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TECHNOLOGY-MEDIATED INSTRUCTION IN TRAINING TRANSFER: A SYSTEMATIC REVIEW

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Abstract:

The transfer of training remains a critical challenge in achieving effective learning outcomes, particularly within technology-mediated environments. While extensive research has examined trainee characteristics, training design, and work environment as key factors of training transfer, the mediating role of Technology-Mediated Instruction (TMI) has received comparatively limited attention. This systematic literature review (SLR) seeks to examine and consolidate existing research on the mediating influence of TMI in enhancing training transfer outcomes. To address this research gap, the review adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring a methodologically sound and transparent approach. A thorough search was conducted in two prominent academic databases, Scopus and Web of Science (WoS), resulting in the identification of 28 primary studies that met the inclusion criteria. The analysis of these studies led to the emergence of three key thematic areas: (1) Innovative Pedagogies and Learning Transfer, highlighting the role of learner-centred and active learning approaches in promoting transfer; (2) Artificial Intelligence, Digital Technologies, and Instructional Tools, focusing on how emerging technologies and digital platforms facilitate engagement and retention; and (3) Teacher Development, Competencies, and Educational Contexts, emphasising the importance of trainer skills and contextual factors in maximising the effectiveness of technology-mediated delivery. The findings suggest that TMI serves as a critical enabler, connecting instructional strategies, digital tools, and human competencies to training transfer outcomes. This review contributes to advancing the theoretical understanding of TMI as a

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mediator and offers practical insights for designing more effective digital training interventions. The study concludes by highlighting future research directions, including the need for empirical validation of TMI's mediating effects across different organisational and cultural contexts.

Keywords:

Training, Training Transfer, Technology-Mediated Instruction, Literature Review

Introduction

Training transfer, which refers to the degree to which knowledge, skills, and competencies gained through formal learning experiences are successfully transferred to the workplace, remains a crucial focus in the field of human resource development (HRD) (Santana-Domínguez et al., 2022). Organisations invest significant resources in training programmes with the expectation of improved individual performance and broader organisational outcomes (Caliendo et al., 2023). However, the ongoing disparity between the knowledge gained during training and its actual application in the workplace remains a significant challenge (Mohamad et al., 2021). Over time, research has established that the success of training transfer is shaped by a complex interplay of factors, namely trainee characteristics, training design, and the work environment (Baldwin & Ford, 1988). These foundational elements have guided both theoretical and empirical discussions on learning effectiveness (Burke & Hutchins, 2007). Nevertheless, the rise of digital learning environments has brought about a shift in the traditional understanding of how training is delivered and how learning is sustained beyond the classroom (Schroeder-Strong et al., 2024). With the increasing integration of learning management systems, virtual platforms, and blended approaches, Technology-Mediated Instruction (TMI) has become an integral part of training delivery in many sectors (Sepideh & Mahnaz, 2017). As organisations adopt more digital approaches to capacity building, it is essential to examine how TMI interacts with key training factors and whether it holds a greater influence than previously assumed.

TMI is not simply a change in how content is delivered but represents a broader transformation in pedagogy, learner engagement, and performance outcomes (Nelson, 2000). Although digital tools have improved flexibility and access in training, questions remain about how they support the transfer of learning. Much of the current literature has concentrated on assessing the impact of individual technological platforms or tools, as well as learner satisfaction and access (Ganiyu et al., 2023). However, there is limited empirical focus on how TMI may function as a mediator and how it influences the relationships between trainee characteristics, training design, and the work environment with actual transfer outcomes (Nelson, 2000). This distinction is important because it recognises technology not just as a passive delivery medium, but as a dynamic element that can strengthen, weaken, or redirect the impact of key training factors (Zeehan et al., 2020). Furthermore, in public sector training, often driven by compliance and structured curricula, and varying levels of digital literacy, TMI may present unique challenges and opportunities (Hernández et al., 2022). Despite widespread implementation of online and hybrid learning formats (Masalimova et al., 2021), the relationship between digital instruction and training transfer remains unclear, particularly in institutional contexts where traditional learning cultures persist. The limited evidence on how TMI mediates learning application highlights a critical gap in both theory and practice (Bower, 2019), especially when considering how to improve learning efforts in complex organisations.

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This article aims to bridge this gap by examining the mediating role of Technology-Mediated Instruction in the relationship between trainee characteristics, training design, work environment, and training transfer (Baldwin & Ford, 1988; Burke & Hutchins, 2007). The central question driving this study is: Does Technology-Mediated Instruction mediate the relationship between key training factors and the transfer of training to the workplace? This research theorises that TMI does more than facilitate access to content. It potentially shapes how training is perceived, engaged with, and applied by learners. By analysing TMI as a mediating variable, the study extends traditional models of training transfer and offers a fresh perspective that aligns with the current shift toward digital learning ecosystems. The objective of this article is to provide a deeper insight into how TMI contributes to or hinders the application of learning in real-world settings. It aims to generate practical insights for instructional designers, training professionals, and policy makers seeking to enhance training effectiveness in technology-enhanced contexts. Specifically, the findings are expected to inform the design of more impactful, technology-integrated training programmes that consider the multifaceted role of TMI in shaping transfer outcomes. This contribution is particularly timely as organisations, especially in the public sector, seek to adapt to digital transformation (Mateescu et al., 2021) while ensuring that learning interventions yield tangible, measurable results.

Literature Review

The evolution of training methodologies has witnessed a significant shift with the emergence of technology-mediated instruction (TMI). Over the decades, the integration of digital tools has expanded the potential of training programmes across industries and educational settings. Early efforts in institutional settings aimed at enabling access to standardised and scalable educational content, such as the initiative by the Geriatric Education Centre in Pennsylvania, reflected a multi-university collaboration to enhance training via CD-ROMs, videoconferencing, and online modules (Segrist, 2001). This effort demonstrated the feasibility of using technology to reach geographically dispersed learners, highlighting the early promise of digital tools in expanding access and professional development. Meanwhile, in developing countries, internet training initiatives, such as those led by the Romanian Academy of Science, were studied for their longer-term behavioural impacts using established evaluation frameworks. These programmes demonstrated that without structured follow-up and assessment, technology-driven learning may show limited long-term behavioural transfer (Segrist, 2001; Ruth, 2000; Scott et al., 2020).

