AI-ASSISTED LEARNING: A SYSTEMATIC REVIEW

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ABSTRACT

The rapid advancement of artificial intelligence (AI) is pervasive across numerous fields, including education. However, previous literature reviews have not thoroughly examined the current trends in research design pertaining to AI-assisted learning, nor have they sufficiently addressed the roles of AI applications and teachers within this domain, or the prevailing AI technology trends employed in educational settings. Therefore, this review aims to address these gaps by offering a comprehensive understanding of the present-day scenario of AI integration within education, delving into the roles of both AI technologies and teachers in facilitating AI-assisted learning. Utilizing the PRISMA guidelines and specific keywords, a total of 32 articles spanning from January 2019 to May 2023 were meticulously selected for analysis. The findings demonstrate a substantial increase in AI research within education, particularly focused on enhancing English as a Foreign Language (EFL) learning. Most studies involve higher education students, typically with participant counts ranging from 1 to 50 per study. Common application frameworks such as Dialogflow and OpenAI are prevalent, predominantly utilizing text inputs, with limited exploration of voice, image, or mixed inputs. The review underscores the various roles AI applications can serve, including teaching agent, peer agent, virtual student, and teaching assistant. While certain articles acknowledge the teacher's roles as facilitator, assessor, and instructor, there may be additional roles that teachers could undertake when students engage with AI applications. Therefore, specifying the teacher's role in studies involving student use of AI applications is essential to enhance their effectiveness and refine instructional design.

Keywords: AI-assisted learning, ChatGPT, chatbot, teacher's role.

INTRODUCTION

In recent years, AI has transformed educational settings and reshaped traditional teaching and learning methodologies. ChatGPT, one of the most popular AI tools used by users today since it has created a new era of personalized learning experiences for users. ChatGPT not only provides students with real-time feedback but also allows them to identify their weaknesses independently and offers follow-up activities or practice to address those weaknesses or challenges during the learning process (Kim, Yang, Shin, & Lee, 2022; Porter & Grippa, 2020). As a result of the customization provided by ChatGPT, each student can develop at their own pace, reinforcing comprehension and retention.

Moreover, the integration of AI in education is not limited to student-centric applications; it extends to assisting educators in various aspects of their profession. AI can analyze vast datasets to identify patterns in student performance, helping teachers make data-driven decisions to refine their teaching methods(Jeon, 2022; Jeon & Lee, 2023). Additionally, AI applications facilitate administrative tasks, allowing educators to focus more on meaningful interactions with students (Chocarro, Cortinas, & Marcos-Matas, 2023). The use of AI for grading and assessment not only reduces the burden on teachers but also ensures a more objective evaluation process (Jeon, 2022). As educational institutions continue to embrace AI, the potential for collaborative and interactive learning experiences expands. The synergy between human expertise and AI capabilities creates a powerful educational ecosystem that is dynamic, adaptive, and capable of preparing students for the challenges of the 21st century. As we navigate the future of education, the integration of AI stands as a beacon of innovation, promising a more personalized, efficient, and inclusive approach to learning and teaching.

The rapid advancements in AI technologies present a unique opportunity to revolutionize education, making it more personalized, adaptive, and effective. AI offers more personalized, adaptive, and effective learning through its capacity to analyze individualized data, tailor content delivery, and provide real-time feedback (Jeon, 2022; Jeon & Lee, 2023; Kim et al., 2022; Lin & Mubarok, 2021). The personalization aspect of AI in education is exemplified by its ability to understand and adapt to the unique learning styles, strengths, and weaknesses of each student. AI algorithms can process vast amounts of data generated by a student's interactions with educational content, identifying patterns and preferences. This information is then utilized to customize learning experiences, adjusting the difficulty, pace, and type of content to match the individual needs of the learner. This ensures that students receive targeted support in areas where they may struggle while allowing those who grasp concepts quickly to progress at an accelerated pace.

Adaptive learning, facilitated by AI, goes beyond personalized content delivery. AI systems can dynamically adjust the learning path based on a student's performance, providing additional resources or alternative approaches when challenges arise (Jeon, 2022). For instance, if a student is struggling with a particular concept, an AI-powered system might offer additional practice exercises, targeted tutorials, or different types of multimedia content to reinforce understanding. On the contrary, if a student demonstrates mastery quickly, the system can present more advanced materials to keep them challenged. This adaptability optimizes the learning journey, preventing boredom or frustration and fostering a more efficient and enjoyable educational experience (Chiu, Moorhouse, Chai, & Ismailov, 2023).

The effectiveness of AI in personalized and adaptive learning is further emphasized by its ability to offer real-time feedback. AI applications can assess student performance instantaneously, providing feedback on quizzes, assignments, and exercises (Jeon, 2022; Lin & Mubarok, 2021). This immediate feedback loop allows students to address misconceptions promptly, reinforcing correct understanding and facilitating a continuous learning process. Moreover, AI analytics provide educators with comprehensive insights into individual and collective student performance, enabling them to make informed decisions about instructional strategies, identify areas that may need additional focus, and track overall progress (Chiu et al., 2023).

As the educational landscape undergoes this profound shift, it becomes imperative to conduct a systematic review that comprehensively analyzes and synthesizes the trends in AI applications within educational contexts. Several systematic reviews have explored the use of AI-assisted learning from different perspectives. For instance, Chiu et al. (2023) examined how AI technologies have been integrated into educational domains of learning, teaching, assessment, and administration in their systematical review. Zhang and Tur (2023) covered the strengths, weaknesses, opportunities, and threats of AI-assisted learning. Additionally, Zawacki-Richter, Marin, Bond, and Gouverneur (2019) focused on the ethical implications and risks of AI-enhanced higher education. However, existing literature reviews have not examined the current patterns or approaches in the design of research studies that focus on AI-assisted learning, the roles of AI applications and teachers in AI-assisted learning, and the current AI technology trends utilized in education.

PURPOSE OF THE STUDY

This systematical review aims to understand the methods and structures that researchers are employing when investigating the intersection of artificial intelligence and learning processes, provide a nuanced understanding of the current state of AI in education, explore the roles of AI applications and teachers in AI-assisted learning, and offer insights into future directions for research and implementation. This review aims to address the following research questions:

1. What are the current AI technology trends utilized in education?
2. What research design trends are currently used in AI-assisted learning?
3. What are the roles of AI applications and teachers in AI-assisted learning?

