


A Systematic Review of the Potential Influencing Factors for ChatGPT-Assisted Education

Chuhan Xu, Beijing Language and Culture University, China*

 <https://orcid.org/0009-0007-1678-5438>

ABSTRACT

Due to the swift advancement of artificial intelligence, the emergence of ChatGPT has garnered considerable attention within the educational sphere. The aim of the study is to conduct a systematic literature review concerning the potential factors of ChatGPT-assisted education, specifically focusing on learners' acceptance, the accessibility of communication, digital literacy, and motivation. Therefore, pertinent peer-reviewed articles (n=41) were identified using the preferred reporting items for systematic review and meta-analysis protocol (PRISMA-P) for subsequent exploration. The findings indicated that the potential influencing factors in four dimensions have positive contribution to the educational achievements facilitated by ChatGPT. The four primary influencing factors further include 14 sub-influencing factors. Future research may delve into the mode of feedback and the mode of interaction within the context of ChatGPT-facilitated learning and teaching.

KEYWORDS

Artificial Intelligence, ChatGPT, Education, Influencing Factors, PRISMA-P

INTRODUCTION

The swift advancement of intelligent chatbot technology has garnered considerable interest in the enhanced availability of ChatGPT for educational applications. The implementation of ChatGPT for instructional purposes is presently prevalent and widely adopted across diverse domains, such as medical education, language education and so on. Many educators and learners have recognized the immense potential that ChatGPT brings to the process of learning and instruction. By participating in dialogues, rectifying grammatical errors, and providing vocabulary recommendations, chatbots can assist language learners in improving their linguistic proficiency. In addition, chatbots could aid lecturers in the management of virtual classrooms by facilitating tasks such as attendance tracking, lecture recording, fostering group discussions, and supporting collaborative project endeavors. Obviously, abundant educational factors that impact the ChatGPT-assisted environment merit thorough examination and consideration.

The utilization of mobile learning technologies demonstrated a noteworthy enhancement in behavioral, social, cognitive, and emotional engagements, as well as English learning outcomes,

DOI: 10.4018/IJTEE.339189

*Corresponding Author

This article published as an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>) which permits unrestricted use, distribution, and production in any medium, provided the author of the original work and original publication source are properly credited.

surpassing the impact observed with traditional teaching tools (Yu et al., 2022). In the context of English as a Foreign Language (EFL) instruction, individuals utilizing the mobile learning platform exhibited higher satisfaction levels, experienced a notable enhancement in learning outcomes, and demonstrated a significantly reduced cognitive load compared to their counterparts without access to the platform (Yu et al., 2019). Satisfaction in a clickers-aided English as a Foreign Language (EFL) class exhibited a positive correlation with interaction, self-efficacy, and self-regulation, revealing no statistically significant gender differences (Yu, 2015). Furthermore, the persistence intention of students to utilize mobile tools is notably influenced by both peer and superior factors (Yu & Yu, 2019). In the realm of education, virtual reality (VR) technologies predominantly yield a robust and favorable impact on educational outcomes, notwithstanding certain adverse findings regarding their effects on anxiety, cognition, creativity, gender disparities, learning attitudes, learner satisfaction, and engagement (Yu, 2023). Hence, the integration of ChatGPT technology into pedagogical practices is imperative for prospective research endeavors.

Several studies endeavored to investigate the prospective influence of ChatGPT on students in education (Montenegro-Rueda et al., 2023). In classroom teaching, Chatbots could help instructors to create and administer quizzes or tests to assess students' knowledge. They can provide instant feedback on performance and offer suggestions for improvement. In language learning, ChatGPT could provide personalized learning experiences by adapting content and interactions to the individual needs and preferences of students (Kohnke et al., 2023). It can offer explanations, resources, and recommendations tailored to each student's learning pace and style. In the realm of health education, chatbots could assist students and educators in finding relevant research materials, academic papers, and reference information (Sallam, 2023). However, the preponderance of review articles primarily scrutinizes the pros and cons of ChatGPT, with a limited number of studies dedicated to the factors exerting influence.

