face challenges in standardizing the use of technology, which can lead to inconsistencies in teaching approaches and hinder the enhancement of students' skills and competencies in digital literacy. Therefore, addressing these structural and policy-related deficiencies is critical for fostering a robust technological foundation that supports effective digital learning and prepares students for success in a technology-centric workforce.

In conclusion, the review describes the challenges encountered by lecturers and students in TVET education in adapting to digital competencies. A comprehensive strategy is required to confront these challenges, involving investments in technology, continuous professional development, collaborative on the platform, and tailored policies. This will enable TVET lecturers and students to excel in technology-driven workplaces. This strategy will unleash the potential of digital technologies for future workforce enhancement.

**Research Question 2: What strategies can be employed to overcome the barriers to digital competence in Technical and Vocational Education and Training (TVET) education?**

The second theme highlights into strategies can be employed to overcome the barriers to digital competence aimed at improving learning experiences in adapted digital skills literacy, particularly within Technical and Vocational Education and Training (TVET). One of the significant concerns relates to the strategies to overcome the digital competence, which can be classified into different categories as outlined in Figure 4.

**Figure 4** Strategies to Overcome the Digital Competence



**a) Development of a Tailored Framework for Guideline and Standards**

The findings emphasize the importance of digital teaching competencies in academic programs to enhance learning experiences and prepare students for the evolving demands of the digital era and Industry 4.0 (Soeprijanto et al., 2022; Karani et al., 2022; Salleh et al., 2021). One key aspect highlighted is the development of a specific framework tailored to the digital learning needs unique to TVET. This involves establishing guidelines and standards to facilitate efficient and effective digital training that complements the hands-on nature of TVET (Sephokgole et al., 2023; Razak et al., 2022). By focusing on these crucial domains, Technical and Vocational Education and Training (TVET) institutions can enhance their ability to prepare students with the essential digital skills required to excel in the dynamic and technology-oriented work environments anticipated in the future.

**b) Enhance Digital Literacy**

In the field of Technical and Vocational Education and Training (TVET), enhancing the digital literacy of faculty members is a crucial step towards equipping them with the necessary skills and knowledge to effectively integrate digital technologies into their teaching practices. As suggested by Sephokgole et al. (2023), a well-structured approach to digital literacy development should focus on comprehensive training programs that cover a range of digital methodologies and practical skills relevant to the TVET environment.

Additionally, as highlighted by Chiloane et al. (2022), the implementation of regular training workshops can play a significant role in keeping educators up-to-date with the latest digital tools and teaching methods. By investing in the continuous professional development of TVET faculty members, institutions can ensure that they are equipped to leverage digital resources and pedagogy to enhance the learning experiences of their students, ultimately contributing to the overall quality and effectiveness of the TVET system.

### **c) Resource Allocation**

Investing in digital tools is essential for advancing the efficacy of Technical and Vocational Education and Training (TVET) programs, as it directly enhances the teaching and learning processes. Richard et al. (2023) emphasizes the need for improved resource allocation towards the procurement of tools and resources that facilitate digital teaching environments. This may include the implementation of virtual labs and simulation software that effectively replicate real-world scenarios encountered in various vocational fields. By providing faculty and students with access to these innovative resources, educational institutions can create immersive learning experiences that bridge the gap between theoretical knowledge and practical application.

Foreman-Brown et al. (2022) further support this statement, indicating that such investments not only enhance student engagement and understanding but also prepare graduates to meet the demands of the evolving workforce. Ultimately, the strategic allocation of resources towards digital tools is a critical step in equipping TVET learners with the competencies needed for success in their respective industries.

### **d) Industry Collaboration**

The successful integration of digital technologies within Technical and Vocational Education and Training (TVET) programs requires a strong collaborative approach between educational institutions and industry stakeholders. As highlighted by the research of Foreman-Brown et al. (2022), Karani et al. (2022), and Salleh et al. (2021), fostering industry collaborations is crucial to align TVET curricula and learning frameworks with the current and evolving requirements of the workforce. This can be achieved through the implementation of pilot programs that allow for the testing and refinement of new digital learning tools and methodologies based on real-world feedback.

Furthermore, as emphasized by Aina and Ogegbu (2022), TVET institutions should establish continuous research and feedback mechanisms to monitor the effectiveness of their digital learning strategies and make necessary adjustments to ensure they meet the evolving needs of both educators and students. By maintaining a dynamic partnership with industry partners, TVET providers can ensure that their programs remain relevant, responsive, and aligned with the rapidly changing technological landscape, ultimately equipping learners with the necessary digital skills and competencies to thrive in the modern workplace.