METHOD

Procedure and Data Collection

Search Strategy

The Web of Science database is a primary source of our data collection because this database provides high-quality publications or scholarly articles relevant to our research topic. We conducted full-text searches using comprehensive keywords on Artificial Intelligence "ChatGPT" or "Conversational AI" or "Chatbot" or "Text Generation" or "Virtual Assistant" or "AI Chatbot" or "OpenAI GPT" or "Chatbot APIs". The search included published articles from January 2019 to May 2023.

PRISMA Process

This review adopted the PRISMA guidelines as shown in Figure 1, including identification, screening, eligibility, and included studies (Liberati et al., 2009).

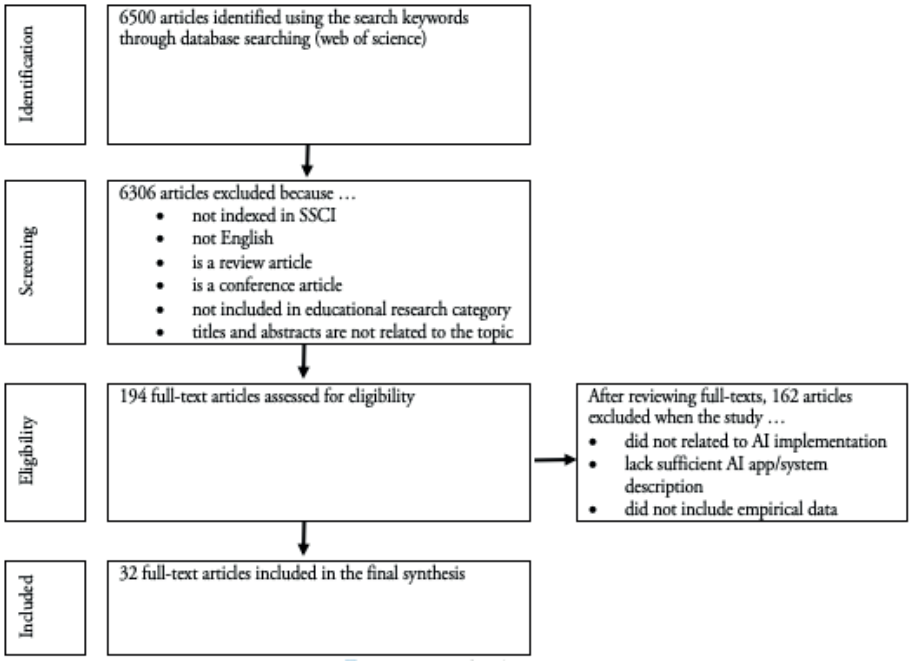

Figure 1. PRISMA process.

Inclusion and Exclusion Criteria

On May 20, 2023, we retrieved 6500 articles from the database using comprehensive keywords. The articles were then screened using the following criteria: (1) the article must be indexed in Social Sciences Citation Index (SSCI), (2) the article must be written in English, (3) The article is neither a review nor a conference paper, and (4) article must be included in education educational research category. This process resulted in 194 full-text articles deemed eligible for further review. The overall inter-rater reliability for the screening title and abstract was 85.75, which showed a good agreement. After reviewing full-texts, 162 articles were excluded because they did not offer empirical data (qualitative, quantitative, or both), were not linked to AI implementation, and lacked sufficient AI application/system description. The overall inter-rater reliability for the screening of full text was 90.55, indicating good agreement. This procedure yielded 32 papers for inclusion in the final synthesis.

Data Extraction and Analysis

This study used both deductive and inductive processes to construct a coding scheme for thematic data analysis (Xu & Zammit, 2020). First, two experienced educational technology experts read all of the articles and extracted all of the information from each article including publication basic information, research course subjects, education levels, research methods, research design formats, number of participants, activity design, application name, application framework, user input form, research data collection and analysis, instructional modes, research durations, type of device platforms, and role of AI apps and teachers. The two experts then classified them into sub-categories as shown in Table 1.

Table 1. Coded categories.

Category	Sub-category	Reference
Basic information	• Year of publication • Journal name	Elaish, Hussein, and Hwang (2023)
Application name	• Application name	N/A
Application framework	• OpenAI • Microsoft AI • Google Dialogflow • Not specified	N/A
Participant's input method	• Mixed (text+voice; text+voice+image) • Text • Voice	N/A
Type of device platforms	• Mobile device • Computer device • VR glass • Smart speaker without screen • Not specified	Xie, Chu, Hwang, and Wang (2019)
Course subjects	• Language • Science • Computer and Engineering • Health Science • Management • Military • Social science • not mentioned	N/A

Participant's educational levels	• Working adult • Higher education • Secondary school • Elementary • Preschool • not mentioned	Fu and Hwang (2018)
Research methodology	• Quantitative • Qualitative • Mixed methods	N/A
Group design formats	• Single-AI chatbot design • AI Chatbot vs. traditional material design • AI Chatbot vs. human vs. human design • AI Chatbot vs. human vs. traditional material design • AI Chatbot vs. AI Chatbot design • AI Chatbot vs. AI Chatbot vs. traditional material	N/A
Sample size	• Small Sample Size (≤ 50) • Moderate Sample Size (51-100) • Large Sample Size (>100) • not specified	N/A
Instructional modes	• Online • Face-to-Face • Mixed Face-to-Face and online • Not specified	N/A
Length of intervention	• Less than 1 week • Between 1 week and one month • More than one month • Not specified	Shadiev and Liu (2023)
Data collection	• Tests (pre- and post-tests) • Total questionnaires • Interviews • user-chatbot interaction logs • Class assignments • Demographic information • Report on user's levels of attention and meditation • User speech input • ChatGPT responses • FGD • Group work assignment • Google Analytics dashboard • Journal writing reports	N/A
Data Analysis	• Quantitative analysis • Qualitative analysis • Mixed analysis	N/A
The role of AI application	• Teaching agent • Teaching assistant • Virtual student • Peer agent	N/A

The role of teacher	• Assessor • Facilitator • Instructor • not specified	N/A

FINDINGS

The Current AI Technology Trends Utilized in Education

This section provides the answer to RQ1. The number of AI studies exhibited a comparatively stable trend between 2019 and 2020, maintaining a relatively stable trajectory that hinted at a period of consolidation and refinement within the field. However, the subsequent years saw a remarkable rise in AI research activity, with the period from 2020 to 2023 witnessing an exponential growth in studies and innovations (Figure 2). This rise reflects an intensifying focus on harnessing the potential of artificial intelligence in a variety of fields, driven by technological advances, increased data accessibility, and growing recognition of AI's transformative capabilities. Furthermore, Education and Information Technologies and Computer Assisted Language Learning were the primary journals for the publication of most articles (Table 2).

