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Teachers' Integration of Artificial Intelligence in Education: A Systematic Review of Applications and Outcomes

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Artificial intelligence (AI) is increasingly shaping teaching practices across diverse educational contexts. However, the existing literature remains fragmented, with limited consensus on how teachers use AI, the contexts in which it is employed, and its implications for teaching and learning. This systematic review synthesizes research published between 2016 and 2025 to examine the use and integration of AI in teaching practices, with particular attention to the educational levels, disciplines, AI modalities, pedagogical applications, and reported learning-related outcomes. Following PRISMA guidelines, 100 articles were identified and analyzed. The findings indicated an imbalance in research trends within the field. Most investigations examined the pedagogical integration of various AI technologies in teaching, including AI-based conversational systems, intelligent assessment and learning systems, extended reality technologies, auditory-visual computing systems, and educational analytics for learning and teaching. Integrating AI in teaching was mainly focused on the higher education context, which accounted for 50% of all the selected articles. Regarding disciplinary focus, English language education (21,6%) and computer science (18,3%) dominated teachers' integration of AI into teaching. The study emphasized the significance of expanding future research on AI-supported professional development and AI literacy while also examining AI integration from both instructional and learner-centered perspectives. Future research should also examine technological limitations and ethical concerns to promote the effective use of AI in education.

Keywords: artificial intelligence, GenAI, teaching, learning, higher education, instruction

INTRODUCTION

Artificial intelligence (AI) has dominated educational practices today (Lo, 2023) and makes accessing and sharing knowledge more feasible (Karakostantaki et al., 2025). It supports students in their learning and teachers in tailoring instruction and facilitating learning (Barrett & Pack, 2023; Chiu et al., 2023). Generative artificial intelligence (GenAI) has brought new attention to its implications in education. Many see it as a powerful means in education (Chen, 2024), as it is mainly employed to generate new content and produce various types of data, including codes, videos, images, and texts (Chiu, 2024). Traditional AI mainly analyzes data and finds patterns. In contrast, GenAI generates content based on what it has been trained for (Barrett & Pack, 2023). This development marks a new stage in technological evolution. It offers greater efficiency and creativity (Chiu, 2024) and, at the same time, raises important ethical concerns and challenges (Edwards & Cheok, 2018).

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Applications of Natural Language Processing (NLP) are becoming important in everyday teaching practices in education (Ng et al., 2023). Research has explored the effects of using AI in teaching using various advanced technologies like chatbots, smart learning systems, and analytical systems (Chiu et al., 2024). The pedagogical function of AI reshaped teaching in academic settings (Zhang & Aslan, 2021). Scholars have drawn attention to the challenges caused by AI, including reduced teacher involvement, lower educational standards, or negative impacts on learners' mental and cognitive development (Chan & Tsi, 2023; Edwards & Cheok, 2018). Nonetheless, scholars remain interested in researching the roles of AI in education and seek to harness its role while addressing its challenges (Memarian & Doleck, 2023).

Before GenAI, AI in education had more limited roles (Karakostantaki et al., 2025). It was mainly used in smart tutoring systems and automated evaluation (Chan & Tsi, 2023). Broadbent (2017) demonstrated that AI tools were widely used to support three main groups: students, teachers, and administrators. For students, intelligent learning systems allow self-paced learning. They also helped adapt learning materials to individual needs (Al-Zahrani, 2025). For teachers, instructional management systems reduced administrative load. They also provided better insights into student performance (Broadbent, 2017). Although these tools improved teaching and learning, their scope was still limited (Chan & Tsi, 2023). In this regard, early AI systems struggled to assess complex thinking skills and were not effective at generating personalized learning content (Barrett & Pack, 2023; Edwards & Cheok, 2018).

Teaching and learning in higher education have traditionally relied on limited staff and largely teacher-centered approaches (Broadbent, 2017; Moorhouse et al., 2023). The emergence of GenAI has reshaped this landscape by offering new possibilities for assessment, personalized learning, and improved educational outcomes (Chiu et al., 2023). However, it introduces significant challenges, particularly around academic integrity, as tools such as ChatGPT enable students to produce essays, proposals, and take-home assignments with ease (Chan & Tsi, 2023; Moorhouse et al., 2023). This shift also affects learning expectations, since students can complete complex tasks even without fully developed disciplinary skills, including generating new ideas and accessing subject knowledge more efficiently (Guo & Wang, 2023). Unlike earlier AI technologies, GenAI has expanded beyond text generation to include image generation, programming, and creative writing, broadening its applications in education (Bengesi et al., 2024). These applications support more flexible learning processes, allowing further personalization of instruction (Moorhouse et al., 2023). As for the teachers, such an innovation makes their work easier and gives them more opportunities for creativity and more engagement with students (Chan & Tsi, 2023; Barrett & Pack, 2023).

Recently, research has increasingly attempted to evaluate the contribution of AI in the education system through systematic reviews and mapping studies (Dertli & Yıldız, 2025; Memarian & Doleck, 2023). In this regard, Ng et al. (2023) have mapped the development of the field from 2000 until 2020. Another review by Chiu et al. (2023) provided a wider-ranging synthesis of the incorporation of AI in education by looking into both its benefits, limitations, and potential directions for the future. In higher education, Crompton and Burke (2023) and Zawacki-Richter et al. (2019) have reviewed AI from 2016 to 2022. Bozkurt et al. (2021) have also critically analyzed AI research in education, pinpointing recurring trends and raising awareness of significant gaps, especially those concerning ethics.

Many years of research have been devoted to AI within diverse disciplines, such as education (Memarian & Doleck, 2023). Nevertheless, there are not enough theories about the link between AI and education, particularly in the field of teaching (Moorhouse et al., 2023). GenAI can respond to questions (Zhai et al., 2021) and perform translation across languages, as well as generate content in various forms and perform data analysis or summaries on the basis of written materials (Chiu et al., 2023). Different approaches have been suggested in classifying AI in teaching (Zawacki-Richter et al., 2019). There is not much literature on the intersection between AI and learning theories (Chiu et al.,

2023). Thus, according to Chen (2024), many papers discuss the use of AI but do not engage deeply with educational theories.