Industrial training programmes have also adopted TMI, particularly in high-tech environments where the transfer of advanced skills is essential. For instance, an in-house initiative at PETROBRÁS utilised intelligent system technologies, combining symbolic AI and neural networks in a structured, project-based model to meet organisational training goals (Da Mota Tenorio et al., 1997). Such project-oriented formats provide evidence that technology, when aligned with authentic workplace challenges, enhances contextual relevance and motivation for transfer. Similarly, research conducted among Japanese, American, and Mexican maquiladora companies found that the cultural context and the depth of training significantly influenced technology assimilation, with Japanese-led models showing higher engagement in skill-based and managerial-level transfer (Chandra et al., 2018; Da Mota Tenorio et al., 1997; Raafat et al., 1992). These insights suggest that TMI's effectiveness may be shaped not only by content design but also by the depth and strategic alignment with professional roles.

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Despite these advances, structural impediments continue to inhibit effective technology transfer. Studies have noted that university-industry collaboration is often hindered by unclear policies, insufficient intellectual property frameworks, and cultural dissonance between academic and commercial goals (Brodhag, 2013). Without institutional support to remove these barriers (Bremer, 1990; Brodhag, 2013; Gering, 1990), even the most robust TMI platforms may fall short in achieving sustained learning application. Furthermore, (Gering, 1990) observed that gaps in intellectual property awareness and contractual knowledge within academic institutions further weaken technology transfer efforts. These findings suggest that institutional ecosystems may play a crucial role in either facilitating or limiting the effectiveness of TMI in both educational and industrial contexts.

On the other hand, recent studies focusing on ICT integration in public education systems provide fresh insight into how TMI operates as a mediator in training transfer. The TeTra-ICT model explored in Greece found that instructors' self-efficacy, perceptions of digital platforms, and training support significantly influenced their intention to integrate and transfer ICT knowledge into classroom practices (Perifanou et al., 2023). These results support the argument that learner confidence and system usability are critical mediators in the transfer process. Similarly, training programmes in the transportation sector advocated for modular hybrid content, continuous researcher mobility, and embedded ICT tools to support lifelong professional growth (Giannopoulos, 2015; Perifanou et al.; Scott et al., 2020). Together, these studies affirm that training transfer is not solely a function of content delivery but is significantly mediated by the perceived value, accessibility, and support embedded in the digital training ecosystem.

In agricultural contexts, technology-mediated training has been examined in relation to institutional barriers and local adaptability. A study from India identified comprehension, customisation, and generalisation as critical variables affecting farmers' adoption of technology through training (Chandra et al., 2018). These insights emphasise the importance of incorporating localised content and ensuring contextual relevance in TMI strategies to bridge the divide between learning and its practical application effectively. The challenge lies in adapting generic technologies to specific community contexts where literacy levels, access to infrastructure, and cultural factors vary widely. Hence, TMI models should not assume uniform applicability across domains, but rather adapt their training design to local realities (Chandra et al., 2018; Ruth, 2000; Scott et al., 2020).

Across all domains reviewed, several key gaps emerge. Firstly, while digital platforms and blended models are frequently employed, few studies explicitly test the mediating role of TMI using formal mediation analysis. Secondly, most evaluations are limited to short-term or immediate post-training measures. Longitudinal studies that track behavioural change or performance metrics over time are rare, leading to uncertainty about the sustained impact of TMI. Lastly, the variability in programme success suggests a need for a unified conceptual framework that integrates individual, organisational, and technological factors in training transfer. The lack of such a framework results in inconsistent practices and limited scalability of successful models.

Given these limitations, there is a strong need for further empirical research focusing on how TMI mediates the relationship between established transfer factors, such as trainee readiness, training design quality, and environmental support, and observable training outcomes. Future studies should adopt a mixed-methods approach, combining statistical mediation models with

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qualitative insights to uncover contextual nuances. A sector-specific focus, especially in public service and institutional training, would help tailor digital interventions more effectively. There is also a need to move beyond descriptive analyses to more predictive and explanatory frameworks that clarify not just whether TMI works, but also how, for whom, and under what conditions it is most effective.

Research Questions

Formulating a well-defined research question in a systematic literature review (SLR) provides a clear direction, ensuring the process stays focused and structured. It helps define the scope, guide the selection of relevant studies, and ensure the review remains targeted and consistent with its objectives (Booth et al., 2016). This becomes particularly important when exploring complex themes such as training transfer and technology-mediated instruction, where clarity in the research question allows for a more focused and meaningful synthesis of existing literature (Gough et al., 2017). In this study, the research questions were carefully crafted to ensure a systematic and well-defined review process.

Defining the Research Questions (RQs) is considered the most crucial step in the planning phase. It serves as a foundational component of any Systematic Literature Review (SLR), as it determines the structure and approach of the entire review process. Defining the Research Questions (RQs) is regarded as the most critical task during the planning phase. It remains a central element of any Systematic Literature Review (SLR), as it shapes the overall review methodology (Kitchenham et al., 2007). As the primary goal of this SLR is to assess the current state of knowledge, the PICo framework was employed in this study to support the formulation of the research questions. The PICo framework, a mnemonic approach specifically designed for developing research questions in qualitative studies, was introduced by(Lockwood et al., 2015). PICo refers to Population, Interest, and Context, each representing the following:

Population (P): Denotes the group or participants targeted by the research, such as a particular demographic, patient category, or community.

Interest (I): Refers to the primary subject or phenomenon under investigation, which may include specific experiences, behaviours, interventions, or issues intended to be explored.

Context (Co): Describes the environment, setting, or specific circumstances in which the population and interest are situated, such as geographical location, cultural background, or social context.

Utilising the PICo framework helps to clearly and methodically organise research questions by dividing the key aspects of the study into its three fundamental components (Cooke et al., 2012). This approach ensures the research stays focused, with questions carefully crafted to guide the identification of relevant literature or the design of the study (Methley et al., 2014). In this study, three specific research questions were formulated as follows:

1) How do innovative pedagogical strategies within technology-mediated instruction influence learning transfer among trainees in digital training environments?
2) What is the mediating role of AI, digital technologies, and instructional tools in enhancing learning transfer among trainees in technology-mediated instructional settings?

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AIJBES
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3) How does teacher competency development within technology-mediated instructional contexts influence the transfer of training in educational and professional development programmes?

Materials and Methods

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework serves as a well-recognised standard for ensuring that the review process is transparent, thorough, and consistent, as outlined by Page et al. (2021). PRISMA enhances research credibility and rigour by providing clear steps for selecting relevant studies and prioritising high-quality, low-bias research. In this review, Web of Science and Scopus were chosen due to their extensive coverage and recognised reliability in providing robust scholarly sources (Falagas et al., 2008).