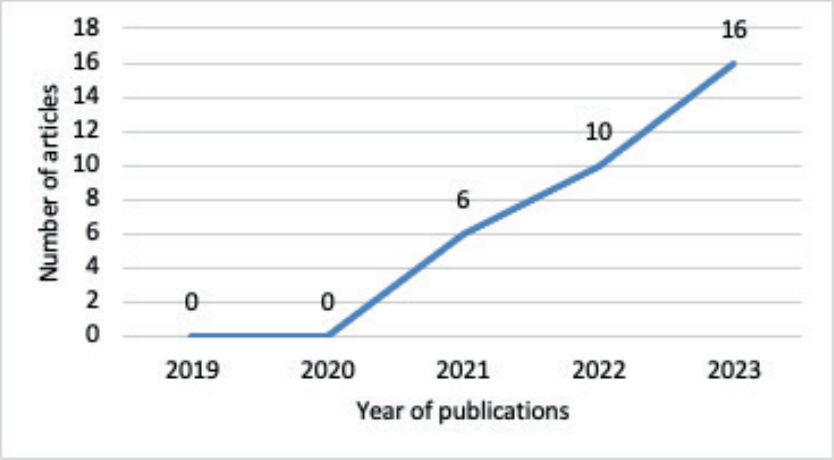

Figure 2. Distribution of articles yearly.

Table 2. Distribution of journal sources vs. number of articles.

Journal Name	Number of Articles
Education and Information Technologies	7
Computer Assisted Language Learning	4
BMC Medical Education	2
British Journal of Educational Technology	2
Educational Technology & Society	2
Interactive Learning Environments	2
International Journal of Educational Technology in Higher Education	2
Medical Education Online	2
Computers & Education	1
Educational Studies	1
IEEE Transactions on Learning Technologies	1
Journal of Educational Computing Research	1
Journal of Science Education and Technology	1

Language Learning & Technology	1
Physical Review Physics Education Research	1
Recall	1
Research in Higher Education	1

In overview, researchers tended to develop their applications instead of utilizing commercial applications (Table 3). This is likely due to the fact that developing their own applications provides them with greater flexibility, enabling the addition of more features and customization to suit their research requirements. Moreover, an interesting finding emerged after studying the extensive data set: ChatGPT was featured in six of the thirty-two selected articles. This finding highlights an important trend in which researchers are increasingly leveraging the accessibility of ChatGPT to enrich their academic activities and experimental efforts. Given that ChatGPT is available at no cost, the researchers took advantage of this opportunity to explore its efficacy in the classroom and conduct research investigations. This phenomenon underscores a broader movement in the academic community, where AI technology is fostering a spirit of experimentation and innovation. By leveraging ChatGPT as an all-in-one tool for communication and inquiry, researchers are not only pushing the boundaries of AI applications but also uncovering new insights into its potential impact on various research domains.

Table 3. Distribution of application name vs. number of articles.

Name of App	Number of articles
Bilge	1
CA-DA & CA-NDA	1
ChatGPT	6
Chatlayer	1
Cognitive Immersive Language Learning Environment (CILLE)	1
EduBot	1
Ellie	2
Fanmodule	1
Fenbotum	1
Google Home	1
Intelligent Health Advice Bot (IHAB)	1
Intelligent Personal Assistant (IPA)	1
KNUSTbot	1
Landbot AI	1
Medical chatbot	1
MM-AI & C-AI	1
MTR's Virtual Ambassador	1
PeeDee	1
Senior See Net	1
Not specified	7

Furthermore, the applications were majorly built using the Google Dialog Flow framework, followed by OpenAI, ChatGPT, and Natural Language Processing (NLP). A plausible reason why most researchers preferred to use Google Dialogflow is that it is easy to use, has pre-built natural language processing, and works smoothly with other apps. OpenAI, on the other hand, is favored by those who want more advanced features and customization, like GPT-3, which can create advanced chatbots.

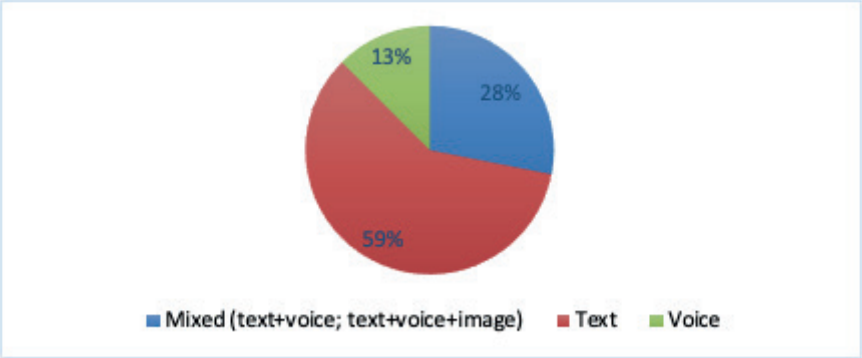

Figure 3. Distribution of input form of apps.

As expected, we also discovered that text input was the most prevalent method of input among the applications (Figure 3). This is likely because popular frameworks like Google Dialogflow and OpenAI primarily focus on text input for NLP tasks at the time. Text is structured and extensively accessible across the internet, in publications, articles, and various written materials. Its structured nature simplifies the operation of machine learning models, which form the foundation of numerous AI applications. The computational demands of processing text are generally lower when compared to the processing requirements associated with audio or video data. Additionally, changing input methods to voice or image requires advanced programming skills and modifications to the original framework. As a result, very few articles explored voice, image, or mixed inputs.

Both Dialogflow and OpenAI are continuously evolving. They may have introduced new features or updates since the time of the study, potentially expanding their capabilities to encompass various input methods like voice or image inputs. This dynamic evolution shows a significant opportunity for future researchers to enrich AI applications by exploring different input methods, thereby enhancing the sophistication and robustness of AI technology.

