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## A SYSTEMATIC REVIEW OF THE IMPACT OF EMERGING TECHNOLOGIES IN SHAPING TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING STUDENTS' LEARNING STYLES

СИСТЕМАТИЧНИЙ ОГЛЯД ВПЛИВУ НОВИХ ТЕХНОЛОГІЙ НА ФОРМУВАННЯ СТИЛІВ НАВЧАННЯ СТУДЕНТІВ ТЕХНІЧНОЇ ТА ПРОФЕСІЙНОЇ ОСВІТИ

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### ABSTRACT

*The rapid advancement of emerging technologies is fundamentally reshaping Technical and Vocational Education and Training (TVET), driving a transformation in both pedagogical practices and student learning styles.*

*Швидкий розвиток нових технологій фундаментально змінює технічну та професійну освіту, стимулюючи трансформацію як педагогічної практики, так і стилів навчання студентів.*

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**Purpose.** This review critically examines the impact of technologies such as Artificial Intelligence (AI), Virtual Reality (VR), Augmented Reality (AR), the Internet of Things (IoT), and digital learning platforms on TVET.

**Methodology.** The study adopted the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) systematic review approach to review relevant articles that explore how emerging technologies facilitate learning in TVET colleges. A literature search was conducted within bibliographic databases to track relevant articles on emerging technologies, TVET, and learning styles. 43 articles that met the final eligibility criteria were subjected to deep review, which yielded the results presented in the study.

**Results.** The study reveals that the integration of these tools enhances hands-on, interactive, and personalized learning experiences, catering to diverse learner preferences and equipping graduates with essential digital skills for the modern workforce. While the adaptation of teaching strategies to individual learning styles remains debated, evidence supports the use of multimodal, technology-enhanced approaches to foster inclusivity and improve educational outcomes.

**Conclusion.** The review identifies gaps between student learning preferences and the evolving technological landscape, offering recommendations for bridging these divides and for the successful integration of emerging technologies in TVET. Ultimately, this study underscores the necessity for ongoing research and strategic implementation to ensure that TVET remains responsive to both learner diversity and industry demands in the 21st century.

**Keywords:** emerging technologies, learning styles, learning preferences, technology adaptation, TVET students.

**Мета.** Огляд критично розглядає вплив таких технологій, як штучний інтелект (ШІ), віртуальна реальність (ВР), доповнена реальність (ДР), Інтернет речей (ІР) та цифрові навчальні платформи на технічну й професійну освіту.

**Методологія.** У дослідженні використано підхід систематичного огляду «Переважні елементи звітності для систематичних оглядів та метааналізу» (PRISMA) для аналізу відповідних статей, що досліджують, як новітні технології сприяють навчанню в закладах технічної та професійної освіти. Проведено пошук літератури в бібліографічних базах даних для відстеження статей про новітні технології, технічну й професійну освіту та стилі навчання. 43 статті, які відповідали остаточним критеріям відбору, було піддано глибокому аналізу, результати якого подано в дослідженні.

**Результати.** Дослідження показує, що інтеграція цих інструментів покращує практичний, інтерактивний і персоналізований навчальний досвід, враховуючи різноманітні вподобання студентів та оснащуючи випускників необхідними цифровими навичками. Хоча адаптація стратегій навчання до індивідуальних стилів навчання залишається предметом дискусій, дані підтверджують ефективність мультимодальних, технологічно вдосконалених підходів, які сприяють інклюзивності та покращують освітні результати.

**Висновок.** Огляд виявляє розриви між уподобаннями студентів у навчанні та технологічним ландшафтом, що розвивається, і пропонує рекомендації щодо подолання цих розбіжностей та успішної інтеграції нових технологій у технічну й професійно-технічну освіту. Дослідження підкреслює необхідність постійного вивчення й стратегічного впровадження інновацій, щоб забезпечити технічну та професійну освіту, зорієнтовану на різноманітність студентів і вимоги галузі ХХІ ст.

**Ключові слова:** новітні технології, стилі навчання, адаптація технологій до уподобань у навчанні, студенти професійно-технічної освіти.