Despite the fact that numerous studies have been conducted on AI in education, the issue of looking at education from the perspective of the way it is incorporated in teaching and learning remains a neglected one (Memarian & Doleck, 2023). Most studies are dedicated to how various AI tools can be used in education, but not specifically the ways they are employed for teaching and learning and how such integration relates to students' learning experiences and outcomes (Zawacki-Richter et al., 2019). This review addresses this gap by systematically synthesizing research on AI integration in teaching and learning environments, identifying dominant applications and contexts, comparing reported outcomes, and highlighting underexplored areas for future research. By bringing these strands of evidence together, the review provides a more comprehensive picture of how AI is being incorporated into educational practice and where further empirical investigation is needed. The analysis is structured around these two research questions:

1. How have research trends in the application of AI in teaching and learning evolved with respect to specialization, educational context, and types of AI modalities adopted?

2. How are AI modalities employed across diverse educational levels and academic disciplines?

The first research question seeks to identify the main trends within this field by examining the thematic emphasis of research. The aim is to examine variations in AI integration practices across educational contexts and disciplinary focuses and provide a structured understanding of current research trends. This helps identify underexplored areas that require further investigation and supports the development of future research directions. The second research question explores how AI modalities are employed across diverse educational levels and academic disciplines. The aim is to identify variations in AI integration practices across educational contexts and disciplinary focuses. Examining these variations would guide the development of targeted integration approaches and more effective professional growth programmes tailored to the requirements of several educational settings.

METHOD

For this systematic review, we adopted the PRISMA method (Elsman et al., 2024). PRISMA framework is known for its structured framework that helps in carrying out systematic reviews, comprising different stages like searching for literature, screening, data extraction, analysing data, and reporting findings (Bingham, 2023; Elsman et al., 2024). Therefore, based on this framework, the review was performed through five consecutive steps (Bingham, 2023). The first step involved searching for literature using predetermined inclusion and exclusion criteria (Walsh & Rowe, 2023). The second step included screening all the identified papers using a two-stage screening process (Valizadeh et al., 2022). In the third step, we extracted relevant data from the final sample and organized it into structured tables to ensure clarity and consistency (Bingham, 2023). The fourth step was to analyze the data in relation to the questions being addressed. Finally, the findings were reported following the PRISMA guidelines (Elsman et al., 2024).

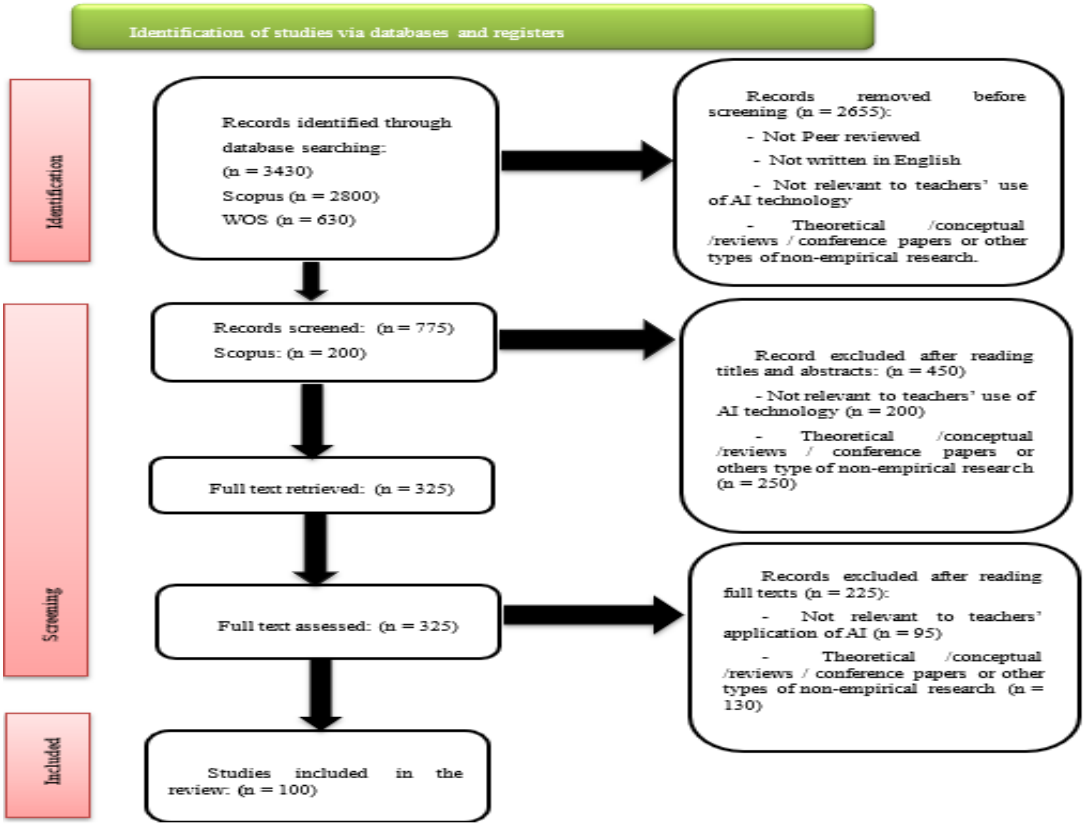
Search process

This study examines the integration of AI technologies in education. To answer the stated research questions, a search strategy was developed. The search strategy was designed to capture the broad range of terminology used to describe AI and its application in teaching and learning. Searches were conducted in Scopus and WOS for publications dated from 2016 to 2025. The search strategy combined AI-related terms with teacher and teaching-related terms. In Scopus, the following search string was applied to titles, abstracts, and keywords: *TITLE-ABS-KEY* (("*artificial intelligence*" OR "generative AI" OR ChatGPT OR "machine learning" OR "intelligent system*") AND (*teacher** OR *educator** OR *instruction** OR *pedagogy*)). In Web of Science, the corresponding search string was:

TS= (("*artificial intelligence*" OR "*generative AI*" OR *ChatGPT* OR "*machine learning*" OR "*intelligent system**") AND (*teacher** OR *educator** OR *instruction** OR *pedagogy*)). Truncation and Boolean operators were used to capture variations in terminology.

The last search was done in the titles, keywords, and abstracts of articles. Studies included in the analysis were those including terms related to AI and teaching and learning. For the literature search, we opted to use WOS and Scopus as the two major indexing databases for publishing high-quality academic publications in the domains of education and AI (Ng et al., 2023). This selection criterion was also based on the databases' reputation in indexing within evidence-based studies (Saif-Ur-Rahman et al., 2022). The initial search identified 3,430 records (2,800 from Scopus and 630 from Web of Science). After removing 2,655 records that did not meet the preliminary criteria, 775 records were screened by title and abstract. Of these, 450 were excluded, leaving 325 articles for full-text assessment. Following full-text screening, 225 articles were excluded based on the eligibility criteria. Consequently, 100 studies were retained for the final synthesis. To identify significant research trends and maintain the methodological integrity of the study, we included journal articles that were peer-reviewed only, omitting conference articles, reviews, and other types of non-empirical studies (Saif-Ur-Rahman et al., 2022). Using the predetermined inclusion and exclusion criteria, we further narrowed the dataset for screening (see Fig. 1). It is clear from the limited number of studies identified that little research exists at the intersection between AI and education.