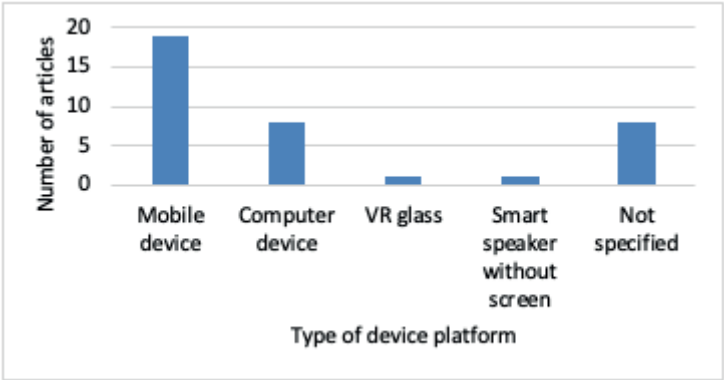

Figure 4. Type of device platform vs. number of articles.

In terms of device platform, mobile devices and computer devices are commonly used to facilitate these applications (Figure 4). Some of them are compatible with multiple device platforms. This finding highlights a substantial demand for AI applications that offer ubiquitous accessibility, allowing users to access them anywhere and anytime. Just like a mobile device that can be used anytime and anywhere and easy and popular.

Moreover, among the selected articles, forty-one percent focused on facilitating language learning. What is even more intriguing is that within this substantial chunk, more than half of the articles explore English as a Foreign Language (Hsu, 2022; Jeon, 2022; Jeon & Lee, 2023; Kim et al., 2022; Mohamed, 2023; Xia, Chiu, & Chai, 2023; Xia, Chiu, Chai, & Xie, 2023; Yang, Kim, Lee, & Shin, 2022) and Chinese as a

Foreign Language (Divekar* et al., 2022). Meanwhile, health science and science obtained sixteen percent each. Health Science encompasses healthcare-related themes such as nursing (Chang, Hwang, & Gau, 2022; Han, Park, & Lee, 2022; Mokmin & Ibrahim, 2021) and medical health (Friederichs, Friederichs, & Marz, 2023; Moldt et al., 2023). Science consists of chemistry (Jasin et al., 2023), physics (Kortemeyer, 2023; Nasri et al., 2023), and general science (Cooper, 2023; Deveci Topal, Dilek Eren, & Kolburan Gecer, 2021). Furthermore, the rest of nine percent is accumulated for social science, including themes such as digital literacy (Sriwisathiyakun & Dhamanitayakul, 2022), instructional technology (Fidan & Gencel, 2022), and school violence prevention techniques (Song, Oh, & Hong, 2022). Despite this diversity, computer and engineering courses (Essel, Vlachopoulos, Tachie-Menson, Johnson, & Baah, 2022; Stojanov, 2023), management courses (Nurshatayeva, Page, White, & Gehlbach, 2021; Yi, Ray, & Segall, 2023), and military studies (Yuan, Li, & Peng, 2023) have received little attention in the last five years and have the potential to be explored more deeply in future research studies.

The Trends of Research Design in AI-Assisted Learning

To answer RQ2, this section further explores the trends of research design in AI-assisted learning, including the educational level of the participants, group size of the participants, research methods, research design formats, instructional modes, duration of interventions, and data collection and analysis of research. Forty-nine percent of the articles involved participants from higher education, followed by twenty-three percent from secondary school education, eleven percent from elementary education, and eleven percent from the working adult demographic. Preschool students were involved in approximately three percent of the articles and the remaining three percent of articles did not specify the educational level of their participants. The variety of educational levels among participants in different research studies indicates a trend towards greater accessibility of AI-supported education across different levels of schooling or learning environments. In other words, AI technology is increasingly reaching and benefiting learners at various levels of education.

Furthermore, the group size of participants has emerged as a critical consideration in research design. The finding shows that more than half of the articles typically used small sample sizes, ranging from 1 to 50 participants in each study. Studies with large sample sizes, exceeding 100 participants, were the second most common, followed by studies with moderate sample sizes ranging from 51 to 100 participants in each study.

Moving on to the aspect of the country where the experiments were conducted, Asian countries like Hong Kong, Malaysia, Saudi Arabia, Singapore, South Korea, Taiwan, Thailand and Turkiye have conducted the most AI chatbot research in the learning. At the meantime, only a few AI research in education settings were conducted within the time in European, USA, ocean pacific country, and Africa. Asian countries like South Korea and Singapore consistently rank among the top performers in global education assessments, with education being a top priority for their governments (Goodwin, 2013). The nations have strong emphasis on education and have swiftly recognized the potential of AI technologies to enhance teaching and learning processes, leading to significant investments in AI-driven educational initiatives.

In parallel, researchers are innovating in their choice of research methods and design formats to capture the multifaceted nature of AI-assisted learning. The findings show that fifty-six percent of articles conducted quantitative research methods including true experimental design (Chiu et al., 2023; Chocarro et al., 2023; Friederichs et al., 2023; Hsu, 2022; Xia, Chiu, & Chai, 2023; Xia, Chiu, Chai, et al., 2023) and quasi-experimental (Chiu et al., 2023; Deveci Topal et al., 2021; Essel et al., 2022; Fidan & Gencel, 2022; Han et al., 2022; Jeon, 2021; Lin & Mubarok, 2021; Nasri, Nasri, Nasri, & Abd Talib, 2023; Nurshatayeva et al., 2021; Song et al., 2022; Xu, Wang, Collins, Lee, & Warschauer, 2021; Yang et al., 2022; Yuan et al., 2023). Twenty-five percent of articles carried out qualitative research methods including case study (Kortemeyer, 2023), applied research (Sriwisathiyakun & Dhamanitayakul, 2022), exploratory research (Cooper, 2023; Jeon & Lee, 2023), survey research (Jasin et al., 2023; Mohamed, 2023; Yi et al., 2023), and autoethnographic (Stojanov, 2023). And nineteen percent of the articles incorporated mixed methods, blending both qualitative and quantitative research approaches. At the meantime, for research design formats, more than half of the studies decided to use single AI-chatbot design, followed by the use of AI chatbot vs. traditional material, and the use comparison of using two different AI chatbots (see Figure 5). This finding highlight that most studies continue to seek perceptions of AI users (Chocarro et al., 2023; Yi et al., 2023),

attitudes (Moldt et al., 2023), and like pilot research to determine if AI could be included in their learning design (Divekar* et al., 2022; Mohamed, 2023; Yang et al., 2022). Consequently, more than half of the articles design format was single AI chatbot only.

