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Artificial Intelligence-Supported Workplace Education: A Systematic Review of Learning Outcomes, Opportunities, and Challenges

Ecehan Kazancı Yabanova

Research Article

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Author for correspondence:
Ecehan Kazancı Yabanova
ecehankazanci@gmail.com
Isparta Süleyman Demirel University, Isparta, Türkiye

Abstract

Background/purpose. In the digital age, education is no longer considered an activity carried out during a specific period of life, but rather a lifelong concept. The skills acquired through formal education processes can become obsolete within a few years due to the rapid pace of the era. It is precisely at this point that corporate structures are under more pressure than ever to keep their employees' skills up to date. These training programmes are conducted with intensive use of educational technologies in order to prevent workforce loss and provide training at an appropriate cost. In the field of corporate learning and development, the impact of artificial intelligence technologies on employee training is also increasing.

Materials/methods. This article systematically examines the effects, opportunities, and challenges of AI applications in employee training. The field of artificial intelligence applications in education has been evaluated within a theoretical framework, and articles published between 2020 and 2025 have been analysed using a systematic review and a thematic content analysis, focusing on impacts, opportunities, and challenges.

Results. The analysis revealed that artificial intelligence affects cognitive, affective, behavioural, and technical-organisational dimensions of employee training. Opportunities were reported in learning quality, cognitive development, affective and social aspects, performance and efficiency, and organisational aspects, while challenges were reported in technical, infrastructure, ethics and law, organisational, and pedagogical dimensions.

Conclusion. Artificial intelligence is expected to make significant contributions to employee training. However, many areas identified as challenges need to be addressed in order to maximise the benefits of these technologies.

1. Introduction

The development of the knowledge economy and digital transformation processes on a global scale has changed the nature of work and created a need to redevelop and update employee skills. This situation highlights the critical importance of employee training processes. Therefore, learning and development processes have become a priority for organisations in order to increase employability and organisational competitiveness (Martinez-Marroquin & Male, 2021). In digital transformation processes, technological innovations, particularly with the proliferation of the internet, have simplified and accelerated work processes, making them an indispensable part of modern life (Meyen et al., 2010). Technological changes, such as advances in artificial intelligence, robotics, the Internet of Things, and automation, are affecting societies in many ways (Dang, 2025). In this regard, the workforce needs to improve its understanding of information technology and develop the necessary skills and abilities, including digital literacy, creative thinking, data processing, and the ability to adapt to new technologies (Schwab, 2017). Developments in artificial intelligence and the automation processes it enables increase various risks for workers, such as workforce contraction, rapid skill changes, and occupational uncertainty. At the same time, individuals with low levels of education experience high anxiety as a result of the significant impact of artificial intelligence on employment (Wang & Xiao, 2025). The extraordinary technological developments over the past half-century, along with the advancement of AI-powered tools, have transformed job roles. Consequently, this has led to new skill requirements for employees and necessitated a reshaping of strategies for developing organisational talent (Ekuma, 2024). Bessen's (2018) historical analysis of technological changes in the workplace shows that new technologies necessitate new skill sets. Therefore, rather than eliminating the nature of existing jobs, they cause changes in the nature of jobs (Bessen, 2018; Xavier et al., 2025). Thanks to the transformation brought about by artificial intelligence technologies, labour markets around the world are redefining the nature of jobs, leading to fundamental transformations in various sectors (Rawashdeh, 2025). Various economies around the world are providing financial support and investment for nationwide skills development initiatives to protect workers from automation and establish effective working relationships with artificial intelligence systems (Shannaq et al., 2025).

The concept of artificial intelligence, which has become a fundamental technology in personalising learning processes, provides personalised learning designs by analysing a wide range of data, from learners' preferences to their prior knowledge levels and performance patterns (Bayly-Castaneda et al., 2024). The use of artificial intelligence in educational processes is not a new phenomenon, but recent developments in artificial intelligence technologies and the increase in applications have transformed both how education is delivered and how individuals experience it (Al Husseiny, 2023). Artificial intelligence has reshaped the global human resources field, offering opportunities and challenges that have initiated a powerful transformation (Dhilipan et al., 2025). Today, as artificial intelligence applications become increasingly widespread across manufacturing, healthcare, finance, and service sectors, they necessitate a systematic restructuring of traditional education models in vocational education (Hong, 2025). Artificial intelligence refers to machines exhibiting intelligent behaviours similar to human cognitive processes such as learning, decision-making, and problem-solving (Buame et al., 2025; Collins et al., 2021; Wang et al., 2024). In other words, artificial intelligence systems include computer software, applications, or web systems that can mimic the human mind and perform cognitive functions such as learning, reasoning, and responding, and can contribute to decision-making processes (Hassan, 2022; Russell & Norvig, 2020). Artificial intelligence systems are machine-based systems that can influence the environment by making recommendations, predictions, or decisions to achieve specific objectives. Accordingly (Johnson et al., 2025; OECD, 2019);

- Perceiving real or virtual environments,

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- Abstracting perceptions manually or automatically using models,
- Analysing machine- or human-based inputs and data in order to formulate results for model interpretation.

Artificial intelligence enhances efficiency in human resources processes by automating routine tasks within organisations, from employee training and recruitment to automation processes (Jia & Hou, 2024). Artificial intelligence applications, which have become an indispensable element in all areas of individuals' lives in today's world, significantly affect daily routines and workforce roles (Morandini et al., 2023). Within the scope of this study, the effects, opportunities, and challenges of artificial intelligence, which have established a strong position for themselves in the field of employee training in recent years, will be examined using systematic analysis methods.

2. Literature Review

The study examines the impact of artificial intelligence on employee training processes. In this context, the literature review section examines adaptive learning systems, chatbots, smart assistants, and learning analytics, which are sub-technologies that form the scope of employee training and the use of artificial intelligence in educational processes.

2.1. Employee Training

Employee training is a learning and development process that systematically equips employees with knowledge, skills, and competencies to develop an organisation's human capital. Employee development is crucial not only for gaining technical skills but also for organisations to create a knowledge-based competitive advantage (Hitt et al., 2001). In the human resource development literature, employee training is considered a strategic investment to improve organisational performance, enhance work processes, and ensure employees' adaptation to changing work conditions. These training programmes consist of needs analysis, design, implementation, and evaluation stages and are measured by the learning outcomes required in the work environment (Goldstein & Ford, 2002). In this respect, it is not only an activity that enhances individual competencies but also one that aligns with organisational strategies. It has become one of the most important phenomena in today's working life, enabling individuals to demonstrate their organisational performance at the highest level in changing working conditions.