The PRISMA process provides a clear and organised framework for conducting a systematic literature review, encompassing four essential stages: identification, screening, eligibility assessment, and data extraction. It starts with a search for pertinent studies, after which titles and abstracts are examined to filter out those that are not relevant. Full texts are then assessed, and key information is extracted for analysis. This structured approach enhances transparency, rigour, and reproducibility (Page et al., 2021), especially valuable in evidence-based fields like education, human resource development, and the social sciences.

Identification

This study adhered to the essential stages of the systematic review process to compile a significant body of pertinent literature. The process began with the careful selection of relevant keywords, which were then broadened by incorporating related terms sourced from dictionaries, thesauri, encyclopaedias, and previous studies. After finalising the relevant terms, search strings were created specifically for the Web of Science and Scopus databases, as detailed in Table 1. In the preliminary stage of the search, a total of 2,532 publications related to the research topic were identified across both databases, forming the foundation for the subsequent stages of the review.

Table 1: The Search String

Scopus	TITLE-ABS-KEY (technology AND instruction AND (training OR learning OR study) AND (transfer OR output)) AND (LIMIT-TO (SUBJAREA , "SOCI")) AND (LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2024) OR LIMIT-TO (PUBYEAR , 2025)) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (LANGUAGE , "English")) **Date of Access: September 2025**
WoS	technology AND instruction AND (training OR learning OR study) AND (transfer OR output) (Topic) and 2025 or 2024 or 2023

Advanced International Journal of Business, Entrepreneurship and SME's
AIJBES
EISSN: 2682-8545
Volume 7 Issue 26 (December 2025) PP. 01-25
DOI 10.35631/AIJBES.726001

(Publication Years) and Article (Document Types) and Education Educational Research or Social Sciences Other Topics (Research Areas)

Date of Access: September 2025

Screening

During the screening stage, the gathered research articles were meticulously evaluated to ensure their relevance to the central research question. Special emphasis was placed on studies addressing TMI and training transfer, ensuring they aligned with the central theme of this review. Duplicate entries were identified and removed to avoid redundancy. Out of the initial pool of 2,532 publications, 2,428 were excluded based on the established inclusion and exclusion criteria (as detailed in Table 2), leaving 104 papers for further assessment. Priority was given to primary sources of evidence, including peer-reviewed journal articles, while materials such as book series, book reviews, meta-syntheses, meta-analyses, conference proceedings, and book chapters not directly linked to recent studies were excluded. The review was limited to English-language publications published between 2023 and 2025 to maintain consistency and relevance. An additional 17 papers were removed during this stage due to duplication, ensuring the final selection was accurate and free from overlap.

Table 2: The Selection Criterion in Searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Time line	2023 – 2025	< 2023
Literature type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press
Subject Area	Social Science	Besides Social Science

Eligibility

The third stage of the process, known as the eligibility phase, involved a detailed review of 104 selected articles. During this phase, the titles, abstracts, and key sections of each publication were meticulously examined to determine if they met the inclusion criteria and were directly aligned with the research objectives. Several articles were excluded at this stage due to their irrelevance to the study, misalignment with the research focus, abstracts that did not correspond to the study's aims, or lack of full-text access to empirical data. Following this detailed assessment, 28 articles were deemed appropriate and proceeded to the next phase of the review.

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Data Abstraction and Analysis

This study employed an integrative analysis method to evaluate and combine findings from multiple quantitative studies. The primary objective of this approach was to identify central themes and subthemes relevant to the research focus. The process of theme development began during the data collection phase. As illustrated in Figure 1, a total of 28 selected publications were carefully reviewed to extract information and evidence relevant to the study objectives. The analysis involved examining how each study addressed the relationship between Technology-Mediated Instruction (TMI) and training transfer, including the research methods used and the main findings reported.

During the data analysis, a logbook was kept to document important observations, insights, and any questions that emerged while interpreting the data. The results were subsequently reviewed to ensure consistency in the identification and development of the themes. In cases where there were differences in opinions or interpretations, these were openly discussed among the authors until a mutual agreement was reached.

Quality of Appraisal

In line with the approach suggested by Kitchenham and Charters [28], after selecting the Primary Studies (PS), it was crucial to evaluate the quality of each study and conduct a systematic comparison. For this purpose, we adopted the quality assessment framework from (Abouzahra et al., 2020), which provides six key evaluation criteria for conducting a robust systematic literature review (SLR).

Each study was assessed against these six criteria using a simple scoring system to ensure consistency and objectivity. The scoring involves three levels: "Yes" (Y) with a score of 1 if the criterion is fully met, "Partly" (P) with a score of 0.5 if the study meets the criterion but with some gaps, and "No" (N) with a score of 0 if the criterion is not met at all. This structured evaluation helped us to gauge the overall quality and reliability of the studies included in our review.

QA1. Is the purpose of the study clearly stated?

QA2. Is the interest and the usefulness of the work clearly presented?

QA3. Is the study methodology clearly established?

QA4. Are the concepts of the approach clearly defined?

QA5. Is the work compared and measured with other similar work?

QA6. Are the limitations of the work clearly mentioned?