## INTRODUCTION

Emerging technologies are transforming education, particularly in Technical Vocational and Education Training (TVET). Educators are integrating digital tools to enhance teaching and meet diverse learning preferences. ICT integration in TVET develops essential digital skills essential for the digital economy (Yeap et al., 2021; Charles et al., 2024). Technology acceptance in TVET is key for educational quality and employability (Charles et al., 2024). Automation, robotics, IoT, and AR are reshaping learning, blending practical and virtual tools to prepare students for industry demands. This shift improves skill development and

efficiency but poses challenges in teacher training, resources, and curriculum adaptation. Effective integration of these technologies into TVET redefines learning styles, driven by digital advancements, sustainability needs, and industry demands.

Emerging technologies in vocational education, such as VR, AR, and AI, offer immersive experiences that support skill development and engagement for diverse learners (Ghosh & Ravichandran, 2024; Bonde, 2024). Khoirunnisa et al. (2025) note that technologies like virtual simulations enhance flexibility and adaptability in TVET, accommodating varied learning styles. According to Rajamanickam et al. (2024), VR, AR, and big data personalize learning in TVET but may increase educational inequality due to access issues. Leong (2024) states that virtual reality boosts practical skills and industry adaptability in TVET. Tshong and Yasin (2023) assert that technology improves learning strategies and access for urban and rural students, influencing industry demands.

#### – **Identifying and understanding students' learning styles and needs in TVET in the 21<sup>st</sup> century**

Understanding students' learning styles is key for effective, inclusive education. Ying (2024) defines these as students' innate preferences for processing information. With diverse classrooms and changing technologies, educators must recognize different learning methods, such as visual, hands-on, or auditory (Hatira & Sarac, 2024; Hernandez et al., 2020; Pascu, 2024). Adapting teaching strategies to these differences can improve engagement, retention, and academic success.

Learning styles are categorized into cognitive, personality, and sensory types (Dornyei, 2005). Cognitive styles include field-dependent/independent, analytical/global, and impulsive/reflective. Sensory styles, known as VARK, consist of Visual, Aural, Read/write, and Kinesthetic (Husmann & O'Loughlin, 2018). Personality styles encompass extrovert/introvert, random-intuitive/concrete sequential, and closure-oriented/open-oriented. Understanding these styles helps TVET teachers and learners improve learning outcomes by adapting to students' preferences.

Integrating digital tools and AI in education involves understanding learning styles to enhance student potential for the future workforce. Education emphasizes critical thinking, creativity, and adaptability over memorization. Recognizing visual, auditory, reading/writing, and kinesthetic styles improves engagement, while cognitive styles like dependent, independent, avoidant, collaborative, competitive, and participant support technology adaptation in class (Grasha, 1996). Tailoring teaching to these styles fosters an inclusive and effective learning environment.

Learning styles affect learners by potentially making their education more efficient (Pritchard, 2013). Teachers can enhance education by adapting methods to match these styles, though the effectiveness is debated. Research, like a study in Anatomical Sciences Education, shows minimal academic improvement from matching teaching to learning styles (Husmann & O'Loughlin, 2018). VARK framework advocates for using diverse methods to vary content, clarify concepts, tackle difficult topics, and expose students to various study techniques.

Overemphasizing learning styles can hinder students' adaptability. Evidence-based teaching with varied methods, like active learning and technology, enhances engagement. VR and simulations benefit kinesthetic learners (Lawrence, 2024), while auditory and visual learners gain from podcasts, lectures, and infographics. Despite increasing engagement, technology's impact on performance is inconsistent. A study

found no significant link between technology use and English performance in Grade 12 students (Edulan et al., 2025).

This review investigates how emerging technologies like AI, VR, AR, IoT, and digital platforms affect TVET students' learning styles amid industry changes. These technologies transform education by altering learning methods and required skills, yet there is a mismatch with TVET students' styles. To address this, the study uses the PCC framework (Population, Concept, Context) for research questions, criteria, and strategy. This framework suits reviews on complex, context-dependent educational phenomena, especially in non-interventional or qualitative studies (Peters et al., 2020).

The Population focuses on TVET students with practice-oriented training, the Concept on emerging technologies' impact on learning style adaptation, and the Context on varying TVET institutions and tech-enhanced learning settings. The PCC offers flexibility for qualitative evidence synthesis (Munn et al., 2018). Using the PCC, the following questions were raised: *What are the emerging technologies that impact TVET students' learning styles? What are the impacts on TVET students' learning styles? and What are the challenges to overcome in the integration of emerging technologies in TVET?* This review explores responses to these questions and ultimately provides conclusions and recommendations.