Shifting focus to instructional modes, more than half of the articles delivered learning instructions through face-to-face meeting (n = 11), followed by online delivery mode (n = 8), mixed modes (n = 5), and not specified (n = 8). Most researchers incorporated individual assignments (n = 26), followed by group assignments (n = 3), and mixed assignments (n = 3, including both individual and group assignments). The combination of face-to-face meetings and individual assignments shows the effort to improve the learning performance by integrating technology into traditional settings environment. Furthermore, the use of AI in face-to-face meetings facilitates personalized learning for individual students where teachers can assess students' strengths and weaknesses. Therefore, AI-driven tools can automate certain aspects of the learning process, such as grading and assessment. This automation allows educators to optimize their time during face-to-face meetings for interactive discussions, addressing questions, and providing targeted support to students.

As researchers delve deeper into the AI interventions, attention to the duration of interventions becomes increasingly crucial. Thirty-four percent of the articles were found performing experiments lasting between a week and a month. The other twenty-five percent of the articles conducted experiments lasting over a month. Nineteen percent of the articles conducted experiments in less than two weeks, while twenty-two percent of the articles did not provide information about the duration of their interventions.

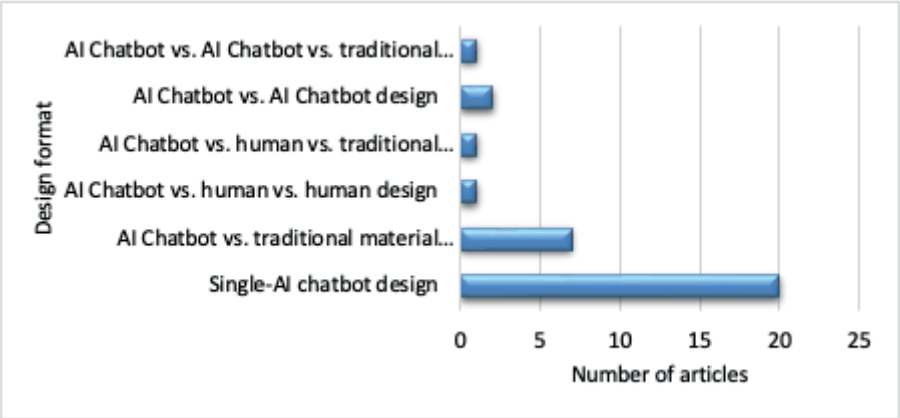

Figure 5. Distribution of design formats vs. number of articles.

Table 4. Distribution of data collection and analysis vs. number of articles.

Data collection	Data analysis	Number of articles
Tests	Shapiro–wilk test; chi-squared test, Fisher's exact test, t-test, ANOVA, Scheffe's post hoc, Wilcoxon test, Mann Whitney U test, one-sample Z-test, ANCOVA, and multiple regressions	17
Questionnaires	Descriptive statistics, Pearson correlation and Wilcoxon test, and Kolmogorov-Smirnov	15
Interviews	Content analysis and thematic analysis	10
User interaction logs	conversation-turns per session and interaction pattern extraction	8
Class assignments	Descriptive statistic	9
Demographic information	Descriptive statistic	5
User levels of attention and meditation	Descriptive statistic	1

Finally, advancements in data collection and analysis methodologies are driving innovation in AI-assisted learning research. Table 4 shows that quantitative data collection mostly from tests (pre and post-tests), user

interaction logs, demographic information, class assignments, and user levels of attention and mediation. Meanwhile qualitative data mostly from interviews and various questionnaires like perceptions questionnaire (Divekar* et al., 2022; Yang et al., 2022; Yi et al., 2023), Self-Regulation Learning Questionnaire (Chiu et al., 2023; Chocarro et al., 2023; Hsu, 2022), Perceived Needs Questionnaire (Xia, Chiu, & Chai, 2023; Xia, Chiu, Chai, et al., 2023), the use of digital platforms questionnaires (Sriwisathiyakun & Dhamanitayakul, 2022), self-efficacy questionnaire (Chang et al., 2022), Story Comprehension Questionnaire (Xu et al., 2021), Digital Literacy Questionnaire (Chocarro et al., 2023), UTAUT2 Questionnaire (Mokmin & Ibrahim, 2021), and Verbal self-report qualitative questionnaires (Jasin et al., 2023). Additionally, Table 4 shows that fifty percent of the articles employed quantitative analysis, twenty-two percent used qualitative analysis, and twenty-eight percent utilized mixed analyses.

The Roles of AI Applications and Teachers in AI-Assisted Learning

This section aims to address RQ3. After thoroughly analyzing each chosen article, four specific roles performed by AI applications during students' interaction with them were identified. These roles include functioning as a teaching agent, teaching assistant, virtual student, and peer agent. Twenty-five out of thirty-two articles demonstrate AI apps as a teaching agent that provides students with learning materials, instruction, and feedback. Six articles reported the apps as peer agents. Meanwhile, the role of a teaching assistant is found in one article, and the role of a virtual student is found in another article. This distribution provides valuable insights into the diverse applications and functionalities of AI within educational settings, emphasizing a predominant focus on AI as a teaching agent in the reviewed literature.

As important as the role of AI apps is, it is also crucial to highlight the role of the teacher when they are using the apps. This is important because understanding the roles of apps and what else should be provided by the teacher to complement each other might support the effectiveness of learning. Unfortunately, only a few of them specify the role of the teacher when students are engaged with the AI apps. The role of the teacher that emerged in eleven articles is facilitator (as seen in n = 5 articles), assessor (as seen in n = 2 articles), and instructor (as seen in n = 8). Some of the articles show multiple roles of the teacher when students engage using the apps, while the remaining 21 articles did not explicitly specify the role of the teacher.

DISCUSSIONS AND CONCLUSION

As observed in our data presented in Table 1, the number of AI studies displayed a comparatively stable trend between 2019 and 2020 and later had a substantial rise from 2020 to 2023. This substantial increase can be attributed to the recognition of AI's immense potential in enhancing educational experiences. Importantly, the work of organizations like OpenAI and the progress in AI research, like the improvements seen in ChatGPT, have played an essential role in driving this trend forward.

According to this systematical review, most selected articles tended to focus on using AI technology to support language learning. It might be because language is a fundamental aspect of human communication and interaction. In addition, NLP advancements have made it possible to analyze and generate human language more accurately and efficiently, leading to increased interest in language-related AI research. Furthermore, large datasets of textual information in multiple languages are readily available, allowing researchers to train and test AI models effectively.