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AIJBES
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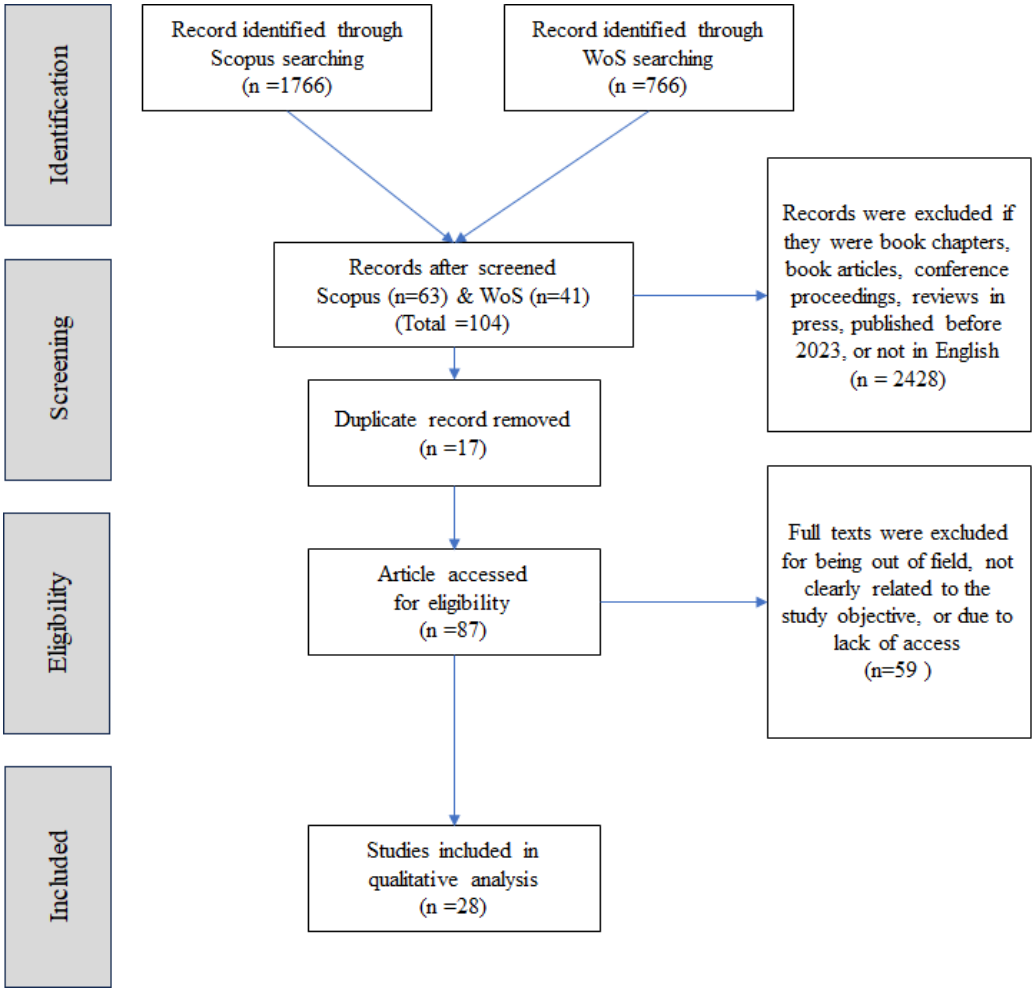

Figure 1: Flow Diagram of the Proposed Searching Study (Moher et al., 2009)

Result and Finding

The quality assessment of the 28 selected studies (Table 3) on learning transfer, instructional technologies, and training interventions demonstrated a generally high standard across the reviewed literature. Out of the 28 primary studies, the majority (22 studies) achieved a total score of 5.0 or higher out of 6.0, indicating strong clarity in their research purpose, usefulness, methodology, and conceptual framework. Notably, one study (PS2 by Schreiter et al., 2024) achieved a perfect score of 6.0 (100%), reflecting exemplary quality in meeting all six quality assessment criteria. Several studies, including PS3, PS8, PS12, PS15, PS22, PS25, and PS28, also scored above 90%, suggesting a well-structured approach to research design and reporting.

However, some papers showed moderate gaps in specific areas, particularly in the definition of concepts (QA4), comparison with similar work (QA5), and the presentation of research limitations (QA6). Studies such as PS1, PS5, and PS19 received lower total scores (4.0 or 66.7%), primarily due to partial fulfilment in these criteria. This indicates that while their research objectives and significance were generally clear, the articulation of methodology

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details, theoretical positioning, and critical reflection on limitations were less comprehensive. The common trend among the lower-scoring papers was the insufficient explanation of how the study's approach relates to or differs from existing literature and a lack of explicit discussion on research constraints.

Overall, the findings from this quality assessment highlight a positive trend in research rigour and reporting practices within the field, particularly among more recent publications. The consistent use of mixed-method designs, systematic reviews, and emerging technologies such as AI, AR, and digital tools reflects the field's alignment with contemporary educational challenges and innovations. However, to strengthen the overall research quality, future studies are encouraged to clearly articulate their conceptual models, engage more thoroughly in comparative analysis, and provide transparent accounts of methodological limitations. This would enhance the replicability, critical appraisal, and practical utility of research outcomes, especially in the context of technology-mediated learning and training transfer studies.

Table 3: Quality Assessment Table for the Selected Papers

Primary Study	QA1	QA2	QA3	QA4	QA5	QA6	Total Mark	Percentage (%)
PS1 (Park, 2023)	Y	Y	P	Y	P	P	4.0	66.7
PS2 (Schreiter et al., 2024)	Y	Y	Y	Y	Y	Y	6.0	100.0
PS3 (Chang et al., 2024)	Y	Y	Y	Y	Y	P	5.5	91.7
PS4 (Aljabr, 2025)	Y	Y	Y	Y	P	P	5.0	83.3
PS5 (Huang, 2023)	Y	Y	P	P	P	P	4.0	66.7
PS6 (Bansal et al., 2024)	Y	Y	Y	Y	P	P	5.0	83.3
PS7 (Li, 2023)	Y	Y	Y	Y	P	P	5.0	83.3
PS8 (Pellas, 2025)	Y	Y	Y	Y	Y	P	5.5	91.7
PS9 (Maulida et al., 2024)	Y	Y	Y	Y	P	P	5.0	83.3
PS10 (Ruff et al., 2024)	Y	Y	Y	Y	P	P	5.0	83.3
PS11 (Cheng et al., 2025)	Y	Y	Y	Y	P	P	5.0	83.3
PS12 (Knoth et al., 2024)	Y	Y	Y	Y	Y	P	5.5	91.7
PS13 (Nyarko & Petcovic, 2023)	Y	Y	Y	Y	P	P	5.0	83.3
PS14 (Wei-Kocsis et al., 2024)	Y	Y	Y	Y	P	P	5.0	83.3
PS15 (Barz et al., 2024)	Y	Y	Y	Y	Y	P	5.5	91.7
PS16 (Gil & Dueñas, 2023)	Y	Y	Y	Y	P	P	5.0	83.3
PS17 (Abdelshiheed et al., 2024)	Y	Y	Y	Y	P	P	5.0	83.3
PS18 (Causey et al., 2025)	Y	Y	Y	Y	P	P	5.0	83.3
PS19 (Ramirez et al., 2023)	Y	Y	P	P	P	P	4.0	66.7
PS20 (Onifade & Alex-Nmecha, 2023)	Y	Y	Y	Y	P	P	5.0	83.3
PS21 (Kim et al., 2025)	Y	Y	Y	Y	P	P	5.0	83.3
PS22 (Mitropoulos et al., 2024)	Y	Y	Y	Y	Y	P	5.5	91.7
PS23 (Taguchi, 2023)	Y	Y	Y	Y	P	P	5.0	83.3
PS24 (Kadhim et al., 2023)	Y	Y	Y	Y	P	P	5.0	83.3
PS25 (Spangenberger et al., 2025)	Y	Y	Y	Y	Y	P	5.5	91.7
PS26 (Ma & Lei, 2024)	Y	Y	Y	Y	P	P	5.0	83.3
PS27 (Zaim et al., 2024)	Y	Y	Y	Y	P	P	5.0	83.3
PS28 (Chen et al., 2023)	Y	Y	Y	Y	Y	P	5.5	91.7

Notes

- Y (1): Yes, fully meets the criterion.
- P (0.5): Partly meets the criterion.
- N (0): Does not meet the criterion.