Figure 1
PRISMA flowchart



Screening

The process of screening went through several stages with meticulous attention to detail (Elsman et al., 2024). Initially, we searched for studies using the same search strings for both databases (Scopus and WOS). After that, we identified duplicates and removed them from the list of articles to ensure a clean dataset, and a total of 490 articles were removed. We made a screening of titles and abstracts of articles to decide on their relevance according to inclusion and exclusion criteria (Valizadeh et al., 2022). Next, we obtained the full texts of those articles we found relevant after the initial screening. Finally, at this stage, we made conclusions on whether to include articles or not depending on their relevance to the topic of our study (Valizadeh et al., 2022). Specifically, only those articles that were empirical and related to the topic of teachers' use of AI technologies were included. Studies that did not meet inclusion criteria after the manual screening process and those lacking full text were excluded (Valizadeh et al., 2022).

A more profound analysis of the full texts of those articles resulted in further exclusion of irrelevant ones (Saif-Ur-Rahman et al., 2022). Consequently, 100 articles focused on AI in teaching were considered relevant and included in this review. The identified papers were assessed using the Mixed Methods Appraisal Tool (MMAT) (Hong et al., 2018). Two reviewers independently assessed each study against the relevant MMAT criteria. Disagreements were resolved through discussion and consensus. The appraisal results were considered when interpreting the findings and identifying limitations in the available evidence, but study quality was not used as an exclusion criterion.

Coding

To meet the study objectives, deductive and inductive coding were used as a basis for a thorough and systematic analysis of the selected papers (Bonner et al., 2021). To ensure reliability and validity, a series of structured codes in light of the methodological assumptions and theoretical framework were developed based on previous studies (Zhang & Aslan, 2021). In the first phase of the analysis, deductive coding was employed (Bonner et al., 2021). Codes involved affiliations, geographical context, fields of study, and year of publication, based on the metadata from the databases of WOS and Scopus. Moreover, codes were used to categorize educational levels and disciplines.

Regarding inductive coding, the grounded theory methodology was applied to identify recurring themes regarding the application of AI within teaching practices (Walsh & Rowe, 2023). Such themes were identified based on the literature itself, enabling emergent patterns to develop from the data. We additionally applied “vivo” coding. In this case, relevant concepts and terms were taken straight from the primary literature sources (Walsh & Rowe, 2023). This ensured that the actual meaning attributed to the terms by the authors remained intact and the analysis remained focused on the literature (Walsh & Rowe, 2023). To ensure consistency, we followed a multi-round iterative coding process (Morgan, 2023). Codes were repeatedly reviewed, compared, and refined across several cycles (Morgan, 2023). In order to improve the reliability of our coding method, we further applied intercoder reliability measures (Bingham, 2023). Two independent coders coded all articles independently. Differences and similarities in their codes were analyzed to identify potential discrepancies and inconsistencies (Bingham, 2023). Agreement between the two coders was computed as Cohen’s Kappa (Cheung & Tai, 2023). The score obtained was 0.83, suggesting a strong level of agreement between coders (Cheung & Tai, 2023). Any differences in coding were considered in detail and resolved through consensus (Coleman et al., 2024).

Following this methodological approach, all codes from the analyzed literature were clustered into one overarching category, namely, "AI in Teaching and Learning." The classification of articles was made according to their use of AI for instruction. After that, the category obtained was subjected to deductive coding (Bingham, 2023). Further, we distinguished between the levels of education, the disciplinary focus, and what AI technologies were used for. Then we carried out axial coding

(Memarian & Doleck, 2023) for each separate subcategory. These codes connect two previously formed dimensions: the discipline and the education level.

FINDINGS

Research Trends in AI-Driven Teaching Practices Across Educational Contexts and Academic Disciplines

Distribution of studies on the Application of AI in teaching

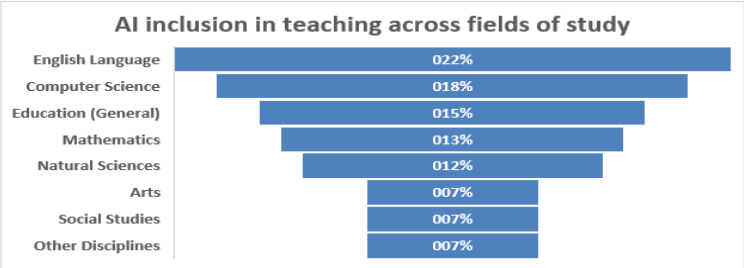
The current systematic review focused on studies published from 2016 to 2025 about the integration of AI in education, with specific emphasis on teachers' use of these tools in teaching practices. The results showed an increasing number of scholarly works starting from 2020, which indicates an increased academic interest in AI in education. The analysis of first-author affiliations revealed that the USA and China accounted for the largest share of publications.

AI use in teaching across fields of study

As part of the deductive coding process, the analyzed papers were classified based on their disciplinary focus (see Fig. 2). The findings show that the use of AI in teaching was mainly conducted in almost the following five disciplines: English language education (21,6%), computer science (18.3%), education (15%), mathematics (13.3%) and natural sciences (11.6%). This distribution seems to be a result of the technological applicability and relevance of AI tools within these disciplines, as well as increasing scholarly interest in applying digital tools to instructional practice in these disciplines. Language learning and computer science proved to be the leading disciplines owing to conversational AI. On the contrary, few investigations examined the integration of AI within fields such as social sciences, music, and others. Another trend that is observed in the literature shows that several studies followed a multidisciplinary approach by incorporating AI for promoting general competency skills.