The **purpose** is to examine critically the impact of technologies such as Artificial Intelligence (AI), Virtual Reality (VR), Augmented Reality (AR), the Internet of Things (IoT), and digital learning platforms on TVET.

## METHODOLOGY

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis PRISMA systematic review approach was used in reporting the findings of this review (Figure 1). It consolidated the existing empirical evidence in the literature on the impacts of emerging technologies on TVET students' learning styles. The methodology comprises the search strategy and database selection, inclusion and exclusion criteria, screening, and selection of eligible studies, synthesizing and analyzing the data in the final selected studies.

### – Search strategy and database selection

Literature search was conducted within bibliographic databases such as ERIC (Education Resources Information Center), SCOPUS and Web of Science to track relevant articles on emerging technologies, TVET and learning styles. Google Scholar was used as a supplementary search source for grey literature and working papers such as the ILO, UNESCO, and OECD. The search string used included (“emerging technologies” or “technology in education” or “21<sup>st</sup> century education”) AND (“students' learning styles” or “learning preferences”) AND (“TVET” or “vocational education” or “technical education”).

### – Inclusion and exclusion criteria

The criterion for inclusion comprises studies within the last ten years (2016-2025), full-text studies, focusing on TVET learners, technology in education and published in the English language. The exclusion criteria were publications before 2016, studies published in languages other than English, studies that do not specifically address emerging technology and TVET students' learning styles and preferences, and studies that address learning styles in fields other than TVET.

### – Screening and selection of eligible studies

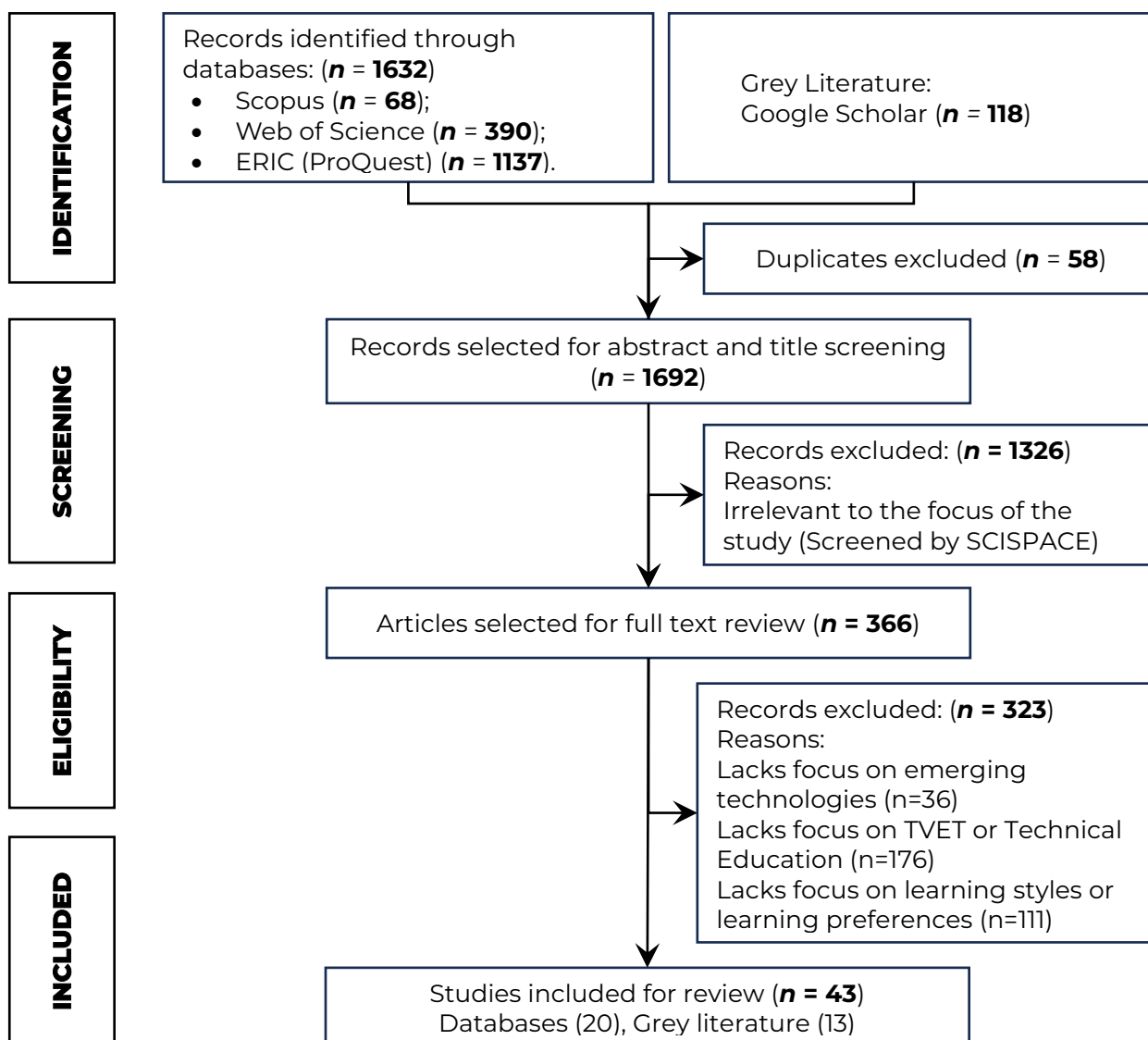
Subsequent to the search conducted in the various databases, applying the inclusion criterion, the initial search result yielded a total of ( $n=1750$ ) published articles altogether.