LITERATURE REVIEW

Artificial Intelligence (AI) was evolving in a way that obfuscates the demarcations between specialized domains of application and enhances its potential for diverse and extensive utility (Jeon & Lee, 2023). Artificial intelligence (AI) and AI-driven conversational agents, exemplified by ChatGPT, were revolutionizing the educational paradigm (Romero-Rodriguez et al., 2023). ChatGPT, an artificial intelligence content generation model crafted by OpenAI, had garnered global recognition due to its prowess in addressing intricate language comprehension and production tasks within conversational contexts (T. Wu et al., 2023). The fundamental technologies underpinning ChatGPT exerted a notable influence on the educational domain, encompassing primarily extensive language models, context-based learning, and reinforcement learning through human feedback (Romero-Rodriguez et al., 2023). Diverse chatbot technologies facilitate educators in the enhanced execution of various administrative tasks, such as the more efficient assessment and grading of student assignments, leading to an elevated standard of instructional activities. Simultaneously, curricular materials and content were tailored and personalized to cater to students' specific needs, thereby fostering improved retention, learning, and the overall quality of the educational experience for learners (Chen et al., 2020).

ChatGPT's performance exhibited disparities within diverse educational domains, thereby presenting numerous prospects for a wide range of disciplines (Lo, 2023). As illustrated in Figure 1, it becomes evident that ChatGPT has made notable contributions to a range of pedagogical domains, including but not limited to computer technology, science, environment, medicine, and linguistics. Educators utilized ChatGPT to decode language inquiries and generate code, as they seek to adapt pedagogical methods and assessment techniques (Piccolo et al., 2023). Within the realm of science education, ChatGPT served as a research instrument for editing assistance and experimentation in enhancing research clarity (Cooper, 2023). From the perspectives of biology and environmental science, ChatGPT had the potential to streamline and accelerate intricate and demanding tasks

(Agathokleous et al., 2023). Medical researchers had the capacity to enhance the efficiency of creating superior medical scientific publications by incorporating ChatGPT into their research processes (Benichou & ChatGPT, 2023). Moreover, ChatGPT excelled in tailoring information to individual patients, aiding them in developing self-management skills for proactive disease management. (Zhang et al., 2023). In the domain of second language acquisition, ChatGPT excelled in furnishing feedback on argumentative writing by English as a Foreign Language (EFL) students (Guo & Wang, 2023). Therefore, it was imperative for educators to acknowledge the instructional merits of ChatGPT and suggest additional investigations to assess its efficacy (Mohamed, 2023).

Despite extensive ChatGPT research, synthesizing key influencing factors remains underexplored in academia. Among the limited previous studies, L. Yan et al. (2023) examined the prevailing research landscape concerning the utilization of large-scale language models for educational purposes. Nonetheless, the aforementioned investigation did not evaluate the caliber of the included studies, and overlooked issues regarding academic integrity. Another research carried out by Sallam (2023) sought to assess ChatGPT's applicability in healthcare education. However, the inclusion of the study was solely determined by a single author, potentially constraining result interpretability. Hence, to investigate the determinants of ChatGPT's educational impact, this study compiles potential factors derived from previous research and classifies them into four distinct categories. The four principal categories are further segmented into various subcategories, as illustrated in the table 1.

The study's objective is to systematically review and amalgamate research findings concerning potential determinants in ChatGPT-aided education, including aspects related to acceptance, accessibility of communication, digital literacy and motivation. The authors proposed the subsequent research questions:

RQ1: What are the potential factors affecting learners' achievement in ChatGPT-assisted educational environment?

Learners' acceptance towards the utilization of ChatGPT significantly impacts their academic achievements in educational settings. Based on the Technology Acceptance Model (TAM) model, learners' acceptance means their inclination, concurrence, and sustained utilization of technological tools (D. Zhang et al., 2023). It was observed that learners who exhibit favorable attitudes regarding