Figure 2

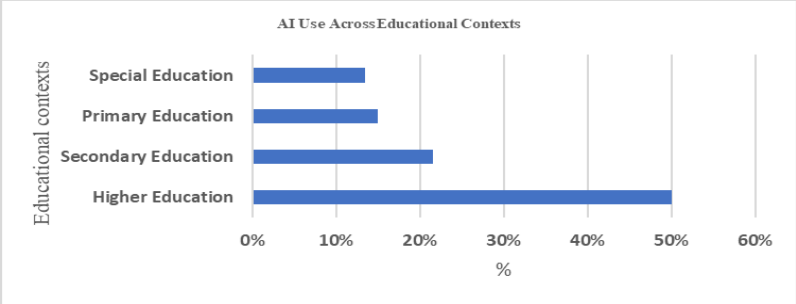
AI inclusion in teaching across fields of study



AI use across educational levels

In the process of deductive coding, the identified studies were categorized based on educational levels (see Fig. 3). Accordingly, studies on higher education were the most common ones (50%). This could be attributed to the fast-paced implementation of AI technologies in higher education institutions and the rising interest in AI-enabled pedagogical methods at tertiary education institutions. The secondary and primary education levels accounted for 21.6% and 15% of the selected articles, respectively. Additionally, the findings revealed that there were new developments regarding the application of GenAI in the realm of special education. Specifically, several articles discussed the use of AI systems to personalize learning and meet learners' needs at various educational levels.

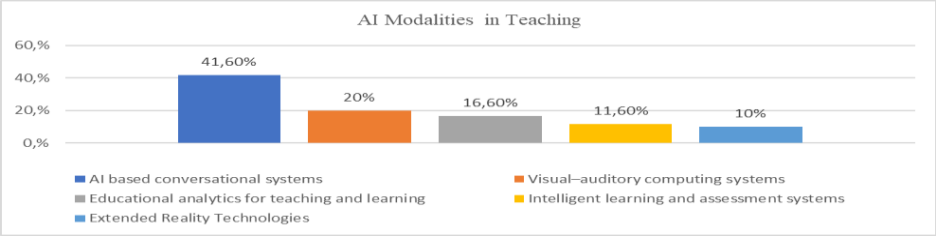
Figure 3
AI use across educational contexts



Types of AI Modalities in Teaching

The examination of the selected studies has revealed five major categories of AI applications in teaching. The most common ones are those that relate to conversational AI (41.6%) (see Fig. 4). Generative AI tools (e.g., ChatGPT) became popular in recent years and attracted significant attention from researchers who explored the role of these tools to encourage interactive learning, personalized feedback, and engagement. It was the nature of conversational AI that made it widely used in instructional practice, as technology possesses key characteristics such as accessibility, flexibility, and interactivity. Visual–auditory computing systems represented 20% of the studies, attracting scholars' interest in the use of multimodal technologies to enhance instructional practice and learner interaction. For educational analytics for teaching and learning, it represents 16.6%, emphasizing the growing importance of data-informed teaching and learning practices.

Figure 4
Distribution of AI modalities in Teaching



Integration of AI Modalities in Teaching and Learning Practices Across Educational Levels and Disciplines

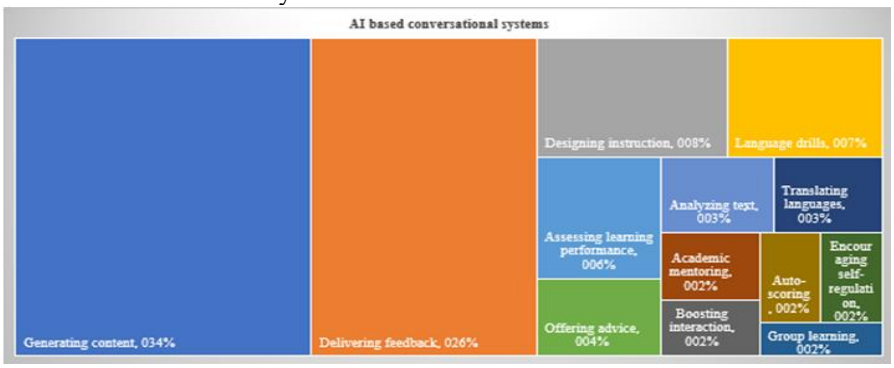
This study examines how AI modalities are incorporated in teaching and learning. The results revealed various AI modalities and systems (see Fig. 4). These tools are grouped into AI-based conversational systems, intelligent learning and assessment systems, extended reality technologies, visual–auditory computing systems, and educational analytics for teaching and learning. The following subsection offers a summary of the incorporation of AI modalities in instruction at diverse levels of education and in various disciplines. The findings are based on the types of AI modalities that have been identified in the reviewed studies, as illustrated in fig. 4.

AI-based conversational systems

The integration of AI-based conversational systems and NLP models such as chatbots was identified in 41.6% of the reviewed papers within various educational contexts (fig. 5). Within this body of research, 64.7% focused on the higher education level. 35.2% of these investigations were carried out

in the context of K-12 education, and 5.8% were conducted at other levels of education. Recent developments in Gen AI have expanded the application of these tools in teaching. This integration is illustrated in Fig. 5. Each area denotes a concrete application; its size depends on the rate of recurrence among the investigations in the educational context. As Figure 5 shows, conversational AI has two main uses in teaching. First, it helps learners by offering a personalized learning experience via generating different forms of content and providing feedback. Second, it supports educators by making instruction more efficient. Specifically, some activities like curriculum development, assessment creation, and student assignment evaluation can be partially automated.

Figure 5
AI-based conversational systems



Higher Education

In higher education, integrating AI-based conversational systems in teaching has received significant attention from researchers. Their studies have covered various academic disciplines. Some of these major disciplines include STEM fields, educational sciences, and languages, namely Chinese and English, stressing the wide-ranging application of these technologies in higher education.

For STEM, research examined the integration of AI-based conversational systems in instructional practices. Lu et al. (2021) studied the use of NLP in generating automatic Q&A, and Demszky et al. (2023) explored the use of an NLP-based system in providing automated feedback. Concerning automation, Jukiewicz (2024) investigated the effectiveness of ChatGPT in automation. He found that the scores generated by ChatGPT were highly correlated with those assigned by the teachers. Rahman and Watanabe (2023) emphasized the integration of ChatGPT in education, and findings raised crucial concerns such as algorithmic bias, plagiarism, and the problem of over-reliance on technology.

Studies have also examined how to improve interaction between learners and AI using structured approaches. Tassoti (2024) introduced a framework known as the "Five S" prompt strategy, which aimed at improving the questioning skills of Chemistry learners. The application of this framework led to increased learner satisfaction with the answers provided by ChatGPT-enabled Discord bots. On the other hand, Bai et al. (2024) introduced a three-stage framework for prompt engineering designed for scenario-based learning. Their results indicated that this framework improved students' learning performance, intrinsic motivation, and overall attitudes toward computational thinking. Moreover, the quality of AI-generated content was evaluated by Jia et al. (2024). The study used a Turing test to assess geometry and algebra advice provided by ChatGPT and that produced by human instructors. Most evaluators failed to differentiate between the two types of content, and findings showed that ChatGPT helps reduce the pedagogical load of teachers.