Hence, it is evident that AI research in language learning has received more attention compared to other fields, such as science, social sciences, computer engineering, and the military. The potential of AI and its continuous advancements do not limit opportunities for these other fields. In the future, AI can be beneficial in science, social sciences, computer engineering, and the military, ensuring a more balanced deployment of AI across various domains.

The research design in AI-assisted learning studies usually involved the participants from higher education. This is because higher education generally uses complex learning environments, with a variety of courses and research activities. As the affordance of AI continues to expand, AI can be adapted and applied in a variety of ways to meet these diverse needs, thereby making higher education an ideal testing ground for AI applications.

What more surprising is we found that most studies commonly employed quantitative research design with a small sample size, ranging from 1 to 50 participants. This approach involves administering a treatment to one or more groups of participants and delivering instructional content through AI-assisted methods.

The approach generally aims to analyze the impact of AI interventions on learning outcomes, providing valuable insights into the effectiveness of these technologies in educational settings. However, it is important for researchers to consider the potential limitations associated with small sample sizes.

Our findings also revealed that not much studies paying attention to the adoption of group assignments and mixed assignments in the learning activities. Through group work, students can think from more diverse perspectives, they can also socialize with their peers and learn from human beings besides the AI tool. Therefore, more studies need to be carried out to fill this gap. Furthermore, exploring various educational levels and incorporating qualitative research methods could provide a more comprehensive understanding of the use of AI-assisted learning.

The integration of AI into the learning process allows practitioners and educators to provide students with more customized educational experiences, tailoring the learning to individual needs, preferences, and learning styles. To this end, this review revealed the main role of the AI application in the learning process as teaching agent, peer agent, virtual student, and teaching assistant.

The AI app plays as a teaching agent to assist and support the teaching and learning process by providing guidance, feedback, and sometimes personalized instruction to learners (Chiu et al., 2023; Essel et al., 2022). For instance, a study of Deveci Topal et al. (2021) employed an AI application named Fenbotum to assist 5th-grade students in their science learning. The app was used to teach the topic Matter and the changing state of matter by enabling students to pose questions related to the subject. Furthermore, the app was integrated with web connections to enhance students' visual and auditory learning through the incorporation of videos and simulations.

As a peer agent, the AI application is designed to engage learners in a manner that simulates interactions students could have with their peers during collaborative learning, discussions, and problem-solving activities. For example, in a study of Yang et al. (2022), a chatbot application called Ellie was utilized to facilitate peer conversations among students on various themes for English language learning. In this setup, students took on the roles of waiters or waitresses in a restaurant, where they were responsible for proposing dishes to the chatbot. If student suggestions did not match chatbot's preferences, the chatbot would encourage the student to suggest alternative dishes. This approach aimed to foster deep conversations and discussions between students and the chatbot, contributing to the enhancement of their EFL learning experience.

As a virtual student, the AI application serves as a computer-generated or AI-driven representation of a student within a digital learning environment. For example, in a study of Song et al. (2022) preservice teachers were instructed to teach a virtual chatbot about handling the topic of school violence. The research highlights the potential of AI technology in providing tailored teaching simulation environments for preservice teachers. The use of AI is seen as a solution to practical limitations in creating real-life settings with students exhibiting manipulative behaviors during teaching practice.

As a teaching assistant, the AI application aims to provide teachers with assistance with their schedule, class details, and teaching content. It accurately conveys the role of the AI apps in assisting teachers with their various tasks and responsibilities in an educational context.

In contrast to the role of AI, the role of teachers during the use of AI in learning receives less attention in this review. The findings merely mentioned three roles of the teacher during the learning process including as instructor, facilitator, and assessor. As an instructor, teachers are responsible for delivering lessons, explaining concepts, and providing information clearly and understandably. As a facilitator, teachers facilitate learning by guiding students through activities, discussions, and projects. They create opportunities for active participation and engagement. Lastly, as an assessor, teachers design assessments, quizzes, exams, and assignments to evaluate students' understanding of the material. They analyze and interpret the results to gauge student progress and adjust teaching methods accordingly.

Combined with AI capabilities, teachers optimize the technology-driven learning experience by taking responsibility as a curriculum designer to control the overall learning process and as a prime guide to maintain

the strength of human teaching. As a curriculum designer, teachers play a crucial role in designing the overall curriculum and selecting appropriate AI tools that align with educational goals and standards. As a prime guide, teachers ensure that AI tools are used ethically and responsibly, fostering a learning environment that prioritizes fairness, transparency, and equity among students. In addition, teachers may also leverage AI tools to enhance student motivation and engagement, creating a positive and interactive learning atmosphere in the classroom.

This review found that the number of AI studies displayed a comparatively stable trend between 2019 and 2020 and later had a substantial rise from 2020 to 2023. Google Dialog Flow and OpenAI were the primary frameworks. Text input was the most common method, used on both mobile and computer devices. Most studies involved 1 to 50 students from higher education institutions, primarily through face-to-face instruction, with some online. The assignments were mostly individual, followed by group work. Quantitative analysis was mostly used to seek perceptions of AI users, attitudes, and sort of pilot research to determine if AI chat could be included in their learning designs. However, computer and engineering courses, management courses, and military studies have received little attention in the last five years and have the potential to be explored more deeply in future research studies.

Furthermore, the review revealed that AI applications can serve various roles, including teaching agent, peer agent, virtual student, and teaching assistant. Yet, the role of teachers in AI-assisted learning received less attention in this review. The findings merely mentioned three roles of the teacher during the learning process including as instructor, facilitator, and assessor. Fundamentally, AI functions as a supportive and enhancing factor in education, aiding educators in establishing personalized (Albdrani & Al-Shargabi, 2023; De la Vall & Araya, 2023), data-driven (Harry, 2023), and efficient learning environments (Albdrani & Al-Shargabi, 2023; De la Vall & Araya, 2023). However, the distinctive human attributes encompassing guidance, mentorship, emotional and ethical support continue to be essential aspects of proficient teaching. By recognizing the strengths of both AI and teachers, the collaboration between AI and teachers may strive to elevate the overall quality of education and student learning outcomes. The findings underscore a successful integration of AI in education, yet this achieving requires a careful balance between highlighting positive learning outcomes and taking advantage of teachers' uniquely human expertise for moral and ethical considerations (Felix, 2020; Gentile, Citta, Perna, & Allegra, 2023). It is essential to continually assess and enhance AI-assisted learning methods to guarantee a positive influence on student learning and overall educational achievements (Harry, 2023).