Employee training is an activity within the field of andragogical approaches, given the characteristics of the target audience. The andragogy theory developed by Knowles (1984) emphasises that adults need experience-based, autonomous, and problem-focused learning. At this point, the andragogical approach provides a critical framework for the design of employee training. With the organisational learning approach model, the application of the knowledge acquired by employees in their job training to work processes creates single-loop and double-loop learning mechanisms within the organisation. This leads not only to individual but also organisational transformation and the formation of a learning capacity at the institutional level (Argote, 2013; Argyris & Schön, 1997). In this context, employee training is a multi-layered process that shapes not only the knowledge and skills of individuals but also the overall learning capacity of the organisation.

Today, employee training is being reshaped by digitalisation and artificial intelligence-based systems. Technology-supported learning, learning management systems (LMS), microlearning, virtual simulations, and learning analytics applications enable personalised, data-driven training optimisation. Noe (2020) states that modern employee training has now transformed into a holistic learning ecosystem that aims to create a culture of continuous learning, rather than merely transferring knowledge. This transformation removes employee training from being a static programme, turning it into a dynamic strategic process that develops organisations' competitive advantage, innovation capacity, and adaptability.

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Consequently, employee training is a critical human resources intervention in terms of both individual performance improvement and organisational sustainability. The theoretical framework shows that this field is positioned at the intersection of psychology, adult education, management science, and learning technologies; it emphasises that the impact of training applications can be realised only through proper design, effective implementation, and comprehensive evaluation.

2.2. Adaptive Learning Systems

Adaptive learning systems are approaches that continuously monitor and dynamically update learning pathways based on real-time data on learners' development and participation (Gladwin-Geoghegan & Thompson, 2021). The evolution of adaptive learning is a broad innovation process, starting with Dewey's progressive education approach in 1916 and extending to current developments in artificial intelligence-supported learning systems and learning systems that integrate artificial intelligence systems and machine learning algorithms that analyse learner behaviour, measure performance, and offer individualised interventions (Chen et al., 2020; Plooy, 2024). The first studies on adaptive learning systems were developed in 1905 by French psychologist Binet and are recognised as the world's first 'adaptive test', the 'Binet IQ Test' (Binet, 1905; Jing et al., 2023). Adaptive learning systems generally require blended or online learning environments to provide a personalised learning experience, and technological systems such as learning analytics and machine learning are used in these learning environments (Becker et al., 2017). The rapid advances in artificial intelligence in recent years have made technology-based adaptive learning systems even more important.

The creation of personalised learning environments, which is the greatest promise of artificial intelligence-based learning systems, depends on the success of this system. Adaptive learning systems involve tailoring content to the learner's prior knowledge and development, dynamically adjusting content, activities, and feedback based on variables such as performance history, speed, and preferences to create personalised learning paths (Kabudi et al., 2021; Merino-Campos, 2025). The effective functioning of this system is possible through the use of qualified data in learning analytics and its evaluation through meaningful queries.

2.3. Chatbots & Smart Assistants

Chatbots are artificial intelligence tools that interact with systems through natural language processing (NLP) and predefined user interface elements, such as commands or buttons (Ans et al., 2025; Bhoir et al., 2022). Chatbots are AI-powered software developed to mimic human interaction through text or interfaces (Nwabekee et al., 2025). Organisations and companies across different industries in the workplace utilise chatbots to improve both their organisational structures and individuals' quality of life (Assayed et al., 2025). For example, chatbots are tools used in smart city applications or to provide smart education incentives for communities (Assayed et al., 2023).

Advanced virtual assistant systems understand verbal and written inputs and have the ability to fulfil user requests and provide information and services to facilitate daily life (Uzoka et al., 2024). Alongside virtual assistant systems, computers, smart speakers, wearable technologies, and smartphones, these technologies are widely used across various digital platforms. It is also expected that in the near future, NLP will enable more effective device control, appointment management, reminder creation, and information retrieval (Shrivastava et al., 2025). These systems can perform a wide range of tasks, from answering frequently asked questions to supporting processes and providing personalised recommendations (Olanrewaju et al., 2024). Chatbots, which are sometimes considered virtual assistants, are systems that mimic human conversations and provide flexibility for users to interact instantly (Hsu et al., 2023). Artificial intelligence-powered chatbots understand natural language and provide instant responses via text or voice, enabling users to engage in simulation and interaction-based communication in a non-judgmental environment (El Shazly, 2021;

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Mohammed et al., 2025). They are used in educational processes for their benefits, such as guidance, instant learning support, and filling the gap left by instructors. AI-based chatbots provide instant responses to student questions, making the learning process seamless (Hwang & Chang, 2021). In this respect, although they are not used directly as an educational tool, they are effective within the scope of educational support activities.

2.4. Learning Analytics

The widespread use of educational technologies has increased the amount of digitally generated data to an unprecedented level. The process of interpreting this data has placed the concept of learning analytics at the centre of education. Learning analytics is defined as a data-driven analysis that aims to better understand learning processes by systematically collecting, analyzing, and interpreting learners' interaction traces left in online environments, providing constructive feedback to education stakeholders (Hwang et al., 2018; Long & Siemens, 2011). In recent years, this field has evolved beyond being merely a tracking technology that monitors online behaviour to become systems that model learner behaviour, predict learning difficulties, and structure instructional design based on these analyses. Advances in artificial intelligence technology, coupled with the ability to interpret large data sets through meaningful queries, have made learning analytics even more important. Learning analytics is approached as a multi-layered system with pedagogical, ethical, and political dimensions (Buckingham Shum & Luckin, 2019). It reinterprets the digital data generated in learning processes for pedagogical purposes, moving beyond quantitative data (Alfredo et al., 2024; Khosravi et al., 2023).

Learning analytics is developed with four fundamental objectives: diagnostic, descriptive, predictive, and prescriptive (Daniel, 2015). The patterns of interaction between the learner and the educational system can provide patterns that can strongly predict educational success, functioning as an early warning system (Tsai et al., 2019). Some researchers have criticised learning analytics for failing to provide qualified decision support, leading to the emergence of the concept of dispositional learning analytics (Buckingham Shum & Crick, 2012; Tempelaar et al., 2021). However, the tremendous advances in artificial intelligence technologies, particularly in the last few years, have enabled much more powerful pedagogical analyses to be performed on the big data collected in learning analytics. Artificial intelligence has enabled analysis of the learner's experience in greater detail by utilising multiple data sources, such as text, voice, and facial expressions (Buckingham Shum & Luckin, 2019). All these developments have also brought with them criticisms such as ethical, privacy, data confidentiality, algorithmic bias risks, transparency, pedagogical inequalities, and a lack of affective domains due to quantitative data sources (Buckingham Shum & Luckin, 2019; Khosravi et al., 2023; Kitto & Knight, 2019; Slade & Prinsloo, 2013; Tsai et al., 2020; Uttamchandani & Quick, 2022; Viberg et al., 2022). Within this framework, learning analytics is discussed in terms of technical accuracy, pedagogical effectiveness, and ethical responsibility. Consequently, current research focuses on questions such as how learning analytics can be integrated into pedagogical decision-making processes, how it can transform teaching and assessment processes when combined with artificial intelligence, and how all these processes can be made ethically secure. Learning analytics provides an important scientific framework for understanding, evaluating, and transforming learning processes.