In education, researchers analyzed the potential applications of chatbots in teaching. For instance, Fidan and Gencel (2022) studied the effect of incorporating peer feedback mechanisms in AI chatbot

systems into video-based instructions. McLeod and Richardson (2023) investigated the integration of ChatGPT in instructional practice. Li (2023) suggested a ChatGPT-driven flipped learning management framework. This framework offered necessary scaffolding that substantially enhanced self-efficacy, creative thinking, and academic performance compared to conventional flipped learning models. Lee and Zhai (2024) examined the integration of ChatGPT in science-related classes. In Chile, Ossa and Willatt (2023) designed the RECaP-GPT procedure. Specifically, their findings indicated the potential of GenAI in providing prompt formative feedback for extensive writing tasks. Davis and Lee (2024) explored ChatGPT's ability to develop lesson plans, as it identified suitable topics for the curriculum; however, it failed to integrate prior knowledge with future learning objectives.

In the field of language education, research has investigated how chatbots can assist in language acquisition. Some studies have been conducted using ChatGPT and its analogues for improving writing skills (Boudouaia et al., 2024), evaluating types of feedback in writing (Sasaki et al., 2024), developing oral communication skills (Kemelbekova et al., 2024), organizing classroom discussions (Guo et al., 2023), increasing academic participation (Wang & Xue, 2024), examining interactions among students, teachers and AI (Ji et al., 2024), designing tests (O, 2024), evaluating academic writing (Lu et al., 2024), and overcoming anxiety in public speaking (Chen, 2024).

Boudouaia et al. (2024) found that ChatGPT could aid in improving the EFL writing skills of their students through error correction and revision processes. Based on a comparative study, Sasaki et al. (2024) claimed that human feedback was more effective at developing linguistic complexity in writing. Their findings revealed that machine translation feedback outperformed human feedback in terms of accuracy and fluency; however, students preferred human feedback emotionally. Lu et al. (2024) claimed that ChatGPT-based feedback seems rather vague compared to human feedback. Consequently, they encouraged students to engage in more critical and independent revision processes.

Oral communication has also been considered in AI technology. Kemelbekova et al. (2024) investigated the development of speaking skills in relation to the use of AI tools. Significant correlations were observed in terms of speaking abilities owing to the fact that the use of technology allowed for accurate pronunciation assessments and relevant feedback. In addition, Guo et al. (2023) established that chatbots are reliable partners when preparing for debate rounds and assist in formulating arguments. Moreover, such technologies increase student participation in their learning process because of personalized feedback given by AI systems, as observed by Wang and Xue (2024).

Collaborative dynamics among teachers and AI technology are equally important. According to Ji et al. (2024), conversational AI is a form of "virtual native speaker," which contributes to vocabulary development. However, they emphasized that teacher involvement was necessary in managing these communication processes by providing constructive feedback. Concerning assessment, it was proven by O (2024) that AI can generate test items similar to human-developed ones, thus reducing teachers' workload. Finally, the psychological use of such technologies was examined by Chen (2024). He investigated how AI and ASR can be used together to tackle speech anxiety problems. Analytical feedback and private tracking made it possible for students to decrease their anxiety levels through the introduction of these technologies.

In other disciplines, research has studied the application of AI-based conversational technologies. Fuller et al. (2024) explored the analysis of feedback using ChatGPT by students in a pharmacy program. The study confirmed a very high consistency between AI interpretations and teacher analysis. Concerning the integration of conversational and GenAI in art programs, Vartiainen and Tedre (2023) looked into the implementation of text-to-image generators within the process of

learning. By using workshops as an experiment, the study revealed that AI technology can be an effective means for generating ideas in both realistic and imaginative ways.

K-12 Education

In K-12 education, AI-based conversational systems were mainly applied in terms of lesson planning, instruction, and assessment. Some studies explored the application of ChatGPT in Kindergarten classes. For instance, AlAli & Al-Barakat (2023) revealed that ChatGPT helps kindergarten teachers in two key ways. To begin with, it aids in language acquisition by generating sentence illustrations based on certain vocabulary items. Next, it helps adapt learning activities to meet learners' needs. For instance, it enables the design of materials for students suffering from ADHD or autism, promoting a more inclusive and engaging learning experience. Yuan (2023) investigated the application of AI chatbots in language instruction in China. Participants who utilized AI chatbots scored higher than those taught conventionally, particularly when it comes to oral fluency and communication intentions.

In another study, Evmenova et al. (2024) investigated how AI as a tool for generating feedback on writing skills is efficient among elementary school students. Although their results showed that ChatGPT can use criterion-based scoring rubrics for grading essays, the consistency of the results varied according to different versions of the program. The study emphasized that the feedback generated by ChatGPT was not aligned with the learning objectives. Moreover, Yuxiu (2024) developed an AI model that integrates statistical and neural approaches in machine learning for translation to increase the effectiveness of teaching. The adoption of such software by students at the secondary level helped them gain improved knowledge through the provision of evaluative and instructive measures in real-time mode. Furthermore, Karaman and Göksu (2024) investigated the use of AI in planning lessons in elementary math classes. The evidence showed that lessons planned through AI were equally effective for boosting the performance of students as compared to those planned by educators.

However, Yetisensoy & Karaduman (2024) explored the effect of using "SosyalciBot," an intelligent chatbot, on teaching "Culture and Heritage" in the 6th grade. They found that the learners who used the chatbot scored better in tests and showed improved knowledge retention over time. This was because of the chatbot's multimodal presentation and its Q&A feature. Within the secondary level, Kasepalu et al. (2022) examined AI's ability to assist instructors in facilitating collaborative learning in biological programs. In real-life face-to-face interactions, the AI helps in pedagogical intervention. The study found that educators perceived the AI to be a useful tool as it facilitated the implementation of its suggestions in optimizing collaborative learning. Nevertheless, the studies noted several challenges related to the use of AI in educational processes and challenges facing its incorporation in instructional practice. For instance, Fassbender (2024) noted that teachers have reservations regarding issues of data privacy, academic integrity, and effective use of such tools.