Our findings may not fully represent the entirety of AI-assisted learning research in education due to the narrow scope of data collection, which spans only the five most recent years from January 2019 to May 2023 and is limited to the Web of Science database, specifically within the SSCI category. Expanding both the database used and the timeframe of data collection could yield different findings, particularly in a more comprehensive analysis of the roles of AI applications and the interaction between teachers and students when utilizing AI applications. Therefore, future studies might benefit from broadening their search across multiple databases with varying index categories. In addition, exploring the theoretical framework underlying AI-assisted learning research could be a promising area for investigation. A robust theoretical framework could inform how teachers integrate and scaffold the use of educational AI apps in alignment with educational goals and pedagogical principles. Teachers' decisions and actions could influence how students engage with the app and its impact on learning outcomes. Conversely, the effectiveness of the app in supporting learning could depend on how well it aligns with pedagogical theories and how teachers leverage its features to facilitate meaningful learning experiences.

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REFERENCES

Albdrani, R. N., & Al-Shargabi, A. A. (2023). Investigating the Effectiveness of ChatGPT for Providing Personalized Learning Experience: A Case Study. *International Journal of Advanced Computer Science & Applications, 14*(11). doi:10.14569/ijacsa.2023.01411122

Chang, C. Y., Hwang, G. J., & Gau, M. L. (2022). Promoting students' learning achievement and self-efficacy: A mobile chatbot approach for nursing training. *British Journal of Educational Technology, 53*(1), 171-188. doi:10.1111/bjet.13158

Chiu, T. K., Moorhouse, B. L., Chai, C. S., & Ismailov, M. (2023). Teacher support and student motivation to learn with Artificial Intelligence (AI) based chatbot. *Interactive Learning Environments*, 1-17. doi:10.1080/10494820.2023.2172044

Chocarro, R., Cortinas, M., & Marcos-Matas, G. (2023). Teachers' attitudes towards chatbots in education: a technology acceptance model approach considering the effect of social language, bot proactiveness, and users' characteristics. *Educational Studies, 49*(2), 295-313. doi:10.1080/03055698.2020.1850426

Cooper, G. (2023). Examining science education in chatgpt: An exploratory study of generative artificial intelligence. *Journal of Science Education and Technology, 32*(3), 444-452. doi:10.1007/s10956-023-10039-y

De la Vall, R. R. F., & Araya, F. G. (2023). Exploring the benefits and challenges of AI-language learning tools. *International Journal of Social Sciences and Humanities Invention, 10*(01), 7569-7576. doi:10.18535/ijsshi/v10i01.02

Deveci Topal, A., Dilek Eren, C., & Kolburan Gecer, A. (2021). Chatbot application in a 5th grade science course. *Education and Information Technologies, 26*(5), 6241-6265. doi:10.1007/s10639-021-10627-8

Divekar*, R. R., Drozdal*, J., Chabot*, S., Zhou, Y., Su, H., Chen, Y., . . . Braasch, J. (2022). Foreign language acquisition via artificial intelligence and extended reality: design and evaluation. *Computer Assisted Language Learning, 35*(9), 2332-2360. doi:10.1080/09588221.2021.1879162

Elaish, M. M., Hussein, M. H., & Hwang, G.-J. (2023). Critical research trends of mobile technology-supported English language learning: A review of the top 100 highly cited articles. *Education and Information Technologies, 28*(5), 4849-4874. doi:10.1007/s10639-022-11352-6

Essel, H. B., Vlachopoulos, D., Tachie-Menson, A., Johnson, E. E., & Baah, P. K. (2022). The impact of a virtual teaching assistant (chatbot) on students' learning in Ghanaian higher education. *International Journal of Educational Technology in Higher Education, 19*(1), 1-19. doi:10.1186/s41239-022-00362-6

Felix, C. V. (2020). The role of the teacher and AI in education *International perspectives on the role of technology in humanizing higher education* (pp. 33-48): Emerald Publishing Limited.

Fidan, M., & Gencel, N. (2022). Supporting the instructional videos with chatbot and peer feedback mechanisms in online learning: The effects on learning performance and intrinsic motivation. *Journal of Educational Computing Research, 60*(7), 1716-1741. doi:10.1177/07356331221077901

Friederichs, H., Friederichs, W. J., & Marz, M. (2023). ChatGPT in medical school: how successful is AI in progress testing? *Medical Education Online, 28*(1), 2220920. doi:10.1080/10872981.2023.2220920

Fu, Q.-K., & Hwang, G.-J. (2018). Trends in mobile technology-supported collaborative learning: A systematic review of journal publications from 2007 to 2016. *Computers & Education, 119*, 129-143. doi:10.1016/j.compedu.2018.01.004

Gentile, M., Citta, G., Perna, S., & Allegra, M. (2023). *Do we still need teachers? Navigating the paradigm shift of the teacher's role in the AI era.* Paper presented at the Frontiers in Education.

Goodwin, A. L. (2013). Perspectives on high performing education systems in Finland, Hong Kong, China, South Korea and Singapore: What lessons for the US? *Educational policy innovations: levelling up and sustaining educational achievement* (pp. 185-199): Springer.

Han, J.-W., Park, J., & Lee, H. (2022). Analysis of the effect of an artificial intelligence chatbot educational program on non-face-to-face classes: a quasi-experimental study. *BMC Medical Education, 22*(1), 830. doi:10.1186/s12909-022-03898-3

Harry, A. (2023). Role of AI in Education. *Interdiciplinary Journal and Hummanity (INJURITY), 2*(3), 260-268. doi:10.58631/injurity.v2i3.52

Hsu, L. (2022). To CALL or not to CALL: Empirical evidence from neuroscience. *Computer Assisted Language Learning, 35*(4), 792-815. doi:10.1080/09588221.2020.1750429

Jasin, J., Ng, H. T., Atmosukarto, I., Iyer, P., Osman, F., Wong, P. Y. K., . . . Cheow, W. S. (2023). The implementation of chatbot-mediated immediacy for synchronous communication in an online chemistry course. *Education and Information Technologies*, 1-26. doi:10.1007/s10639-023-11602-1

Jeon, J. (2021). Chatbot-assisted dynamic assessment (CA-DA) for L2 vocabulary learning and diagnosis. *Computer Assisted Language Learning*, 1-27. doi:10.1080/09588221.2021.1987272

Jeon, J. (2022). Exploring AI chatbot affordances in the EFL classroom: Young learners' experiences and perspectives. *Computer Assisted Language Learning*, 1-26. doi:10.1080/09588221.2021.2021241

Jeon, J., & Lee, S. (2023). Large language models in education: A focus on the complementary relationship between human teachers and ChatGPT. *Education and Information Technologies*, 1-20. doi:10.1007/s10639-023-11834-1

Kim, H., Yang, H., Shin, D., & Lee, J. H. (2022). Design principles and architecture of a second language learning chatbot.