Learning analytics is particularly important in areas such as lifelong learning, informal education, and employee training, where there is no teacher guidance, in terms of providing the pedagogical support learners need and personalising teaching methods. The reuse of digital traces left in digital systems for learner guidance through meaningful contextual analysis, and the enhancement of this analysis with artificial intelligence technologies, presents great opportunities for next-generation learning technologies. In this context, learning analytics is the starting point for providing qualified decision support for artificial intelligence.

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3. Methodology

In this study, a systematic literature review (SLR) method was used to comprehensively present the results of current scientific articles on the use of artificial intelligence in employee training. This approach ensures that existing studies addressing a specific research question are examined in a planned, transparent, reproducible, and unbiased manner (Page et al., 2021). In this study, the identification, screening, exclusion, and inclusion processes were carried out in accordance with the PRISMA 2020 reporting standards.

3.1. Research Question

This study aims to reveal the effects, opportunities, and challenges of artificial intelligence in employee training. The research seeks to answer the following questions;

RQ1. What are the characteristics of studies on artificial intelligence in employee training?

RQ2. What are the effects of artificial intelligence in employee training?

RQ3. What are the opportunities of artificial intelligence in employee training?

RQ4. What are the challenges of artificial intelligence in employee training?

3.2. Search and Eligibility Criteria

Within the scope of the study, a search was conducted using the (TITLE-ABS-KEY("employee training" OR "in-service training" OR "workplace learning" OR "employee development" OR "staff training" OR "corporate training" OR "workforce development") AND TITLE-ABS-KEY("artificial intelligence" OR "AI" OR "machine learning" OR "deep learning" OR "intelligent tutoring" OR "adaptive learning systems" OR "learning analytics"))search query via the Scopus database. The search results were reported using the PRISMA diagram. To ensure relevance and conceptual consistency, the following inclusion criteria were applied in the study;

- Experimental, theoretical or review-type articles,
- Including artificial intelligence applications in employee training,
- Published between 2020 and 2025,
- Including studies with full text access in English.

Exclusion criteria:

- Not directly related to employee training,
- Not research-type articles,
- Focusing on artificial intelligence at an educational level without an employee context,
- Studies without full-text access were not included.

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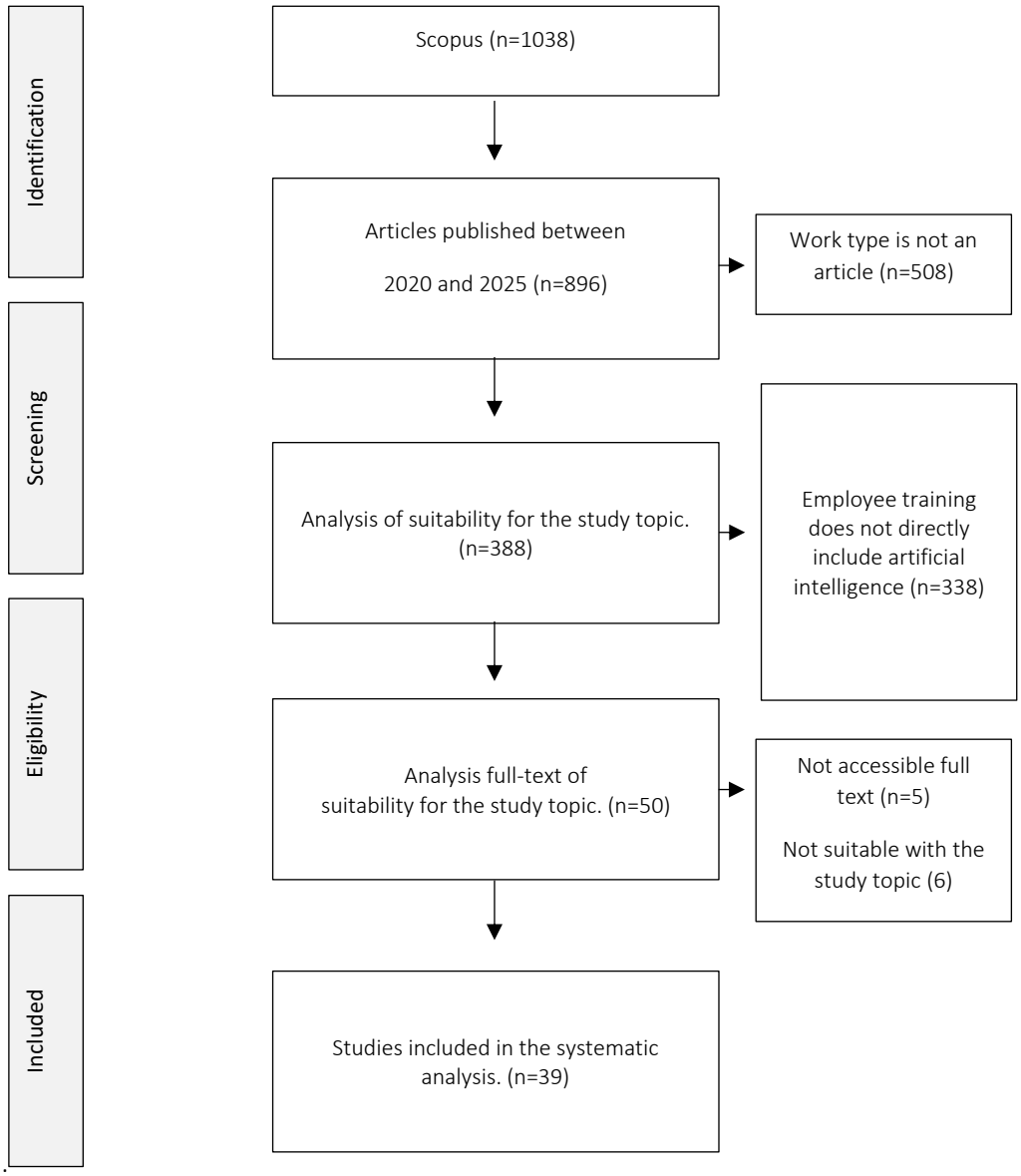

Figure 1. PRISMA Flow Diagram

A search using the query phrase specified in the Scopus database identified 1,038 studies across all time periods. Due to significant developments in artificial intelligence technologies in recent years, studies from 2020 to 2025 were filtered (n=896). Subsequently, only article studies were selected as the study type (n=388). A list containing the metadata of the filtered studies was downloaded from the Scopus database. The studies were screened by title and abstract, and 338 that did not include artificial intelligence in employee training were excluded. In the next stage, 50 articles were evaluated through full-text analysis; 6 were excluded due to topic incompatibility and 5 due to lack of full-text access, resulting in 39 articles selected for systematic analysis.