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Innovative Pedagogies and Learning Transfer

The findings presented across the selected abstracts provide a multifaceted view of how innovative pedagogies, particularly those involving technology-mediated instruction, enhance the process of learning transfer. (Aljabr, 2025; Park, 2023; Taguchi, 2023) (Aljabr, 2025) and (Taguchi, 2023) each focused on language acquisition, showing how digital technologies support skill development in second language contexts. (Park, 2023) study demonstrates the usefulness of corpus-aided instruction in increasing lexicogrammatically awareness among multilingual learners, enabling transfer of knowledge in academic writing. Similarly, (Aljabr, 2025) investigation into Automatic Speech Recognition (ASR) reveals notable improvements in English pronunciation and prosody when integrated with peer feedback. Taguchi's research on digital games for teaching pragmatics shows that contextualised feedback within game-based environments enhances learners' pragmatic competence. Collectively, these studies highlight that digital linguistic tools, when grounded in pedagogically sound frameworks, serve as effective mechanisms for facilitating language-based skill transfer.

Further contributions underscore the significance of immersive, experiential, and interactive learning methods in improving cognitive and self-regulated learning outcomes. (Maulida & Nurlaelah, 2024) report that the application of augmented reality in experiential learning significantly boosts mathematical reasoning, particularly when directed instruction complements the experience. (Cheng et al., 2025) reinforce the relevance of technological aids by revealing that digital diaries promote self-regulated learning (SRL), especially during the shift between online and face-to-face learning contexts. Meanwhile, (Abdelshiheed et al., 2024) explore how metacognitive knowledge and learner motivation impact learning transfer across Intelligent Tutoring Systems (ITSs). Their findings confirm that personalised instructional strategies, including nudges and worked examples, can compensate for gaps in procedural and conditional knowledge. Together, these studies highlight the crucial role of tailored technological support in enabling learners to take control of their learning processes and apply acquired knowledge across different settings.

Hands-on, problem-based, and game-driven approaches also feature prominently as mechanisms to promote effective learning transfer. (Chang et al., 2024) report that online STEAM hands-on learning fosters engagement and creativity in artificial intelligence education, while also significantly influencing learners' understanding and attitudes. (Mitropoulos et al., 2024) similarly demonstrate that using simple mechanical objects in problem-solving tasks leads to better comprehension of complex engineering concepts, reinforcing the role of tangible learning aids in abstract domains. (Barz et al., 2024), in a meta-analysis of digital game-based learning (DGBL), affirm that such interventions yield moderate to high gains in cognitive outcomes, though effects on metacognitive skills are limited. These insights confirm that learners benefit from practical, interactive environments that bridge conceptual knowledge and real-world applications, especially when supported by educational technology.

Lastly, collaborative and context-specific pedagogies remain critical for preparing learners with transferable interpersonal and cognitive skills. (Nyarko & Petcovic, 2023) address this through their case study in geoscience fieldwork, showing that students naturally develop teamwork competencies such as leadership, communication, and peer mentoring, even without explicit teamwork instruction. This aligns with findings from (Barz et al., 2024) and (Abdelshiheed et al., 2024), where collaborative dynamics, either through group learning or peer scaffolding, are recognised as catalysts for effective knowledge transfer. These

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contributions collectively reinforce the importance of embedding social learning opportunities and reflection-based practices in instructional designs to optimise the application of learned skills in varied contexts.

No.	Article Title
1	Learning Transfer through Corpus-Aided Instruction
3	Influence of online STEAM hands-on learning on AI learning, creativity, and creative emotions
4	ASR Using Speechnotes for EFL Learners: A Study of the Effects on English Pronunciation and Prosody Skills
9	The Effect of Experiential Learning and Directed Instructions Assisted by Augmented Reality on Students' Self-Regulated Learning
11	Digital diaries supporting self-regulated learning during in-person and online transitions
13	Do students develop teamwork skills during geoscience fieldwork? A case study of a hydrogeology field course
15	The Effect of Digital Game-Based Learning Interventions on Cognitive, Metacognitive, and Affective-Motivational Learning Outcomes in School: A Meta-Analysis
17	How and When: The Impact of Metacognitive Knowledge Instruction and Motivation on Transfer Across Intelligent Tutoring Systems
22	The utility of mechanical objects: Aiding students' learning of abstract and difficult engineering concepts
23	Technology-enhanced language learning and pragmatics: Insights from digital game-based pragmatics instruction

Artificial Intelligence, Digital Technologies, and Instructional Tools

The integration of artificial intelligence (AI) and digital technologies within educational contexts has led to significant advancements in instructional tools and learning strategies. Multiple studies have confirmed the increasing impact of AI-generated instructional resources in enhancing learner engagement and knowledge retention. (Pellas, 2025) demonstrated that AI-generated instructional videos contribute positively to self-efficacy, task performance, and learning outcomes within science teacher education, supporting knowledge transfer and retention. Similarly, (Zaim et al., 2024) highlighted that generative AI, when incorporated into English as a Foreign Language (EFL) pedagogy, significantly influences behavioural intentions and adoption among university lecturers. This relationship is moderated by factors such as performance expectancy and social influence, as confirmed through structural equation modelling. (Knoth et al., 2024) further reinforced this by emphasising the importance of AI literacy and prompt engineering strategies, which significantly predict the quality of outcomes from interactions with large language models (LLMs). Together, these studies suggest that AI-powered instructional designs hold considerable promise in improving learner autonomy, engagement, and knowledge transfer.

Further analysis across several studies supports the view that immersive and interactive digital tools significantly contribute to enhancing educational delivery. (Spangenberger et al., 2025) provided evidence that immersive virtual reality (iVR) applications, when aligned with curricula and learning objectives, enhance factual knowledge and comprehension in vocational

Advanced International Journal of Business, Entrepreneurship and SME's
EISSN: 2682-8545
Volume 7 Issue 26 (December 2025) PP. 01-25
DOI 10.35631/AIJBES.726001

training contexts. Complementing these insights, (Ruff et al., 2024) assessed the use of ChatGPT in chemistry education, concluding that while the tool offers a valuable starting point for method development, critical evaluation and AI literacy remain necessary to achieve effective application. (Wei-Kocsis et al., 2024) proposed a proactive and collaborative paradigm for cybersecurity education that incorporates AI-based simulations and social constructivist approaches, which engage learners in real-world problem-solving scenarios. These findings collectively suggest that active and immersive learning technologies, particularly those leveraging AI, can promote critical thinking and effective knowledge application across various domains.