Kortemeyer, G. (2023). Could an artificial-intelligence agent pass an introductory physics course? *Physical Review Physics Education Research, 19*(1), 010132. doi:10.1103/PhysRevPhysEducRes.19.010132

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., GOtzsche, P. C., Ioannidis, J. P., . . . Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *Annals of internal medicine, 151*(4), W-65-W-94. doi:10.7326/0003-4819-151-4-200908180-00136

Lin, C.-J., & Mubarok, H. (2021). Learning analytics for investigating the mind map-guided AI chatbot approach in an EFL flipped speaking classroom. *Educational Technology & Society, 24*(4), 16-35.

Mohamed, A. M. (2023). Exploring the potential of an AI-based Chatbot (ChatGPT) in enhancing English as a Foreign Language (EFL) teaching: perceptions of EFL Faculty Members. *Education and Information Technologies*, 1-23. doi:10.1007/s10639-023-11917-z

Mokmin, N. A. M., & Ibrahim, N. A. (2021). The evaluation of chatbot as a tool for health literacy education among undergraduate students. *Education and Information Technologies, 26*(5), 6033-6049. doi:10.1007/s10639-021-10542-y

Moldt, J.-A., Festl-Wietek, T., Madany Mamlouk, A., Nieselt, K., Fuhl, W., & Herrmann-Werner, A. (2023). Chatbots for future docs: exploring medical students' attitudes and knowledge towards artificial intelligence and medical chatbots. *Medical Education Online, 28*(1), 2182659. doi:10.1080/10872981.2023.2182659

Nasri, N. M., Nasri, N., Nasri, N. F., & Abd Talib, M. A. (2023). The Impact of Integrating an Intelligent Personal Assistant (IPA) on Secondary School Physics Students' Scientific Inquiry Skills. *IEEE Transactions on Learning Technologies, 16*(2), 232-242. doi:10.1109/TLT.2023.3241058

Nurshatayeva, A., Page, L. C., White, C. C., & Gehlbach, H. (2021). Are artificially intelligent conversational chatbots uniformly effective in reducing summer melt? Evidence from a randomized controlled trial. *Research in higher education, 62*, 392-402. doi:10.1007/s11162-021-09633-z

Porter, B., & Grippa, F. (2020). A platform for AI-enabled real-time feedback to promote digital collaboration. *Sustainability, 12*(24), 10243. doi:10.3390/su122410243

Shadiev, R., & Liu, J. (2023). Review of research on applications of speech recognition technology to assist language learning. *ReCALL, 35*(1), 74-88. doi:10.1017/S095834402200012X

Song, D., Oh, E. Y., & Hong, H. (2022). The Impact of Teaching Simulation Using Student Chatbots with Different Attitudes on Preservice Teachers' Efficacy. *Educational Technology & Society, 25*(3), 46-59.

Sriwisathiyakun, K., & Dhamanitayakul, C. (2022). Enhancing digital literacy with an intelligent conversational agent for senior citizens in Thailand. *Education and Information Technologies, 27*(5), 6251-6271. doi:10.1007/s10639-021-10862-z

Stojanov, A. (2023). Learning with ChatGPT 3.5 as a more knowledgeable other: an autoethnographic study. *International Journal of Educational Technology in Higher Education, 20*(1), 35. doi:10.1186/s41239-023-00404-7

Xia, Q., Chiu, T. K., & Chai, C. S. (2023). The moderating effects of gender and need satisfaction on self-regulated learning through Artificial Intelligence (AI). *Education and Information Technologies, 28*(7), 8691-8713. doi:10.1007/s10639-022-11547-x

Xia, Q., Chiu, T. K., Chai, C. S., & Xie, K. (2023). The mediating effects of needs satisfaction on the relationships between prior knowledge and self-regulated learning through artificial intelligence chatbot. *British Journal of Educational Technology*. doi:10.1111/bjet.13305

Xie, H., Chu, H.-C., Hwang, G.-J., & Wang, C.-C. (2019). Trends and development in technology-enhanced adaptive/personalized learning: A systematic review of journal publications from 2007 to 2017. *Computers & Education, 140*, 103599. doi:10.1016/j.compedu.2019.103599

Xu, W., & Zammit, K. (2020). Applying thematic analysis to education: A hybrid approach to interpreting data in practitioner research. *International journal of qualitative methods, 19*, 1609406920918810. doi:10.1177/1609406920918810

Xu, Y., Wang, D., Collins, P., Lee, H., & Warschauer, M. (2021). Same benefits, different communication patterns: Comparing Children's reading with a conversational agent vs. a human partner. *Computers & Education, 161*, 104059. doi:10.1016/j.compedu.2020.104059

Yang, H., Kim, H., Lee, J. H., & Shin, D. (2022). Implementation of an AI chatbot as an English conversation partner in EFL speaking classes. *ReCALL, 34*(3), 327-343. doi:10.1017/S0958344022000039

Yi, P. K., Ray, N. D., & Segall, N. (2023). A novel use of an artificially intelligent Chatbot and a live, synchronous virtual question-and answer session for fellowship recruitment. *BMC Medical Education, 23*(1), 1-7. doi:10.1186/s12909-022-03872-z

Yuan, C.-C., Li, C.-H., & Peng, C.-C. (2023). Development of mobile interactive courses based on an artificial intelligence chatbot on the communication software LINE. *Interactive Learning Environments, 31*(6), 3562-3576. doi:10.1080/10494820.2021.1937230

Zawacki-Richter, O., Marin, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education–where are the educators? *International Journal of Educational Technology in Higher Education, 16*(1), 1-27. doi:10.1186/s41239-019-0171-0

Zhang, P., & Tur, G. (2023). A systematic review of ChatGPT use in K-12 education. *European Journal of Education, 59*(2), e12599. doi:10.1111/ejed.12599