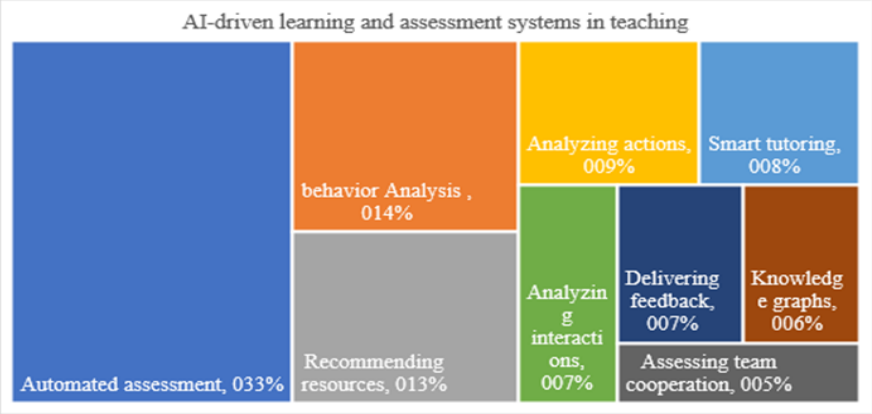
Other educational contexts

Conversational AI and similar systems have been integrated into other educational settings. Chatbots help teachers create learning objectives and employ various teaching strategies. Karatas et al. (2024) studied the impact of employing ChatGPT for enhancing the learning experience in foreign language preparatory programs. Students used AI technology in multiple aspects such as content development, planning, role play, and brainstorming. The results indicated that the integration of AI positively affected the improvement of writing skills, grammar, and vocabulary. Moreover, Chiu (2024) examined the ability of ChatGPT to meet learners' basic psychological needs. The study adopted an educational approach to self-regulated learning, leading to the design of a classification model incorporating 20 unique ChatGPT-enabled activities.

AI-driven learning and assessment systems in teaching

Many researchers have explored how AI-enabled instruction and assessment can improve teaching practices. Fig. 6 illustrates that automatic assessment dominates the application of AI (33.2%), indicating growing dependence on AI tools for improving the efficiency and accuracy of assessment. Other major applications included behavior analysis (14%) and recommending learning resources (12.6%).

Figure 6
AI-driven learning and assessment systems in teaching



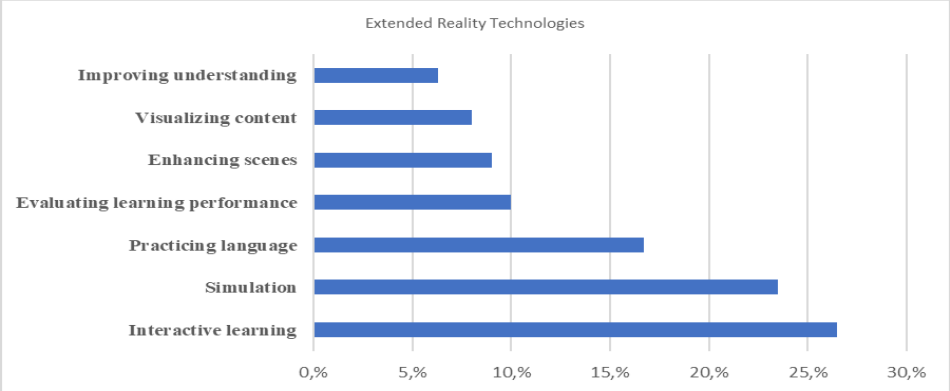
Niu et al. (2022) studied the use of the AI-based "Smart-Learning Partner" platform. The model enabled the development of personalized learning pathways by improving students' access to digital learning content in Chinese secondary schools. Zhang (2024) studied assessment models and flipped teaching. The study employed a platform powered by AI and MOOCs to improve the TPACK skills of university English teachers. The research shows that this approach positively impacted students' writing skills and the digital pedagogical skills of participating teachers.

At the secondary level, Krange et al. (2023) introduced essay assessment based on AI to help 8th graders with writing assignments in English. Additionally, Tomić et al. (2023) examined the effectiveness of an AI-based approach designed to assess students' collaborative performance during group programming projects. The findings revealed highly reliable suggestions for grading students when using the described AI model.

Extended reality technologies

Several researchers examined the role of extended reality technologies in supporting innovative teaching and learning experiences and creating immersive, interactive learning environments. Fig. 7 illustrates that the most common applications were interactive learning (26.5%) and simulation-based learning (23.5%), highlighting the role of these technologies in boosting learner engagement and providing experiential learning opportunities.

Figure 7
Extended Reality Technologies



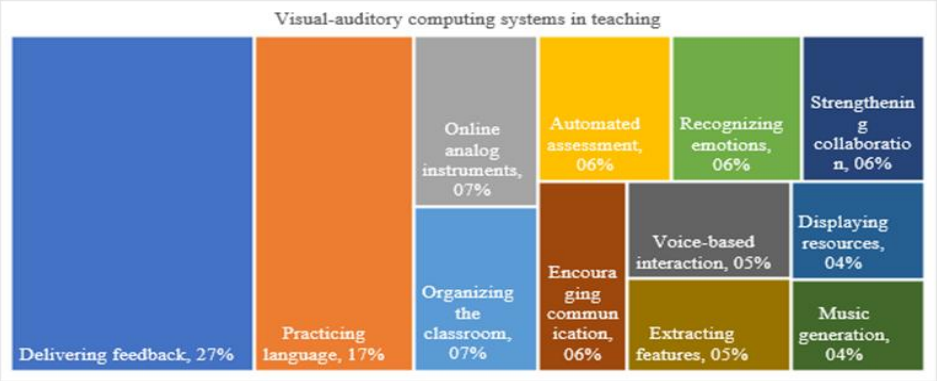
In art education, Miralay (2024) investigated the incorporation of AI and AR for university students. The study found their efficiency in helping learners to develop dynamic visual products; this resulted in increased levels of motivation, creativity, and imagination. Ma (2021) examined VR-assisted immersive learning in English language instruction for college students in an experimental study. The study found that learners who were trained with the help of VR showed better performance in listening and speaking compared to their peers from traditional classes.

The Edu-Metaverse-enabled intelligent learning approach in university English education was investigated by Shu and Gu (2023). The findings suggest that this intelligent learning model encourages deep learning, the development of high-level cognitive abilities, and increased learner engagement. This is claimed due to the new teaching methods through multimodal instructional media resources. Moreover, a gamified AI educational robot was suggested by Yang et al. (2023) for university laboratory safety classes. Results from their study show that there was significant improvement in academic performance, motivation, problem-solving skills, and engagement among students when using it compared to traditional teaching techniques.