### **e) Policy Support**

Transforming Technical and Vocational Education and Training (TVET) requires a dual-pronged policy approach. First, a robust digital infrastructure is essential to support modern educational practices. Advocating for policy reforms that enhance digital infrastructure within TVET institutions is crucial. This includes ensuring adequate access to technology, internet connectivity, and digital learning resources. Second, collaboration among stakeholders is paramount. Encouraging communication and information sharing between educators, policymakers, and other actors within the TVET system is essential. This can be facilitated by creating collaborative online platforms where teachers can share best practices, discuss challenges, and explore innovative solutions. These platforms foster a community of practice, allowing educators to learn from each other and drive impactful change (Richard et al., 2023; Sefhokgole et al., 2023).

Improving resource allocation is also essential, suggesting the need for tools and resources that support digital teaching environments (Richard et al., 2023; Foreman-Brown et al., 2022), such as virtual labs or simulation software for replicating real-world TVET tasks. Continuous research and

feedback collection are recommended to monitor and enhance digital learning approaches, refining strategies to meet the needs of educators and students (Aina & Ogegbo, 2022). Collaborative efforts with industries are proposed to ensure alignment with current industry requirements. Training workshops should be conducted regularly to update educators on the latest digital tools and teaching methods (Chiloane et al., 2022). The combined efforts of these methodologies are oriented towards establishing a more resilient and adaptable digital learning atmosphere within Technical and Vocational Education and Training (TVET) contexts, enabling educators and learners alike to excel in the era of digitalization.

The literature highlights a comprehensive set of strategies to overcome the digital competence aimed at enhancing digital skills literacy and learning experiences within Technical and Vocational Education and Training (TVET) contexts. A key focus is on developing tailored frameworks and standards to guide effective digital training that aligns with the hands-on nature of TVET (Sephokgole et al., 2023; Razak et al., 2022). This includes strengthening the digital competencies of faculty members through specialized preparation and training programs in digital methodologies and skills suited for TVET (Sephokgole et al., 2023).

### **Limitation and Recommendations**

This scoping literature review on digital competence in TVET educations acknowledges several limitations. Firstly, the literature search was limited to publications up to August 2024, potentially excluding more recent research on this evolving topic. Additionally, the review was restricted by the specific search terms and databases employed, which may have resulted in the omission of relevant studies published elsewhere.

Another limitation of this study is its primary focus on the perspective of TVET (Technical and Vocational Education and Training) training providers, despite the aim to offer policy guidelines for a broader range of TVET stakeholders, including policymakers, industry representatives, government authorities, funding agencies, researchers, and academia. This narrow focus may have restricted the comprehensiveness of the insights generated. Nonetheless, the study's systematic approach to reviewing existing literature on digital competence in the TVET perspectives provides a valuable foundation for understanding the current state of knowledge and informing future research and policy initiatives. The findings and recommendations presented should be interpreted and applied within the context of these acknowledged limitations.

### **CONCLUSIONS**

The scoping review on the integration of digital competency skills in educational settings highlights the promising opportunities and challenges presented by these technologies within the context of Technical and Vocational Education and Training (TVET). The review emphasizes the transformative impact of technology integration, showcasing advanced technologies such as Artificial Intelligence (AI), Virtual Reality (VR), Augmented Reality (AR), the Internet of Things (IoT), and Robotics. These technologies offer interactive, immersive, and personalized learning experiences that effectively bridge the gaps between practical and theoretical knowledge.

Moreover, these understanding will enhance student engagement and improve learning outcomes, indicating a bright future for educational advancements. Additionally, the review underscores the importance of incorporating digital competency into learning experiences. By integrating these technologies into academic curricula, students not only acquire practical skills but also develop competencies essential for navigating the digital landscape of Industry 4.0. AR and IoT, in particular, provide real-world contexts, interactive learning opportunities, and hands-on experiences, simplifying complex concepts and rendering the learning process more engaging.

While the benefits of adapting digital learning experiences in education are evident, the review identifies several challenges that must be addressed for successful implementation. These challenges include inadequate technical infrastructure, insufficient teacher training, content development issues, and financial constraints. Collaboration and investment are essential for effectively overcoming these obstacles. Furthermore, the study emphasizes the necessity for further investigation into the factors influencing the digital competence of TVET teachers, indicating a research gap in understanding the

various internal and external elements that impact teacher competence in the digital realm.

In conclusion, effectively addressing the challenges in integrating digital competency within Technical and Vocational Education and Training (TVET) necessitates a comprehensive strategy that includes enhancing digital infrastructure, improving teacher training, integrating digital skills into curricula, and strengthening industry partnerships. These efforts are essential for aligning TVET education with the demands of the digital era. By leveraging digital competencies, educational institutions can create enriching learning environments that not only prepare students for a technology-driven future but also cultivate critical thinking and essential practical skills.

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