3.3. Data Extraction and Coding

A structured data extraction file was used to collect the following information from the studies included in the systematic analysis. This file, created in Excel, contains the following data fields:

- Author(s), year of publication, country, article type,
- Research methods, data collection tools,
- Sector characteristics of employees,
- Thematic area of the artificial intelligence technology used,

- Impact on employee training, opportunities, and challenges mentioned in the findings and conclusions section of the study.

The study was coded using a thematic analysis approach. Similar patterns were coded and grouped under a main theme. The coding performed by the researcher was evaluated by an independent researcher specialising in educational technologies to increase reliability.

3.4. Data Analysis

The data collected within the scope of the study were analysed using a qualitative synthesis approach. The impacts, opportunities, and challenges identified during the analysis process were grouped under higher-level themes. To utilise the original data generated within the scope of the studies, the statements in the results section were included in the content analysis, whereas the theoretical sections were excluded. In this context, the study's impact on employee training, the prominent opportunities and challenges, and the artificial intelligence technology used were examined.

4. Results

The aim was to reveal how artificial intelligence is integrated into employee training through a systematic review, and the effects, opportunities, and challenges it creates in corporate learning environments. A content analysis of a total of 39 articles was reported in light of the research questions.

RQ1. What are the characteristics of studies on artificial intelligence in employee training?

The characteristic features of the studies included in the systematic analysis were analysed to understand the dimensions in which artificial intelligence stands out in employee training. There are 33 research and 6 review studies conducted in 24 different countries between 2020 and 2025. When examined methodologically, the studies show that artificial intelligence research in the field of employee training is spread across different focuses, such as experimental, system design, application evaluation, and theoretical framework development. This situation reveals the scientific effort in producing knowledge on the theory and application of artificial intelligence for employee training, which is still a new field.

When examining the sectors in which the studies were conducted, 11 different sectors were identified: Aviation, Construction, Education, Health, Information Technology, Manufacturing, Maritime, Multi-sector, Office Workers, Public Sector, and Tourism. When examining the distribution of the studies, the health sector (DiDonna et al., 2024; Gupta et al., 2023; Hoelscher & Pugh, 2025; Humar et al., 2023; Jain et al., 2024; Mitsugi et al., 2025; Rizzo et al., 2024; Romanyukha et al., 2025; Seneca et al., 2025) stands out for studies aimed at evaluation, clinical decision support, skills training, etc. XR/VR-based simulations, computer vision, and sensor-based analysis studies are seen in the manufacturing (Gallagher et al., 2024; Gezdur & Bhattacharjya, 2025) and construction (Jelodar, 2025; Wang et al., 2025) sectors. In the public sector (Love et al., 2025; Shamaylah et al., 2025; Wang et al., 2025), there are applications, particularly in machine learning and decision support. In the education sector (Alshahrani, 2025; Enakrire et al., 2025; Srirevathi & Aravind, 2025), natural language processing, digital twins, decision support, etc., are seen. In aviation (Togambayev et al., 2025) and maritime (Viktorelius & Larsson, 2025), digital twins, simulation-based vocational training, predictive analytics, etc. are used. In the tourism sector (Menshikova et al., 2025), cobots, office workers (Martinez -(Marroquin & Senadji, 2025; Watanabe et al., 2025), GenAI, and in information technology (Khot & Goyal, 2025; Pammer-Schindler & Rosé, 2022; Whale & Scholtz, 2024), learning analytics, machine learning, etc.

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When examining the data collection techniques used in the studies, it is evident that innovative methods such as system log records, sensor-based data, assessment outputs, and data generated by artificial intelligence are used alongside traditional techniques such as surveys, scales, interviews, and reflective writing. An examination of the artificial intelligence technologies used reveals that large language models (LLM) and generative artificial intelligence, machine learning and deep learning, learning analytics and workplace learning analytics, NLP-based systems, XR/VR/AR and digital twins, and predictive analytics and decision support systems are prominent. The characteristic features of the studies are presented in Table 1.

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Table 1. Characteristic Features of the Studies

ID	Study	Country	Type	Sector	Method	Data Collection Instrument	AI Technology*
1	Wang et al. (2025)	Malaysia, China	Research	Construction	Quantitative	Sensor-based / Multimodal data	Multimodal / Cross-Modal AI
2	Watanabe et al. (2025)	Japan	Research	Office Workers	Quantitative	Survey + System logs	LLM & GenAI
3	Srirevathi & Aravind (2025)	India	Research	Education	Mixed	Survey + Qualitative	NLP
4	Martinez-Marroquin & Senadji (2025)	Australia	Review	Office Workers	Systematic	Documentary analysis	LLM & GenAI
5	Romanyukha et al. (2025)	Belgium	Research	Health	Quantitative	System testing / Validation	LLM & GenAI
6	Khot & Goyal (2025)	India	Review	Information Technology	Theoretical	Documentary analysis	ML & DL
7	Hoelscher & Pugh (2025)	United States	Review	Health	Theoretical	Documentary analysis	ML & DL
8	Wang et al.(2025)	United States	Research	Public Sector	Quantitative	Secondary datasets + AI outputs	LLM & GenAI
9	Enakrire et al. (2025)	South Africa	Research	Education	Mixed	Survey + Qualitative	XR/VR/AR & Digital Twin
10	Seneca et al.(2025)	United States	Research	Health	Qualitative	Qualitative + Survey	-
11	Kaszalik et al. (2025)	Hungary, Germany, Scandinavian	Research	Multi-sector	Mixed	Documentary + Secondary data	ML & DL

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ID	Study	Country	Type	Sector	Method	Data Collection Instrument	AI Technology*
12	Gezdur & Bhattacharjya (2025)	Australia	Research	Manufacturing	Mixed	Testing + Logs	LLM & GenAI
13	Jelodar (2025)	New Zealand	Research	Construction	Qualitative	Documentary qualitative	XR/VR/AR & Computer Vision
14	Love et al. (2025)	United States	Review	Public Sector	Theoretical	Documentary analysis	ML & DL
15	Viktorelius & Larsson (2025)	Sweden	Research	Maritime	Qualitative	Qualitative (observational + interview)	ML & Predictive Analytics
16	Shamaylah et al. (2025)	Jordan	Research	Public Sector	Mixed	Survey + System data	RS & AL
17	Menshikova, et al. (2025)	Russia	Research	Tourism	Qualitative	Qualitative	Cobots
18	Alshahrani (2025)	Saudi Arabia	Research	Education	Quantitative	Secondary datasets	ML & DL
19	Togambayev et al. (2025)	Kazakhstan	Research	Aviation	Quantitative	System simulation data	Fuzzy Logic & Digital Twin
20	Depoo et al. (2025)	Czechia	Research	Multi-sector	Quantitative	Survey	ML & Predictive Analytics
21	Mitsugi et al. (2025)	Japan	Research	Health	Mixed	Logs + Qualitative	NLP
22	Bharwaney et al. (2025)	USA, Europe, Asia	Research	Multi-sector	Mixed	Mixed: Survey + Qualitative	DSS
23	Phillip-Durham & Deasey-Weinstein (2025)	Cayman Islands	Research	Multi-sector	Mixed	Survey + Documentary	Adaptive Learning & GenAI
24	Gallagher et al. (2024)	Germany	Research	Manufacturing	Quantitative	Experimental interface + Psychometric scale	Learning Analytics (LA)