The role of digital infrastructure, such as cloud-based and mobile learning systems, also remains central in facilitating technology-mediated learning environments. (Causey et al., 2025) illustrated how remote and cloud-based simulation through web conferencing platforms supports skill development in perfusion education by enabling flexible and high-fidelity learning experiences. (Kadhim et al., 2023) advanced this discussion by proposing an IoT-based assessment framework for engineering education, demonstrating improved classification of student activities and learning outcomes through automated data processing. (Huang, 2023) contributed to this discourse by optimising multimodal learning environments through knowledge base technologies, leading to enhanced learning abilities and teaching effectiveness. These contributions underline the importance of technological infrastructure as a backbone for innovative learning environments, where digital tools enable real-time feedback, personalised instruction, and enhanced learning achievement.

The expansion of digital instructional tools has also opened discussions on the need for effective design and user experience in AI-mediated learning systems. (Kim et al., 2025) explored user experiences with AI-based image generation systems, indicating that interactive feedback mechanisms and two-way communication features significantly enhance user satisfaction and creativity. Similarly, (Schreiter et al., 2024) emphasised the importance of teacher preparedness in statistical and data literacy, advocating for tailored pedagogical approaches that align with current curriculum needs in K-12 STEM education. These findings resonate with the observations made by (Knoth et al., 2024), suggesting that both AI literacy and the thoughtful design of interactive systems are critical factors in ensuring the successful implementation of technology-mediated instruction. Such insights reaffirm the necessity of balancing technological innovation with sound pedagogical principles to achieve meaningful learning transfer.

No.	Article Title
5	Open Learning Environment for Multimodal Learning Based on Knowledge Base Technology
8	The Impact of AI-Generated Instructional Videos on Problem-Based Learning in Science Teacher Education
10	Using ChatGPT for Method Development and Green Chemistry Education in Upper-Level Laboratory Courses
12	AI literacy and its implications for prompt engineering strategies
14	Cybersecurity Education in the Age of Artificial Intelligence: A Novel Proactive and Collaborative Learning Paradigm
18	Advances in remote and cloud-based simulation through web conferencing platforms

Advanced International Journal of Business, Entrepreneurship and SME's
AIJBES
EISSN: 2682-8545
Volume 7 Issue 26 (December 2025) PP. 01-25
DOI 10.35631/AIJBES.726001

21	Journey of Finding the Best Query: Understanding the User Experience of AI Image Generation System
24	Enhancement of Online Education in Engineering College Based on Mobile Wireless Communication Networks and IOT
25	Orchestrating iVR technology in an authentic classroom setting and its effects on factual knowledge, comprehension and transfer
27	AI-powered EFL pedagogy: Integrating generative AI into university teaching preparation through UTAUT and activity theory

Teacher Development, Competencies, and Educational Contexts

The evolving landscape of education necessitates continuous enhancement of teacher competencies, particularly concerning digital technologies and data literacy. (Schreiter et al., 2024) highlighted the significant gaps in teachers' statistical and data literacy within K-12 STEM education, noting that while cognitive variables have been a focus, affective components and practical applications in classroom practice remain underexplored. Similarly, (Bansal et al., 2024) underscored the role of computer-based skill training for persons with disabilities (PwDs), illustrating how ICT-driven vocational education not only enhances employability but also facilitates independence and societal inclusion. The study by (Gil & Dueñas, 2023) further reinforced this narrative by emphasising the necessity of professional development for English Medium Instruction (EMI) lecturers, pointing out that pedagogical and communicative skills are essential alongside linguistic proficiency. These findings suggest that the integration of technology into teacher training programmes supports both technical and soft skills development, contributing to improved learning outcomes.

Emerging research also illustrates the importance of rethinking instructional design frameworks to better support teacher competencies in the digital era. (Ramirez et al., 2023) introduced the concept of Knowledge Systems Design (KSD) as a modern approach to instructional technology, focusing on processes that facilitate knowledge transfer across various contexts. This aligns with the observations of (Ma & Lei, 2024), who identified Artificial Intelligence Literacy (AIL) and perceived usefulness as crucial factors influencing teacher education students' willingness to adopt AI technologies for information-based teaching. Their work, rooted in the Technology Acceptance Model (TAM), demonstrated that enhancing AI literacy directly contributes to positive behavioural intentions among pre-service teachers. (Onifade & Alex-Nmecha, 2023) also contributed to this discourse by addressing the ethical dimension of teacher competencies, specifically in managing plagiarism within academic institutions in Nigeria. Their study recommended a multifaceted strategy involving plagiarism detection tools, information literacy programmes, and advocacy to foster ethical writing and research practices.

No.	Article Title
2	Teaching for statistical and data literacy in K-12 STEM education: a systematic review on teacher variables, teacher education, and impacts on classroom practice
6	Importance of computer in learning of person with disabilities in skill training
7	A Survey of Translation Learners' Uses and Perceptions of Neural Machine Translation
16	Designing and Implementing a Professional Programme for ICLHE Teachers: Beyond Linguistic and Communicative Competence

Advanced International Journal of Business, Entrepreneurship and SME's
AIJBES
EISSN: 2682-8545
Volume 7 Issue 26 (December 2025) PP. 01-25
DOI 10.35631/AIJBES.726001

19	Knowledge Systems Design (KSD): Rebranding the Field of Instructional Technology in the Education and Professional Development Community
20	Tackling the challenges of plagiarism in the age of information overload by LIS professionals in Nigerian academic institutions
26	The factors influencing teacher education students' willingness to adopt artificial intelligence technology for information-based teaching
28	Exploring contributors, collaborations, and research topics in educational technology: A joint analysis of mainstream conferences

Discussion

The findings of this systematic literature review underscore the evolving role of Technology-Mediated Instruction (TMI) as a mediating mechanism in facilitating effective training transfer. Across the 28 selected studies, three primary themes emerged: Innovative Pedagogies and Learning Transfer, AI, Digital Technologies, and Instructional Tools, and Teacher Development, Competencies, and Educational Contexts. These themes reflect significant trends within the training and educational landscape, particularly in the context of digital learning environments. The first theme highlighted how learner-centred approaches, experiential learning, problem-based tasks, and digital games significantly support the application of knowledge across varied settings. The second theme emphasised the transformative potential of AI-powered tools, immersive technologies such as virtual reality (VR), and cloud-based infrastructures in enhancing engagement and knowledge retention. The third theme focused on the critical role of trainer competencies, digital readiness, and contextual factors, demonstrating that human capabilities remain central in maximising the effectiveness of TMI. These thematic patterns suggest that effective training transfer is not merely the product of content delivery but stems from a multifaceted interaction between pedagogical strategies, technological innovation, and human capital development. The quality assessment results, where most studies scored highly on research clarity and methodology, further support the credibility of these findings, although certain gaps remain, particularly in articulating limitations and comparing outcomes across similar interventions.