Scopus yielded ( $n=68$ ) articles, ERIC (ProQuest) yielded ( $n=1137$ ) articles, while Web of Science yielded ( $n=390$ ) articles. Additional sources from grey literature, such as Google Scholar, yielded ( $n=118$ ) articles. The publication titles and abstracts were screened to remove duplicate articles, where ( $n=58$ ) articles were deleted, leaving ( $n=1692$ ) articles.

The remaining articles ( $n=1692$ ) were screened using SCISPACE software to remove irrelevant works based on the exclusion criteria, leaving ( $n=366$ ) articles. The software further screened the ( $n=366$ ) adopting deep reviews, ( $n=323$ ) were excluded, leaving ( $n=20$ ) from databases and (13) from other sources, adding up together, the top ( $n=43$ ) articles met the final eligibility criteria for review based on the research objectives and questions.

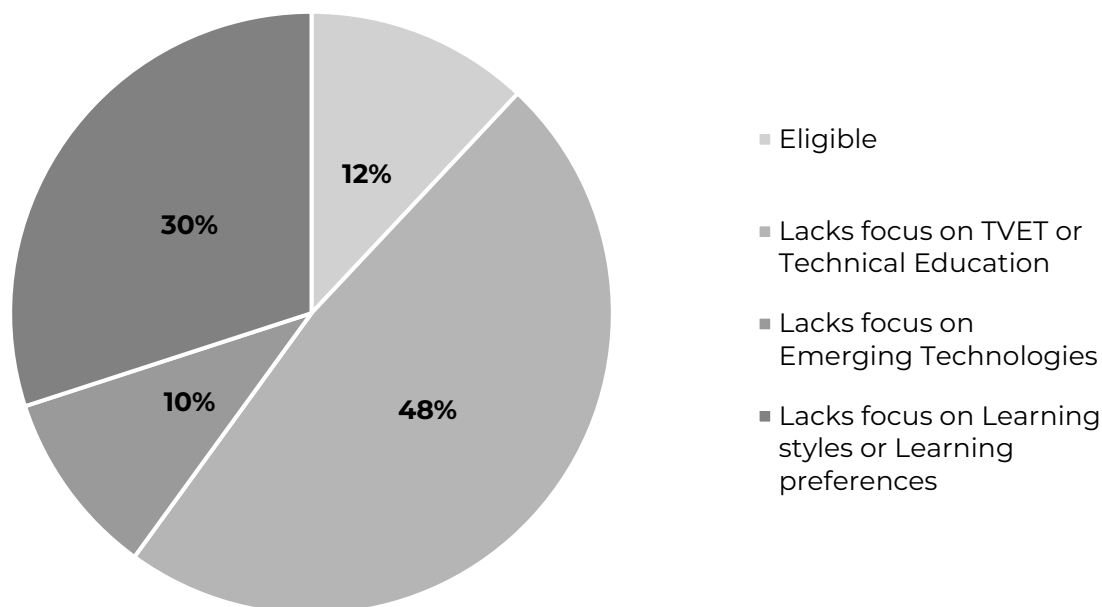
**Figure 1**

*Flow diagram of the PRISMA procedure*



**RESULTS**

The eligible articles ( $n=43$ ) were finally subjected to deep review by the authors, and four key concepts were identified across the forty-three studies based on the research objectives and questions raised for the study. The analysis of the screening procedure is shown in Figure 2.

**Figure 2***Analysis of studies reviewed*

Screening reveals only 12% (n=43) of articles are eligible for study. Of the rest, 30% lack focus on learning styles, 48% on TVET, and 10% on emerging technologies. Although there are enough studies on emerging technologies, they often overlook TVET and its impact on learning styles, highlighting a significant gap in the study.

– **Overview of emerging technologies impacting TVET student learning in the 21st century**

Emerging technologies in the 21st century are rapidly influencing sectors like healthcare, education, and industry. They are transforming TVET by offering innovative tools for diverse learning styles, with AI, VR, AR, IoT, and others reshaping traditional learning.

*Artificial Intelligence (AI) and Machine Learning (ML)*

AI in TVET develops adaptable systems that tailor education to individual needs via tools like adaptive learning, tutoring, and chatbots (Amdan et al., 2024; Ghosh & Ravichandran, 2024; Thakur et al., 2024). AI and ML are essential for data analysis, modeling, and automation, enhancing efficiency and decision-making. They ensure responsible and fair technology use in industries. AI complements educators by customizing learning, automating tasks, and simulating real-world scenarios. It provides feedback, adaptive platforms, and simulations for safe skill practice. AI transforms higher education by fostering critical thinking and creativity, converting readings to audio, summarizing studies, and aiding with assignments, making learning engaging (Lu, 2025). This aids TVET students in adapting to new industries and decision-making.