Visual–auditory computing systems

Research has examined the use of visual-auditory computing systems in educational settings, mostly centered around understanding the multimodal behavior and performance of the learners (see fig. 8). According to the reviewed studies, the role of AI in visual-auditory teaching systems is directed towards helping students improve their learning experiences. One of the common uses is providing feedback (26.70%), as AI can offer instant and personalized responses to students. The second main use is language practice (17.40%), which shows that AI tools are often employed to help learners practice language skills. Less common usages of AI include organizing classes (6.70%) and automated assessment (6.30%).

Figure 8
Visual-auditory computing in teaching



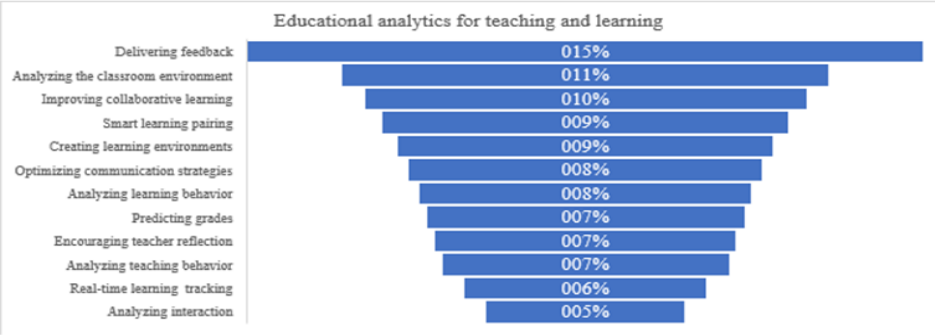
In language instruction, Qiao and Zhao (2023) investigated the efficacy of AI in helping L2 learners enhance their speaking skills and become more self-regulated through their exposure to the Duolingo application. The study revealed that participants trained via Duolingo reached significantly higher levels of speaking proficiency than those trained traditionally. Similarly, Shafiee Rad (2024) studied the effects of Speeko, a speech recognition tool, on L2 learners' spoken communicative competence. The findings showed that users of Speeko improved their speaking skills. Mohammadkarimi (2024) conducted a study on pronunciation improvement using AI-supported software like Listnr and Murf AI. These programs make use of machine learning and speech recognition techniques to offer dynamic feedback and evaluation. The study reported improvements in pronunciation accuracy, learner confidence, and engagement.

In music education, Liu (2022) found that using AI technologies enhanced teachers' efficiency in teaching without increasing human and monetary costs. Additionally, Mao (2022) proposed an AI-driven model in music education. Findings showed better satisfaction levels among participants compared to conventional models. Lee et al. (2023) introduced an AI Speaker-supported collaborative learning system designed for Jigsaw-based group activities in science education. The system integrated small groups of human learners with an AI agent acting as a peer participant. With respect to the ADDIE instructional design framework, the development and testing of the system have been conducted on preservice elementary science teachers. The results indicated generally positive perceptions from participants across multiple roles, including learners, peers, and instructors. In physical education, an AI-based model that facilitates the process of instruction in higher education was introduced by He et al. (2024). This model includes three essential aspects: behavioral information processing, user information gathering, and performance evaluation. It was found that training with the system's assistance led to a notable improvement in performance, where time was cut down by 6-7 seconds during the 400-meter run.

Educational analytics for teaching and learning

Some studies examined the implementation of AI for learning and teaching analytics to improve instructional practices and learning achievements. These studies had the common objective of improving teaching practices and student learning achievements by using systematic data gathering and analysis in education. Fig. 9 illustrates areas of these interventions. The most common uses highlight the importance of providing feedback (15.30%), analyzing classroom environments (11 %), and improving collaborative learning (10 %), which signifies the important role that AI plays in evaluating the process of learning.

Figure 9
Educational analytics for teaching and learning



Holstein et al. (2019) proposed Lumilo as an AI tool for supporting classroom learning. The study integrated a learning analytics framework that used mixed reality smart glasses for middle school mathematics instruction. This technology allowed instructors to receive instant visual feedback about students' understanding, allowing for prompt teaching adaptations. Lampos et al. (2021) explored the use of machine learning algorithms to improve oral skills and offer adapted support to learners who suffer from autism spectrum disorders in specialized education. The results indicated that AI-based technology might recognize schemes associated with more learner feedback, supporting the development of personalized instructional interventions.

Echeverria et al. (2023) studied shared-control mechanisms to manage adaptive transitions between different learning activities. A technology-based probing system was used to measure student competencies and facilitate dynamic group matching among learners with different competencies. The results emphasized the significance of shared control, based on contextual factors, for efficient learning transitions. Li (2024) explored the influence of data science and AI in facilitating technology-enabled educational transformation in higher education. The study integrated AI, Internet of Things, and data science to create personalized learning environments. The performance was measured using fuzzy hierarchical analysis, providing a structured assessment of instructional outcomes.

DISCUSSION

Trends in Research on AI in Teaching

Based on the analyzed studies, the development of research in AI in teaching has been moving forward rapidly. Most academic studies have been conducted on the teaching of English and Chinese, computer science, mathematics, and science fields, while music, social sciences, and other humanities fields have received significantly less attention (Liu, 2022; Mao, 2022). This observed research trend is due to the nature of AI systems in relation to language instruction or computer-based tasks (Yuan, 2023). The overrepresentation of English language education can be explained in the sense that AI has a relatively established history in language education, and language learning offers particularly strong opportunities for AI-supported feedback, translation, text generation, conversational practice, and individualized learning. This still highlights the need for thorough empirical studies in these areas.

Moreover, the development of multidisciplinary studies suggests a gradual shift toward considering AI as a flexible educational tool that can support teaching across different subject areas. Another trend observed in the findings suggests that most investigations were carried out in higher education rather than at other educational levels. This can be explained by higher flexibility and a faster adoption cycle typical of higher education institutions. This also reflects its greater research capacity, technological infrastructure, and institutional readiness to experiment with emerging AI tools. However, the area of

special education perceives AI as a way to promote personalized learning (Lampos et al., 2021; Al-Zahrani, 2025).