Interpreting these results through the lens of transfer theories and digital pedagogy frameworks offers valuable insights into why these themes hold significant weight in current discourse. The selection of these thematic areas was deliberate, as they directly align with the core determinants of training transfer: trainee characteristics, training design, and work environment, with TMI positioned as the mediating factor. The emphasis on innovative pedagogies resonates with the recognition that active engagement, hands-on experiences, and personalised feedback mechanisms strengthen cognitive and behavioural outcomes, thus bridging the gap between learning and application. This aligns with Baldwin and Ford's (1988) assertion that learning design plays a critical role in shaping transfer effectiveness. The prominence of AI, digital technologies, and instructional tools reflects the contemporary push toward adaptive learning environments where instructional content can be tailored to individual needs. Technologies such as intelligent tutoring systems, AI-generated instructional videos, and immersive VR applications enhance learning autonomy and engagement, supporting Davis's Technology Acceptance Model (TAM), which emphasises the significance of perceived usefulness and ease of use in the adoption of technology. Meanwhile, the third theme on teacher development reinforces Holton's Learning Transfer System Inventory (LTSI) framework,

Advanced International Journal of Business, Entrepreneurship and SME's
AIJBES
EISSN: 2682-8545
Volume 7 Issue 26 (December 2025) PP. 01-25
DOI 10.35631/AIJBES.726001

particularly regarding the role of environmental support and supervisory influences. Trainer readiness, digital literacy, and ethical practices such as plagiarism management are shown to directly affect the success of TMI-mediated learning environments. Collectively, these interpretations affirm that the effectiveness of TMI as a mediator is contingent not only upon technological integration but also on strategic alignment with pedagogical models and human competencies.

The insights from these findings provide valuable recommendations for instructional designers, policymakers, and training professionals seeking to optimise the use of TMI in real-world contexts, especially within public sector training environments. First, the evidence suggests that training programmes should adopt a blended approach, combining innovative pedagogical strategies such as problem-based learning, experiential activities, and interactive simulations with the flexibility offered by digital tools. Rather than focusing solely on technology as a delivery mechanism, emphasis should be placed on designing active learning experiences that promote reflection, feedback, and application. Second, AI-powered instructional technologies, including intelligent tutoring systems and adaptive feedback tools, should be integrated thoughtfully into training designs. However, successful implementation depends on building AI literacy and user confidence, ensuring that both trainers and trainees can effectively utilise these technologies. This is particularly relevant in public sector contexts where varying levels of digital literacy exist. Third, the role of trainers and facilitators must be strengthened through continuous professional development (CPD) focusing on digital competencies, instructional design, and ethical considerations. Institutional investment in teacher upskilling, supported by structured frameworks like Knowledge Systems Design (KSD) and informed by TAM, would further enhance the quality of training delivery and learning transfer. From a policy perspective, these findings advocate for the institutionalisation of digital training standards, embedding TMI considerations into national training frameworks and capacity-building strategies. Additionally, robust evaluation mechanisms, including the use of mediation analysis and longitudinal tracking of learning outcomes, should be employed to assess the sustained impact of TMI on transfer effectiveness. Finally, recognising the limitations of this review, such as reliance on recent literature (2023–2025) and the focus on journal articles while excluding grey literature, future research is encouraged to explore the mediating effects of TMI through empirical validation across diverse organisational and cultural contexts. Further studies could adopt mixed-method approaches, including structural equation modelling and qualitative interviews, to uncover the nuanced dynamics of how TMI interacts with individual, instructional, and environmental variables. By closing these gaps, future studies can provide a more thorough understanding of the factors that drive successful training transfer and inform the next generation of technology-integrated learning interventions.

Conclusion

This systematic literature review aimed to investigate the mediating role of Technology-Mediated Instruction (TMI) in the relationship between trainee characteristics, training design, work environment, and the transfer of training. This study was designed to examine how TMI operates as more than just a delivery channel, focusing instead on its potential influence in shaping effective learning transfer outcomes within digital training contexts. Utilising the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol, the review effectively identified 28 relevant studies from Scopus and Web of Science databases, with each study contributing valuable perspectives to this area of inquiry. Three

Advanced International Journal of Business, Entrepreneurship and SME's
AIJBES
EISSN: 2682-8545
Volume 7 Issue 26 (December 2025) PP. 01-25
DOI 10.35631/AIJBES.726001

core thematic categories were derived from the analysis: innovative pedagogies and learning transfer, AI and digital technologies with instructional tools, and teacher development alongside educational contexts. These themes were selected to represent the interconnected factors that influence training transfer, while positioning TMI as a key component that mediates these relationships. The synthesis of these findings highlighted the importance of learner-centred strategies, digital innovation, and trainer competencies in supporting learning applications beyond the classroom. The evidence suggests that successful training transfer is achieved not only through the content or the method of delivery but also through the careful integration of technology with instructional design and human capability development.

This study adds to the body of knowledge by providing a clearer conceptual understanding of how TMI enhances or limits training transfer processes, particularly in digital learning environments where technology usage has become increasingly dominant. The review provides new insights into how emerging technologies, including artificial intelligence, virtual reality, and adaptive digital tools, support engagement, autonomy, and retention, which are essential for facilitating behavioural change and skills application. The findings imply that effective training transfer requires a holistic approach where pedagogical strategies are blended with appropriate digital tools and strengthened through continuous trainer development. However, this study also acknowledges several limitations, including the restricted timeframe of publications (2023–2025) and the exclusion of grey literature and non-English sources, which could restrict the generalisability of the findings. Additionally, most of the reviewed studies focused on short-term outcomes, with limited exploration of long-term behavioural changes or performance impacts. Future research is encouraged to address these gaps by applying longitudinal methods and formal mediation analysis to validate the role of TMI across various sectors and cultural settings. Further investigation into sector-specific training environments, especially within public service contexts, is necessary to provide deeper insights into how digital tools interact with organisational structures and trainee readiness. The findings of this study are anticipated to provide valuable insights for instructional designers, policymakers, and practitioners, offering actionable recommendations for enhancing technology-mediated learning strategies to ensure effective transfer. Ultimately, this review reinforces the importance of aligning digital innovation with pedagogical effectiveness, trainer competency, and environmental support to strengthen the success of training programmes in an increasingly digital learning landscape.