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ID	Study	Country	Type	Sector	Method	Data Collection Instrument	AI Technology*
25	Jain et al. (2024)	United States	Research	Health	Quantitative	AI–human comparison dataset	NLP
26	Tusquellas et al. (2024)	Spain	Review	Multi-sector	Qualitative	Documentary analysis	ML & DL
27	DiDonna et al. (2024)	United States	Research	Health	Quantitative	Assessment data	LLM & GenAI
28	Whale & Scholtz (2024)	South Africa	Research	Information Technology	Theoretical	Qualitative	WLA / LA
29	Rizzo et al. (2024)	United States	Research	Health	Quantitative	Assessment data	LLM & GenAI
30	Goel et al. (2024)	United States	Research	Multi-sector	Theoretical	Learning analytics logs	AI Teaching Assistants (GenAI)
31	Li & Yeo (2024)	United States, Australia, China	Research	Multi-sector	Theoretical	Documentary analysis	AI-Human Integration (LLM/ML)
32	Gupta et al. (2023)	United States	Research	Health	Quantitative	Assessment data	LLM & GenAI
33	Humar et al. (2023)	United States	Research	Health	Quantitative	Assessment data	LLM & GenAI
34	Rožman et al. (2023)	Slovenia	Research	Multi-sector	Quantitative	Survey	AI-supported Training
35	Sabale & Gomathi (2022)	India	Research	Multi-sector	Theoretical	Documentary analysis	ML & Analytics
36	Barthakur et al. (2022)	Australia, United States	Research	Multi-sector	Quantitative	Reflective writing + Learning analytics	Automatic Scoring (ML/NLP/CDM)
37	Barthakur et al. (2022)	Australia, United States, Brazil	Research	Multi-sector	Qualitative	Qualitative	ML & NLP

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ID	Study	Country	Type	Sector	Method	Data Collection Instrument	AI Technology*
38	Pammer-Schindler & Rosé (2022)	Austria, the United States, Germany	Research	Information Technology	Qualitative	Digital trace data + Qualitative	Adaptive LA
39	Ruiz-Calleja et al. (2021)	Spain, Estonia, Austria	Review	Multi-sector	Systematic	Documentary analysis	WPLA

* * The definitions of the concepts are provided in Table 2.

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The studies examined within the scope of the analysis were conducted in 2020 (n=0), 2021 (n=1), 2022 (n=4), 2023 (n=3), 2024 (n=8) and 2025 (n=23). This situation reveals that artificial intelligence in employee training is a very new field and will establish itself more strongly in the scientific field with each passing year. It is seen that artificial intelligence sub-technologies in employee training show significant differences. It is seen that the studies focus on different artificial intelligence technologies rather than a single technology field.

Table 2. AI Technology Types

AI Technology	Frequency
Large Language Models & Generative Artificial Intelligence (LLM & GenAI)	14
Machine Learning & Deep Learning (ML & DL)	12
Natural Language Processing (NLP)	5
XR/VR/AR & Digital Twin Technologies (XR/VR/AR & DT)	5
Learning Analytics / Workplace Learning Analytics (LA / WLA)	4
Decision Support Systems / EPSS / Recommender Systems (DSS / EPSS / RS)	3
Multimodal / Cross-Modal Artificial Intelligence (Multimodal AI)	1
Robotics and Autonomous Systems (RAS)	1

When examining artificial intelligence technologies used in employee training, Large Language Models & Generative Artificial Intelligence (LLM & GenAI) and Machine Learning & Deep Learning (ML & DL) stand out. Large Language Models and Generative Artificial Intelligence (LLM & GenAI), which appear with the highest frequency, have become a fundamental technology widely used in employee training for functions such as content generation, intelligent tutoring agents, and personalised feedback. Machine Learning and Deep Learning (ML & DL), on the other hand, are heavily utilised in data-driven processes such as performance prediction, automated assessment, and classification. Mid-level Natural Language Processing (NLP) contributes to language-based interaction and text analysis-based training applications, while XR/VR/AR & Digital Twin Technologies (XR/VR/AR & DT) are used specifically for skill development through simulations in hazardous sectors. Learning Analytics (LA/WLA) is used to improve training processes by analysing the digital traces left by employees in learning systems. Decision Support and Recommendation Systems (DSS/EPSS/RS) play a role in supporting organisational-level training decisions and workforce development planning. Finally, Multimodal Artificial Intelligence and Robotics and Autonomous Systems (RAS) emerge as an example of innovative and future-oriented educational applications using multiple sensors, etc.