*Internet of Things (IoT)*

The IoT ecosystem links physical devices to the internet, enabling seamless data exchange and automation. It allows remote monitoring and control of systems, offering hands-on training in technical fields (Bonde, 2024; Ghosh & Ravichandran, 2024). This has spurred innovations in smart homes, healthcare, and industrial automation. Integrating IoT with TVET enhances real-time monitoring, responsiveness, and efficiency in education. Despite benefits, IoT faces security, data management, and interoperability

challenges. IoT creates smart educational environments by connecting devices for real-time data analysis. In technical education, it supports interactive learning and hands-on experiences with connected technology (Badshah et al., 2023). IoT-enabled labs and platforms like Blynk and Particle.io let students manage experiments remotely, strengthening their understanding of interconnected systems (Badshah et al., 2023).

#### *Augmented Reality (AR) and Virtual Reality (VR)*

AR and VR enhance TVET training by creating immersive environments for practicing technical tasks in simulated real-world scenarios (Leong, 2024; Gaikwad & Mulay, 2024; Sheela et al., 2023), improving labor market skills. Despite high costs, tech limits, and acceptance issues, AR and VR apply theoretical knowledge practically in safe environments. They are vital for hands-on learners, simulating tasks like machinery troubleshooting and logistics (Morley, 2024), and allowing safe experimentation with complex processes. AI tools like Siemens NX enable safe practice of industry skills, while AR apps such as SketchAR and AR Circuits enhance interactive learning by overlaying digital information onto the physical world, making abstract concepts tangible (Godoy & Carlo, 2022). This technology adapts learning to individual needs and styles.

#### – **Interactions between students' learning styles and emerging technologies in TVET**

Emerging technologies have significantly transformed TVET. Aligning these innovations with diverse learning styles such as visual, auditory, kinesthetic, and reading/writing offers challenges and opportunities (Wang, 2024). These technologies can either bridge or widen gaps between learning styles and teaching, and their success relies on matching students' preferred modalities.