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Volume 7 Issue 26 (December 2025) PP. 01-25
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EISSN: 2682-8545
Volume 7 Issue 26 (December 2025) PP. 01-25
DOI 10.35631/AIJBES.726001

Appendix A

Number and Details of Primary Studies Database

No	Authors	Title	Year	Journal	Scopus	WoS
1	Park (Park, 2023)	Learning Transfer through Corpus-Aided Instruction	2023	Lublin Studies in Modern Languages and Literature	/	
2	Schreiter et al. (Schreiter et al., 2024)	Teaching for statistical and data literacy in K-12 STEM education: a systematic review on teacher variables, teacher education, and impacts on classroom practice	2024	ZDM - Mathematics Education	/	
3	Chang et al. (Chang et al., 2024)	Influence of online STEAM hands-on learning on AI learning, creativity, and creative emotions	2024	Interactive Learning Environments	/	/
4	Aljabr (Aljabr, 2025)	ASR Using Speechnotes for EFL Learners: A Study of the Effects on English Pronunciation and Prosody Skills	2025	Journal of Ecohumanism	/	
5	Huang (Huang, 2023)	Open Learning Environment for Multimodal Learning Based on Knowledge Base Technology	2023	International Journal of Emerging Technologies in Learning	/	
6	Bansal et al. (Bansal et al., 2024)	Importance of computer in learning of person with disabilities in skill training	2024	Journal of Applied Research in Higher Education	/	
7	Li (Li, 2023)	A Survey of Translation Learners' Uses and Perceptions of Neural Machine Translation	2023	Theory and Practice in Language Studies	/	
8	Pellas (Pellas, 2025)	The Impact of AI-Generated Instructional Videos on Problem-Based Learning in Science Teacher Education	2025	Education Sciences	/	/
9	Maulida et al. (Maulida & Nurlaelah, 2024)	The Effect of Experiential Learning and Directed Instructions Assisted by Augmented Reality on Students' Self-Regulated Learning	2024	Infinity Journal	/	
10	Ruff et al. (Ruff et al., 2024)	Using ChatGPT for Method Development and Green Chemistry Education in Upper-Level Laboratory Courses	2024	Journal of Chemical Education	/	/

Advanced International Journal of Business, Entrepreneurship and SME's
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DOI 10.35631/AIJBES.726001

11	Cheng et al. (Cheng et al., 2025)	Digital diaries supporting self-regulated learning during in-person and online transitions	2025	Internet and Higher Education	/	
12	Knoth et al. (Knoth et al., 2024)	AI literacy and its implications for prompt engineering strategies	2024	Computers and Education: Artificial Intelligence	/	
13	Nyarko & Petcovic (Nyarko & Petcovic, 2023)	Do students develop teamwork skills during geoscience fieldwork? A case study of a hydrogeology field course	2023	Journal of Geoscience Education	/	
14	Wei-Kocsis et al. (Wei-Kocsis et al., 2024)	Cybersecurity Education in the Age of Artificial Intelligence: A Novel Proactive and Collaborative Learning Paradigm	2024	IEEE Transactions on Education	/	
15	Barz et al. (Barz et al., 2024)	The Effect of Digital Game-Based Learning Interventions on Cognitive, Metacognitive, and Affective-Motivational Learning Outcomes in School: A Meta-Analysis	2024	Review of Educational Research	/	/
16	Gil & Dueñas (Gil & Dueñas, 2023)	Designing and Implementing a Professional Programme for ICLHE Teachers: Beyond Linguistic and Communicative Competence	2023	Journal of Language Teaching and Research	/	
17	Abdelshiheed et al. (Abdelshiheed et al., 2024)	How and When: The Impact of Metacognitive Knowledge Instruction and Motivation on Transfer Across Intelligent Tutoring Systems	2024	International Journal of Artificial Intelligence in Education	/	
18	Causey et al. (Causey et al., 2025)	Advances in remote and cloud-based simulation through web conferencing platforms	2025	Perfusion (United Kingdom)	/	
19	Ramirez A et al. (Ramirez et al., 2023)	Knowledge Systems Design (KSD): Rebranding the Field of Instructional Technology in the Education and Professional Development Community	2023	TechTrends	/	/
20	Onifade & Alex-Nmecha (Onifade & Alex-Nmecha, 2023)	Tackling the Challenges of Plagiarism in the Age of Information Overload by LIS Professionals in Nigerian Academic Institutions	2023	Folia Toruniensia	/	
21	Kim et al. (Kim et al., 2025)	"Journey of Finding the Best Query": Understanding the	2025	International Journal of Human-Computer Interaction	/	

Advanced International Journal of Business, Entrepreneurship and SME's
AIJBES
EISSN: 2682-8545
Volume 7 Issue 26 (December 2025) PP. 01-25
DOI 10.35631/AIJBES.726001

		User Experience of AI Image Generation System				
22	Mitropoulos et al. (Mitropoulos et al., 2024)	The utility of mechanical objects: Aiding students' learning of abstract and difficult engineering concepts	2024	Journal of Engineering Education	/	/
23	Taguchi (Taguchi, 2023)	Technology-enhanced language learning and pragmatics: Insights from digital game-based pragmatics instruction	2023	Language Teaching	/	
24	Kadhim et al. (Kadhim et al., 2023)	Enhancement of Online Education in Engineering College Based on Mobile Wireless Communication Networks and IOT	2023	International Journal of Emerging Technologies in Learning	/	
25	Spangenberger et al. (Spangenberger et al., 2025)	Orchestrating iVR technology in an authentic classroom setting and its effects on factual knowledge, comprehension and transfer	2025	Educational Technology Research and Development	/	/
26	Ma & Lei (Ma & Lei, 2024)	The factors influencing teacher education students' willingness to adopt artificial intelligence technology for information-based teaching	2024	Asia Pacific Journal of Education	/	
27	Zaim et al. (Zaim et al., 2024)	AI-powered EFL pedagogy: Integrating generative AI into university teaching preparation through UTAUT and activity theory	2024	Computers and Education: Artificial Intelligence	/	
28	Chen et al. (Chen et al., 2023)	Exploring contributors, collaborations, and research topics in educational technology: A joint analysis of mainstream conferences	2023	Education and Information Technologies	/	