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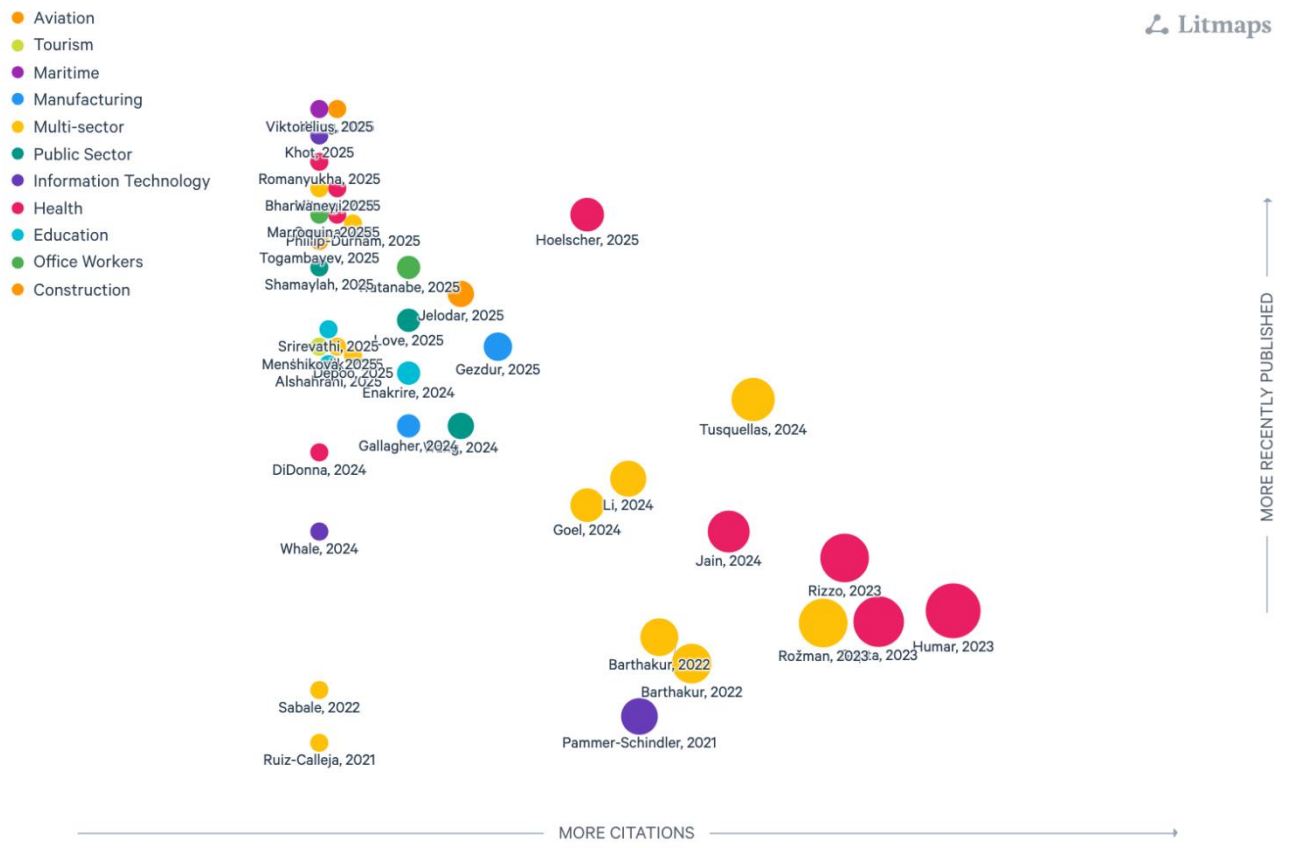

Figure 2. Citation, Publication Year and Link Relationships of the Studies

The relationship between the publication date and citation count of the studies examined is shown in Figure 2. On the vertical axis, the studies are positioned upwards according to their publication date, while on the horizontal axis, studies with more citations are shown growing to the right. The studies are colour-coded according to their sector representation. The study, which examined publications between 2020 and 2025, shows a significant accumulation in the last two years. Due to the novelty of these studies, the number of citations is still limited. When examined in terms of citation count, the studies on the right side of the visualisation are particularly related to health and multiple sectors. The fact that pioneering studies on the use of artificial intelligence in employee training have been conducted in the health sector has led to this result. Studies such as Humar (2023), Gupta (2023), Rizzo (2023), and Rožman (2023), in particular, stand out for their high number of citations despite being recent. When examining the sector distribution, it is seen that the health and multi-sector fields show a wide spread and have a stronger impact in terms of citation size. In this Litmaps analysis, the connections between the studies were also evaluated; however, no connections were found between any studies except Barthakur et al. (2022) and Barthakur et al. (2022). This can be attributed to the field being relatively new and the majority of published studies being released in similar years.

RQ2. What are the effects of artificial intelligence in employee training?

Another area covered by the study, identified through content analysis and thematic analysis, is the impact of artificial intelligence in employee training. Within this scope, the results of the studies were examined through thematic analysis, and the frequencies were calculated within a common framework. These impacts were categorised into cognitive, behavioural, affective, and technical-organisational effects. The themes, impacts, and frequency distributions identified in the analysis are presented in Table 3.

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Table 3. The Effects of Artificial Intelligence in Employee Training

Theme	Impact	Study ID	Frequency
Cognitive	Higher-level cognitive skills (critical thinking, problem solving, decision making)	4,10,13,14,18,20,21,27,36	9
	Development of digital literacy and digital skills	3,7,8,9,11,13,17,23	8
	Strengthening reflective and metacognitive learning	30,31,36,37,38,39	6
	Increased decision-making and clinical reasoning capacity	7,13,18,27	4
	Development of rapid access to information and content comprehension skills	4,5,12,17	4
	AI's logical explanations supporting learning	25,27,32,33	4
	Professional competence and expertise development	10,27,45	3
	Increased adaptability to technology and capacity to learn new tasks	3,17	2
Behavioral	Acceleration of learning speed and skill acquisition process	1,11,12,17,19,22	6
	Increased self-regulation, self-directed learning and task independence	12,16,22,25,37	5
	Increased accuracy in task performance and reduced error rate	1,19,22	3
	Reduced workload and increased productivity	7,17	2
Affective	Increased learning motivation and affective engagement	6,11,16,17	4
	Improved working climate and learning culture	17,34	2
	Increased autonomy and independent working capacity	12,21	2
	Increased professional self-efficacy	2	1
Technical and Organizational	Provision of personalised learning paths, content, and support	11,12,14,17,23,26,35	7
	Strengthened collaboration, teamwork and team performance	20,21,27,34,45	5
	Data-driven monitoring and support of learning processes	28,34,36,37,39	5
	Acceleration of reskilling–upskilling processes	11,20,23,26	4
	Early warning for at-risk learners	23	1

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The effects of artificial intelligence applications in employee training are concentrated under four themes. This result demonstrates that the effects of artificial intelligence technologies are multifaceted. The first area, the cognitive theme, has the highest frequency effect. In the cognitive dimension, it was concluded that higher-level cognitive skills (n=9), digital literacy (n=8), and the strengthening of metacognitive learning (n=6) were developed with artificial intelligence applications. Beyond these, cognitive effects such as rapid information access, easier learning through logical explanations, and the development of clinical or professional judgement are also observed.

At the behavioural level, it was reported that artificial intelligence accelerated employees' learning and skill acquisition processes (n=6), increased self-regulation, individual learning and task independence (n=5), improved task performance and reduced errors (n=3), and reduced workload and increased productivity (n=2). At the affective level, it was concluded that AI increases learning motivation and affective participation (n=4), improves the working climate and learning culture (n=2), and increases independent working capacity (n=2) and professional self-efficacy (n=1).

At the technical and organisational level, artificial intelligence creates transformative effects on the corporate learning ecosystem. These include personalised learning paths, content and support delivery (n=7), strengthening collaboration, teamwork and group work (n=5), data-driven monitoring and support of learning processes (n=5), acceleration of reskilling and skill development processes (n=4), and early detection of risky learning (n=1).

RQ3. What are the opportunities of artificial intelligence in employee training?