Recent studies emphasize the gap between students' learning styles and technology, highlighting the need for integration, blended learning, and digital pedagogy for personalized education. Ying (2024) addresses diverse learning challenges in digital education, making traditional TVET settings obsolete. In wealthier countries, digital TVET supports knowledge economies and workplace tech changes (Perumal & Orji, 2024). By 2005, most EU states had adapted digital tools for future skills (UNESCO-UNEVOC, 2022). Developing nations use digital tools to expand post-secondary education access, driven by global partners and donors emphasizing blended learning (UNESCO-UNEVOC, 2022).

The UNESCO-UNEVOC (2022) framework highlights two key aspects of digitalization reshaping student learning in TVET. These include integrating digital tools like augmented reality for experiential engagement and delivering distance learning through videoconferencing and online platforms for ubiquitous experiences. These dimensions are complementary and show how technology alters learning modalities. Considering how disruptive technologies affect learning styles is necessary.

#### – **Cases Studies of TVET institutions adapting AI technologies in TVET**

Case studies show that integrating emerging technologies into TVET is gaining a successful move. Riski and Nuryanto (2024) reported that, in vocational high schools, AI-based learning improved students' technical skills and motivation, with average post-test scores rising to 81.18 from 76.26 for conventional learning. The AIM@VET project has equally integrated AI into VET programs to enhance students' AI skills and prepare them for the digital workforce (Emeršič et al., 2024). These highlighted cases indicate the transformative potential of technology in TVET, enhancing education and training in line with technological advancements. In India, AI-driven platforms analyse student progress and recommend tailored content to ensure skill mastery (George, 2024; Ghosh & Ravichandran, 2024).

In Germany, smart factories for apprenticeships were applied to train vocational schools students, it yielded improved grid efficiency (Mika & Goudz, 2021). Adopting virtual welding trainers using AI, virtual trainers provide instant feedback to students in Australia, resulting in improved precision and reduced material waste (Ghosh & Ravichandran, 2024). The TVET sector in the Philippines introduced 3D-printed electronics training, increasing student engagement and reducing material costs (Calma, J. & Calma, F. 2024). In Kenya, vocational centers implemented solar energy training programs, increasing graduates' employability in the green energy sector by 35% (Silva et al., 2016).

South Korea initiated the smart factory TVET initiative, equipping students with hands-on experience in robotic automation (Wee et al., 2024). With Indonesia's integration of AI in vocational education, specifically in vocational high schools, students' technological proficiency and learning efficiency were enhanced, aligning their competencies with Industry 4.0 requirements. TVET organizations across countries provide insights into effective technology integration despite not elaborating on specifics.

These success stories highlight that AI and other emerging technologies in TVET are not about replacing traditional methods but enriching them to achieve better outcomes. The integration of these emerging technologies in TVET programs with proper alignment of students' learning styles enhances student competency, aligns with industry needs, and promotes employability in modern TVET fields. Policymakers and educators must continue upgrading curricula to ensure TVET institutions remain relevant in the 21st-century workforce.

#### – **Challenges and barriers**

While integrating new technologies in TVET provides benefits, it also presents challenges. Fast technological advances create new learning opportunities but may not suit all student learning styles. Many TVET students thrive in hands-on environments, yet smart technologies, automation, and AI could reduce engagement. Such challenges associated with the integration of technologies are highlighted in this section.

#### ***Digital readiness and context sensitivity***

A major challenge in implementing tech-enhanced learning in TVET is ensuring digital readiness. Policymakers should assess their readiness and evaluate challenges in meeting specific student needs (UNESCO-UNEVOC, 2020). This is crucial, as digital tool effectiveness relies on context, such as infrastructure, teacher skills, and student backgrounds. Successful integration requires prioritizing the readiness of institutions, teachers, and students.

#### ***Mismatch in pedagogical approaches***

Traditional TVET learners favor practical learning, while digital tools like AR and VR may not suit their hands-on style, causing adaptation issues (Keaveney & Dowling, 2018; Joshi, et al., 2021). Educators often lack skills to integrate these technologies, necessitating ongoing professional development (Wahjusaputri et al., 2024). Hasnan et al. (2021) highlighted a skill mismatch in Malaysian TVET teachers, underscoring the need for continuous development to meet technological advancements.