Conversational AI technology is dominant. This reflects their accessibility and direct applicability to teaching and learning. Tools like ChatGPT reflect the obvious trend towards a clear shift in educational research toward systems efficient in simulating dialogic interaction, supporting personalized feedback, and facilitating adaptive question–answer exchanges (Demszky et al., 2023; Fidan and Gencel, 2022). Such an approach can be seen as both a natural combination of technological and pedagogical convergence. The former is relatively easy to use and implement into educational processes and is closely connected with fundamental aspects of education such as explanations, tutoring, and assessments (Barrett & Pack, 2023). The reviewed articles have demonstrated that using conversational AI leads to positive results in the educational process. However, certain challenges arise from the utilization of such technologies, like issues of academic integrity, reliability, and over-reliance on AI-generated materials (Memarian & Doleck, 2023).

Technological variety and incorporation

The incorporation of AI in education is changing the nature of instruction. The combination of these technologies affects teaching practices concerning planning, evaluation, and learner interactions. However, integrating these technologies into different educational contexts is challenging, especially considering the fast pace at which AI systems evolve (Galindo-Domínguez et al., 2024). This development creates additional pressures for teachers concerning their AI skills, flexibility, and decision-making (Yildirim & Celepcikay; Jia et al., 2024; Tang et al., 2023). Conversational AI, like ChatGPT, has become the most widely adopted since it is more convenient for improving teaching practice (Zhang & Aslan, 2021; Jukiewicz, 2024). This reflects pragmatic educational needs more than technological preference.

Moreover, the rapid development of AI technologies implies additional challenges for teachers' professional knowledge and AI literacy. AI effective integration in teaching implies both a technical understanding of emerging tools and systems and the ability to assess, adapt, and use AI outputs in different educational contexts and situations (Tang et al., 2023; Yildirim & Celepcikay, 2021). AI tools often lead to efficient and relevant outputs, but they may lack contextual sensitivity and deeper pedagogical reasoning. Successful implementation of AI mainly depends on teachers' professional knowledge (Yildirim & Celepcikay, 2021).

Consequently, teachers' professional experience is a vital component in the interpretation of feedback, validation of content, and guaranteeing the appropriateness of AI-assisted tasks. The evolution of AI urges educators to change their approaches, methods, and strategies (Galindo-Domínguez et al., 2024; Zhang & Aslan, 2021). This calls for ongoing professional development and efforts to make teachers AI literate and equip them with the ability to use AI tools and apply them appropriately, critically, ethically, and efficiently in their instructional practices (Zhang & Aslan, 2021).

Implications and future research directions

Professional development for AI-based instruction and AI literacy

Effective incorporation of AI, especially conversational AI, in teaching relies on prompt design (Bai et al., 2024). Structured prompt strategies improved learning outcomes (Bai et al., 2024). Teachers should be supported in developing this kind of pedagogical AI literacy through targeted professional development. Future research should shed light on professional development in relation to AI integration. In particular, there is a need to examine how structured professional development initiatives could strengthen educators' knowledge of AI and support its successful integration in instructional practice (Yildirim & Celepcikay, 2021). Empirical studies should also investigate contextual factors that shape teachers' AI literacy, AI use, and AI instructional decision-making

(Meylani, 2024. In addition, future studied should give greater attention to teachers' experiences with AI integration. This includes exploring how educators' attitudes, self-efficacy, and pedagogical competencies related to AI and how they interpret and adapt to emerging technologies in practice (Ding et al., 2024).

There is also a growing need to design and implement targeted professional development opportunities focusing specifically on developing teachers' AI literacy. Online learning modules, workshops, and seminars that focus on fundamental principles of AI, classroom implementation, and ethical use can be used to enhance teachers' AI literacy (Kitcharoen et al., 2024; Al-Zyoud, 2020). However, equally important is the design of accurate evaluation frameworks for measuring the effect of these programs on the professional knowledge of educators and promoting their continuous professional development (Celik, 2023; Lin, 2022; Ning et al., 2024). This will help them align with teachers' changing demands and rapid technological developments.

AI in teaching and integrity

With respect to AI integration in teaching, many opportunities have appeared for enhancing the learning experience, yet some challenges related to academic integrity and instructional quality have emerged as well. The growing use of AI in instructional processes entails using such innovative approaches reflectively, critically, and ethically (Chiu, 2024; Gou & Wang, 2023; Moorhouse et al., 2023). Thus, educators should know how to implement AI technology in education effectively to improve instructional practices (Moorhouse et al., 2023). Reflective thinking has an important role in such a case, as it would allow teachers to be aware of its integration. So, using AI in teaching effectively relies on balancing technological innovation with ethical awareness, critical engagement, and meaningful pedagogical practices.

Future Research Direction

This systematic review unlocks several avenues for future research directions. Future investigations can conduct more experimental studies to measure the efficiency of different AI modalities in teaching practice. More attention should be paid to fields with limited studies, such as Music, social studies, and vocational training. Furthermore, most reviewed studies focused on short-term outcomes; hence, there is a need for longitudinal studies examining how AI impacts teacher education, academic performance, and interactions with AI models. Many of the reviewed studies relied on small samples; consequently, there is a need for more empirical quasi-experimental designs along with a large sample, involving teachers, students, and policymakers. Finally, more research is needed on educators' AI literacy, professional development, and the challenges of integrating AI in teaching (Davis & Lee, 2024). This will help teachers, designers, and policymakers set realistic expectations for AI integration in teaching.

CONCLUSION

The findings revealed that among AI technologies, conversational AI and related technologies were dominant. The analysis revealed that most studies (50%) were carried out in higher education. This could be ascribed to the fast-paced utilization of AI models in higher education institutions and the growing interest in digitally enabled pedagogical methods in this context. The results also showed that the integration of AI in education was mainly conducted in language education, computer science, mathematics, natural sciences, arts, and education. This distribution of fields of study seems to be a result of the technological applicability and relevance of AI tools within these disciplines, as well as increasing scholarly interest in applying digital tools to instructional methods in these disciplines. This study emphasizes the necessity of developing educators' AI literacy and professional skills. This aligns with the increasing need for teachers to be knowledgeable about successful AI implementation in education.

Future studies need to transcend the debate about technology usage in favor of more integrative approaches. First, researchers should consider the potential role of AI technologies in assisting the instruction process, creating innovative methods, and providing engaging learning environments. The growing expansion of GenAI makes such an approach highly significant for identifying possible ways to integrate AI systems into instructional practice. Nevertheless, several ethical issues related to bias, privacy, transparency, accountability, and academic integrity require immediate attention and consideration.

USE OF GENERATIVE AI

"The authors used Paperpal to assist with grammar checking and language editing. All content has been reviewed and revised by the authors. The authors take full responsibility for the accuracy and originality of the work."

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