The opportunities presented by artificial intelligence in employee training have also been identified through thematic content analysis. The opportunities outlined within the scope of the studies were analysed and summarised under five distinct themes. These themes are: learning quality, cognitive development, emotional and social development, performance and productivity, and organisational aspects. Similar to the impact analysis, the identified opportunities were grouped under common expressions using frequency analysis. The themes, opportunities, and their frequencies obtained from the analysis are presented in Table 4.

Table 4. Opportunities for Artificial Intelligence in Employee Training

Theme	Opportunities	Study ID	Frequency
Learning Quality	Personalised education and learning pathways	4,6,7,11,12,13,14,16,17,20,23,26,30,35	14
	Continuous learning, micro-learning and JIT support	4,7,8,11,12,14,22,30,38	9
	Accurate, context-appropriate information production	5,7,25,29,32,33	6
	Case-based learning and explanatory feedback	25,27,29,32,33	5
	Simulation, VR/MR with a safe practice area	1,7,19,24	4
Cognitive	Development of clinical/branched specialisation skills	7,25,27,29,32,33	6

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Theme	Opportunities	Study ID	Frequency
	Reduced cognitive load, accelerated comprehension	1,5,12,17,24	5
	Information transfer efficiency and learning transfer	1,4,6,11,19	5
	Multilingual/inclusive learning support	13,23	2
Affective and Social	Increased learning motivation	12,16,17,24	4
	Strengthened human–AI complementarity	2,4,21,31	4
	Culturally sensitive learning and sense of belonging	10,13	2
Performance and Efficiency	Reduced workload and training time	7,8,12,17,30,35	6
	Reduced error rate and increased accuracy	1,5,7,17,19,22	6
	Increased service quality, customer/student satisfaction	7,11,17,31	4
Organizational	Scalable training infrastructure	3,4,6,7,8,11,13,14,17,23,26,28,30,35	14
	Data-driven decision-making and learning analytics	6,12,21,22,28,31,34,35,36,37,38	11
	Closing skill gaps and rapid upskilling/reskilling	6,11,13,14,16,20,23,26	8
	Savings in training costs	6,11,12,17,26,30,35	7
	Workforce planning, talent management	8,16,20,26,31	5
	Security, quality control and risk reduction	7,17,19,20,38	5
	Organisational memory and knowledge management	21,28,34,39	4

Upon examining the table, the themes of learning quality and organisational opportunities stand out. In terms of learning quality, personalised education and learning pathways (n=14) and opportunities for continuous learning and microlearning (n=9) are prominent. In the cognitive development theme, opportunities for the development of clinical/specialist skills (n=6), reduction in cognitive load, increase in comprehension (n=5), information processing efficiency, and learning transfer (n=5) stand out. In the affective and social theme, increased learning motivation (n=4) and strengthened human-AI complementarity (n=4) stand out. In the performance and productivity area, opportunities such as reduced workload and training time (n=6), decreased errors and increased accuracy (n=6), and increased service/satisfaction (n=4) are observed. The most important

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opportunity theme was the organisational theme. This theme area presents opportunities for scalable training infrastructure (n=14), data-driven decision-making and teacher analytics (n=11), reduction in skills gaps and increased skills acquisition capacity (n=8), and savings in training costs (n=7).

RQ4. What are the challenges of artificial intelligence in employee training?

The final question addressed in this study concerns the challenges of applying artificial intelligence in employee training. To maximise the opportunities offered by a technology, it is essential to have a thorough understanding of its challenges. Therefore, these challenges are of particular importance. The thematic content analysis of the challenges identified 26 challenges grouped into five categories, which are presented along with their frequency distributions.

Table 5. Challenges of Artificial Intelligence in Employee Training

Theme	Challenges	Study ID	Frequency
Technical	LLM hallucinations and accuracy errors	4,5,7,8,12,13,15,25,27,29,30,31,32,33	14
	Model's lack of up-to-date information	5,25,27,29,32,33	6
	Inability to answer questions containing visual/medical tables	25,27,29,32,33	5
	Calculation delay/technical slowdown	1,4,19	3
	Model parameter-hyperparameter sensitivity	5,12,19	3
	Data imbalance and model performance deviation, inability to generate data	5, 18,37	3
	Simulation–real environment mismatch	1,7,24	3
Infrastructure	Insufficient digital infrastructure (internet, device, system)	3,8,9,11,23,30	6
	Data quality/integrity issues	6,12,13,19,21,36	6
	High data cost/technical requirements	9,12,28,30	4
	Weak corporate integration	4,19,28,39	4
Ethics and Law	Data privacy and security risks	4,5,7,8,11,12,14,17,18,20,21,23,28,30, 31,38,39	17
	Requirement to validate AI outputs	4,5,12,15,21,25,30,32,33	9
	Lack of transparency/unexplained decisions	5,6,7,8,12,26,30,35	8
	Risk of algorithmic bias	7,13,14,20,26,31,35	7

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Theme	Challenges	Study ID	Frequency
	Over-automation/need for human judgement	8,20,31	3
Organizational	Resistance to technology and change	3,6,9,13,15,26,30,31,34	9
	Skill gaps in workforce/planning uncertainty	6,9,20,21,31	5
	Fear of job loss/role uncertainty	17,20,31	3
	Communication/compatibility issues in human–AI interaction	2,15,17	3
	Lack of leadership support	22,34	2
Pedagogical	Low digital literacy/user competence differences	3,8,9,11,16,30,31	7
	Limitations of personalisation	12,16,30	3
	Incompatibility of AI outputs with learning objectives	24,32,37	3
	Cultural incompatibility/context differences	3,10,23	3
	Subjectivity of reflective data and measurement errors	36,37	2

Within the scope of the analysis, five themes were identified: technical, infrastructure, ethical and legal, organisational, and pedagogical. The most significant challenges were found to be in the technical and ethical-legal themes. In the technical dimension, LLM hallucinations and accuracy errors (n=14), lack of up-to-date information (n=6), and inability to answer questions containing visual information (n=5) constitute the most fundamental areas of difficulty. In the infrastructure dimension, digital infrastructure deficiencies (n=6) and data quality issues (n=6) stand out. The ethical and legal dimension indicates the highest level of difficulty. The ethical and legal dimension includes challenges such as data privacy (n=17), the requirement to verify AI outputs (n=9), lack of transparency (n=8), and algorithmic bias (n=7). Organisational challenges include resistance to technology and change (n=9) and workforce skill gaps/planning uncertainty (n=5). In the pedagogical dimension, low digital literacy (n=7) has been identified as a significant challenge area.