#### ***Digital literacy gaps***

Emerging technologies can enhance learning, but digital literacy challenges persist. Many TVET instructors require more training to use smartboards effectively (Okanya, 2023). Limited access to digital tools and the internet exacerbates educational

inequalities (Amdan et al., 2024). Digital technologies cannot replace hands-on training. Balancing tech-mediated learning with traditional skill development is essential in TVET. AR and VR complement but do not replace real workplace experience, necessitating blended approaches for diverse learning styles and needs.

### **Access to resources**

Inadequate funding and resource allocation hinder the effective deployment of technology in TVET. Many institutions, especially in low-income nations, lack the infrastructure to support emerging educational tools, limiting the potential for adaptive learning environments (UNESCO-UNEVOC, 2024). High costs associated with VR and AR equipment, as well as insufficient technological infrastructure, can also hinder widespread adoption (Leong, 2024; Gaikwad & Mulay, 2024). Research has shown that infrastructure requirements are a crucial factor for technology integration in TVET colleges (Leong, 2024; Amdan et al., 2024; Wahjusaputri et al., 2024).

### **Cognitive overload and learning fatigue**

AI-based learning systems can overwhelm students who prefer hands-on instruction over algorithm-driven approaches (Maghsudi et al., 2021). This creates limitations for these students. Additionally, AI and IoT use poses privacy and security concerns, necessitating strong measures to protect student data (Yakkala, 2024).

## **DISCUSSION**

Emerging technologies in TVET have impacted and transformed students' learning styles into more interactive, personalized, and immersive experiences, shifting from traditional classrooms to flexible learning accessible anytime and anywhere. The impacts on learning styles are categorized into the following four, which are engagement, experience, practical skills, and inclusivity.

### *Enhanced engagement and motivation*

AI tools like ChatGPT boost student engagement, especially among skilled users (Hamid et al., 2023). However, they don't fully address the impact of all emerging technologies on technical education learning styles. Immersive technologies like VR and AR enhance engagement by making complex concepts interactive and accessible (Leong, 2024; Gaikwad & Mulay, 2024). VR, in particular, revolutionizes practical skills training with immersive, risk-free environments. Despite its potential, most TVET institutions need better training for teachers in VR (Sheela et al., 2023).

Blended learning and flipped classrooms have made learning more active, allowing students to prepare independently and enhance knowledge through peer interaction (Boehm-Fischer & Beyer, 2024). This approach lets TVET students engage with content at their pace before collaborating. Additionally, online social networks offer just-in-time learning from peers and experts. This social learning fosters practice communities where TVET students bridge theory and workplace application.

### *Personalized learning experiences*

Personalized learning focuses on the unique attributes of each learner by tailoring content, pacing, and assessment to individual needs, moving away from a one-size-fits-all model. It adapts teaching to each student's learning style, be it visual, auditory, or kinesthetic (Hornostaieva & Kravchenko, 2021; Sumarni et al., 2023; Tverdokhliebova & Yevtushenko, 2023). AI algorithms enhance personalized learning by addressing diverse styles and reducing educational disparities. AI-driven adaptive systems adjust difficulty and pace

based on performance (Amdan et al., 2024; Thakur et al., 2024). AI in TVET enhances learning with personalized, immersive methods using tools like adaptive systems and VR for diverse needs, boosting skill development and delivery (Thakur et al., 2024).

VR simulations enable task practice without resource depletion or safety risks, supporting self-paced learning (Leong, 2024). These technologies provide immediate feedback and use big data for diverse learners (Yakkala, 2024). Personalized learning improves experiences and comprehension in fields like TVET. VR boosts knowledge mastery and skills, increasing satisfaction and interest, though it doesn't cover all emerging technologies. Limited specialized resources might hinder its effectiveness.

#### *Improved practical skills and problem-solving*

The integration of e-learning in TVET presents both opportunities for enhancing accessibility, engagement, and practical skill development. It provides another technology innovation in TVET by infusing the use of simulation and problem-based learning (PBL) frameworks. These teaching strategies have been shown to significantly improve the practical skills of students while also developing their critical thinking abilities, thereby bridging the gap between theoretical knowledge and real-world application (Mulaudzi et al., 2023).