5. Discussion

The most striking finding in the field of artificial intelligence applications in employee training is the significant increase in publications over the last two years. This situation is directly proportional to the extraordinary changes in artificial intelligence applications after 2023. According to Eurostat (2025) data, the proportion of businesses with at least 10 employees in the European Union using artificial intelligence technology was 8% in 2023, rising to 13.5% in 2024, just one year later, representing an annual increase of approximately 60%. Similarly, according to McKinsey's (2025) global artificial intelligence research, the use of GenAI in at least one business function was 33 per cent in 2023 and is projected to reach 79 per cent by 2025. All these results explain the increase in artificial intelligence research in employee training, particularly regarding its use in working life after

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2023. A sector-based analysis reveals that the healthcare sector stands out. Looking specifically at citation-based impact measures, studies conducted in the healthcare sector are again prominent. In the context of data collection tools, artificial intelligence has introduced unconventional methods that align with its own technology. Sensor-based (Wang et al., 2025), system logs (Gezdur & Bhattacharjya, 2025; Mitsugi et al., 2025; Shamaylah et al., 2025; Watanabe et al., 2025), learning analytics (Barthakur et al., 2022), etc. are used in studies. Among the underlying artificial intelligence technologies used, Large Language Models & Generative Artificial Intelligence (LLM & GenAI) and Machine Learning & Deep Learning (ML & DL) stand out. It is a natural consequence that these sub-technologies are prominent in learning analytics and chatbot architecture for educational support systems.

When evaluating the impact of artificial intelligence applications on employee training, effects have been reported in cognitive, affective, behavioural, and technical-organisational dimensions. This result demonstrates that artificial intelligence has produced positive outcomes in multiple areas. In particular, the effects of higher-level cognitive skills, accelerated learning speed and skill acquisition, increased learning motivation and affective engagement, a personalised learning path, and content and support provision stand out. Beyond these, the effect of early identification of at-risk learners (Phillip-Durham & Deasey-Weinstein, 2025) indicates that one of the most significant expected effects of artificial intelligence technologies on educational processes has emerged.

In terms of opportunities, five sub-themes stand out: learning quality, cognitive development, affective and social, performance and efficiency, and organisational. Personalised education and learning pathways, the development of clinical/branched expertise skills, increased learning motivation, reduced workload and training time, and a scalable training infrastructure stand out as notable opportunities. The finding that artificial intelligence can create its strongest opportunities at the organisational level is also quite significant in terms of the study. Its positive impact on the training infrastructure, its support for data-driven decision-making, its positive impact on the skill teaching-development process, its reduction of training costs, its contribution to workforce planning, its contribution to the quality control process, and the opportunities it offers for creating organisational memory reveal that artificial intelligence will be a technology that institutions will frequently turn to for employee training in the future.

An assessment of potential challenges identified difficulties in the areas of Technical, Infrastructure, Ethics and Law, Organisational, and Pedagogical. These include BLLM hallucinations and accuracy errors, inadequate digital infrastructure (internet, devices, systems), data privacy and security risks, resistance to technology and change, differences in digital literacy/user competence, etc. The technical theme refers to the area involving a number of software-related problems with artificial intelligence technologies. In this respect, it does not include areas that can be directly overcome during the implementation phase of scientific studies. Similarly, the ethical and legal dimension constitutes one of the most fundamental areas of difficulty for artificial intelligence technologies. Data privacy and security risks, the need to verify AI outputs, algorithmic bias, etc., constitute a fundamental challenge for AI integration. As with the technical dimension, the ethical dimension is a challenging area, dependent on global regulations, making AI applications a risky prospect for the future.

6. Conclusion

Employee training has become an extremely important concept for social progress, alongside the birth of skilled professions during the industrial revolution. To this end, secondary and higher education programmes targeting professions requiring expertise were developed within formal education processes, and this planning was largely sufficient until perhaps the last quarter of a century. One of the most fundamental reasons for this is that technological developments have not

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been able to impact production and service areas at the same pace. However, especially after 2000, extraordinary technological change has led to an unprecedented transformation in production and service areas, as in all areas of life. This situation has resulted in vocational training received within formal education processes becoming outdated very quickly in the workplace and a mismatch between the labour market's workforce demands and the skill sets of formal education graduates. It is precisely at this point that employee training provided in the workplace after the formal education process has become an increasingly important issue over the last quarter of a century.

In particular, Covid-19 has created sudden and fundamental changes in labour force competencies in both production and service sectors with its profound effects on working life worldwide. All these developments have made the training of employees in the active labour force, regardless of the sector, a more important field of work than ever before. The most important feature that distinguishes employee training from other types of education is that it is an adult education activity and that the duration of the training must be designed in such a way that it does not have a negative impact on working hours. At this point, while educational technologies are seen as an important opportunity, adult education has some shortcomings in terms of meeting andragogical requirements, such as providing educational content tailored to the needs and development pace of adults.

Artificial intelligence technologies are gaining new competence in training technologies used in employee training, with advantages such as the ability to create adaptive learning environments based on learner characteristics and to create simulation-based training environments such as AR/VR. This study is particularly important as it can determine the current and potential effects of artificial intelligence technologies on employee training processes, especially with the proliferation of these technologies after 2020 and their discovery of new application areas every day, and it can serve as an important starting point for future studies. Although educational technologies are not a new concept for employee training, educational technologies enhanced with artificial intelligence technologies are considered a relatively new field. At this point, pioneering studies are particularly evident in the health sector. This is an entirely normal outcome, as health sciences utilise data-driven predictions, possess extensive historical individual health data, and thus contain the meaningful data sets required for artificial intelligence technologies. Similarly, in terms of impact, health studies have created significant scientific influence in the field.

Although the study examined work from 2020 to 2025, the absence of any studies from 2020 and the fact that the majority of studies were conducted after 2023, particularly in 2025, highlights how new this field of study is. At this point, it is anticipated that the number of direct experimental and application-oriented studies in this field will increase in the coming years. Despite the significant impact and opportunities created by artificial intelligence applications in employee training, they still present significant challenges. Ethical and legal risks, as well as risks directly related to the technical capacity of artificial intelligence systems themselves, will be the most important issues for future studies and areas of application. At this point, it is anticipated that universal standards will be established in the ethical and legal dimensions of artificial intelligence in the coming years. In particular, the problems in the ethical and legal fields are not so much preventable as they are solvable through a set of standard practices agreed upon by an international consortium.

Declarations

Author Contributions. The study was conducted by a single author.
Conflicts of Interest. The authors declare no conflict of interest.
Ethical Approval. This study is not part of my research ethics scope and is in the form of a systematic literature review.

Data Availability Statement. The articles used in the study were accessed via the Scopus database, and full access details are provided in the references section.

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About the Contributor(s)

Ecehan Kazancı Yabanova, completed her doctorate in Isparta Süleyman Demirel University, Department of Labor Economics and Industrial Relations. She works in the fields of labor law, Employee training and occupational health and safety.
Email: ecehankazanci@gmail.com
ORCID: http://orcid.org/0000-0002-1602-2904