Effective e-learning strategies for TVET also include modular course design, blended learning approaches, competency-based assessment, online mentorship, and personalized resources. The AI-based learning platforms provide immediate feedback and personalized assessments, improving students' problem-solving skills and technical proficiency (Riski & Nuryanto, 2024). The AI-based teaching factories enhance students' technological adaptation and industry readiness, preparing them for the demands of Industry 4.0 (Wahjusaputri et al., 2024; Emeršič et al., 2024). Emerging technologies such as AI, VR, and AR can be leveraged to build STEM skills such as science observation, experimentation, and critical thinking required in TVET and TVET industries. Such scenarios are particularly relevant in vocational contexts where hands-on experience is crucial.

#### *Accessibility and inclusivity*

Emerging technologies like IoT and VR provide remote access to high-quality training, overcoming geographical and resource constraints (Bonde, 2024; Ghosh & Ravichandran, 2024). Connectivist approaches, including blended learning and flipped classrooms, offer flexible options for diverse student needs (Chen & Chan, 2024). This flexibility enhances engagement, inclusivity, and personalization by enabling learners to select activities matching their styles. Digital pedagogies in TVET, like blended and simulation-based learning, boost flexibility and effectiveness, promoting autonomous and personalized learning, but face challenges like technological disparities, knowledge fragmentation, and insufficient digital literacy among educators.

Emerging technologies profoundly affect students' learning styles in TVET, requiring updates to curricula, teaching methods, and partnerships with industry to meet economic demands. By embracing these changes, TVET institutions will crucially prepare graduates with skills for a technology-driven world

## **CONCLUSIONS**

The impact of emerging technologies on students' learning styles in TVET represents a significant paradigm shift from traditional approaches to more flexible, personalized, authentic, and collaborative learning experiences. Digital tools and technologies are

enabling TVET institutions to accommodate diverse learning preferences, create immersive learning environments, and prepare students for increasingly digitalized workplaces.

The transformation extends beyond simply digitising existing content; it involves reimagining how learning occurs, how skills are developed, and how knowledge is constructed. By leveraging technologies like AR, VR, learning management systems, and social learning platforms, TVET can become more responsive to individual learning styles while maintaining its focus on practical skill development.

However, successful implementation requires careful consideration of context, investment in teacher preparation, and a balance between digital and hands-on learning experiences. As TVET continues to evolve in response to technological advances and changing workforce needs, understanding and accommodating diverse learning styles will remain central to effective educational practice. The promising practices from around the world offer valuable lessons for policymakers and practitioners seeking to enhance the quality and relevance of TVET through technology integration.

### **Recommendations**

Based on the promising practices observed, several policy directions emerge for enhancing the impact of technology on learning in TVET raising the following recommendations.

1. Strategic integration of ICT into TVET systems, aligning technological interventions with labor market needs and student learning preferences.
2. Professional development programmes that prepare TVET teachers not only to use digital tools but also to implement pedagogical approaches that leverage technology to accommodate diverse learning styles.
3. Investment in infrastructure and accessibility to ensure equitable access to technology-enhanced learning opportunities, particularly in developing regions.
4. Development of quality assurance mechanisms that evaluate the effectiveness of digital tools in promoting different learning styles and achieving desired learning outcomes.
5. Recognition of ICT as an essential tool for strengthening education systems and enhancing quality and effective learning, going beyond the traditional view of ICT for increasing access to education.

### **Future directions**

The Education 2030 Framework for Action aims for inclusive, equitable education and lifelong learning, supporting technology-enhanced TVET. Recognizing ICT as transformative aligns with digital societal needs, enabling new TVET possibilities like enhanced knowledge sharing, authentic learning via simulations/VR, improved monitoring, and personalized feedback. Fully utilizing these can advance TVET experiences.

The future of TVET lies in the continued integration of emerging technologies, with a focus on addressing current challenges and leveraging opportunities for innovation. Key areas for future research and development include:

1. Advanced adaptive learning systems: Enhancing AI-driven systems to cater to diverse learning styles and preferences in TVET educational system.
2. Immersive learning environments: Expanding the use of VR and AR to create more realistic and interactive learning experiences in TVET institutions.

3. Inclusive digital solutions: Developing affordable and accessible technologies to bridge the digital divide and ensure equitable access to quality education in TVET programmes.

By embracing these advancements, TVET can continue to evolve, equipping students with the skills and knowledge required to thrive in a rapidly changing world.

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### CONFLICT OF INTERESTS

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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