Figure 1. The research areas of ChatGPT-aided environment

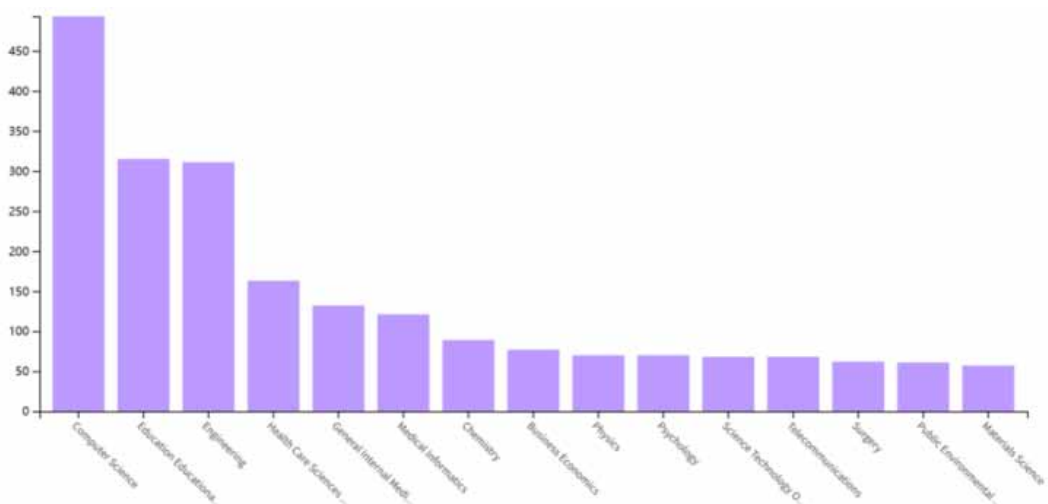


Table 1. The details of potential factors

Factors	Included Studies	Definition
Acceptance	N=6	It mainly consists of perceived of usefulness, perceived ease of use, behavioral intention, actual behavior and attitude.
Accessibility of communication	N=14	It mainly includes feedback, interaction, assessment and simulation.
Digital literacy	N=7	It mainly includes technological comprehension, information manipulation, critical thinking and moral consciousness.
Motivation	N=8	It mainly consists of internal motivation and extrinsic motivation.

the utility of ChatGPT tend to display an elevated level of behavioral intention. This heightened behavioral intention positively and robustly correlated with their subsequent practical usage of ChatGPT for English language learning beyond the classroom setting (Liu & Ma, 2023). Liu & Ma (2023) highlighted the need for further examination of how AI tools could be adopted in learning and teaching, which deserves further investigation in terms of users' attitudes. Nonetheless, numerous studies have delved into the interplay of sub-components, there has been limited exploration of a comprehensive viewpoint. Strzelecki (2023) underscored the necessity for deeper exploration of the integration of AI tools in education, warranting a comprehensive analysis with respect to learners' acceptance. The authors posed the subsequent research question:

RQ2: Could learners' acceptance positively influence learners' outcomes in ChatGPT-assisted educational environment?

Various modes of communication in ChatGPT-supported education have garnered scholarly interest. ChatGPT might be employed to foster the linguistic abilities of students by furnishing feedback on their language proficiency (Bin-Hady et al., 2023). In medical education, ChatGPT served as a performance standard in small group assessments for students to pursuit. Moreover, ChatGPT could be employed to emulate patient interactions for medical students, enabling them to hone their skills in history-taking and symptom documentation (Seetharaman, 2023). However, while most studies focus on developing models to assess ChatGPT's impact in specific educational domains, few comprehensively analyze diverse communication methods and its influence across various educational fields. Thus, the authors proposed the research question:

RQ3: Could accessibility of communication positively influence learners' outcomes in ChatGPT-assisted educational environment?

Digital literacy was defined as an individual's capacity to locate, assess, employ, disseminate, and generate content through the utilization of information technologies and the internet (D. Yazon et al., 2019). The incorporation of digital literacy in ChatGPT-supported education has garnered scholarly interest. Both educators and learners should acquire the requisite digital skills to utilize ChatGPT in pedagogically sound and ethical manners (Kohnke et al., 2023). Kohnke et al. (2023) introduced particular manifestations of digital competence essential for utilizing ChatGPT, underscoring the significance of social awareness. Another study underscored the necessity to cultivate interdisciplinary digital literacy in higher education, emphasizing comprehensive knowledge and adaptability (Dianova & Schultz, 2023). Johinke et al. (2023) suggested that AI-driven text generators, like ChatGPT, had emerged through applications, potentially reshaping the landscape of digital literacy once more. Furthermore, AI tools like ChatGPT were undergoing swift changes, and the digital writing

environment remains highly unstable (Johinke et al., 2023). Hence, the authors raised the research question:

RQ4: Could digital literacy positively influence learners' outcomes in ChatGPT-assisted educational environment?

The motivation of learners significantly influences their academic performance in ChatGPT-assisted education. Many studies hold that AI technologies could prove advantageous for highly motivated and proficient students (Chiu et al., 2023). Chiu et al. (2023) concluded that the intrinsic motivation and aptitude for learning with the chatbot were contingent on both teacher guidance and student proficiency, including self-regulated learning and digital literacy. Furthermore, students in the chatbot learning cohort achieved notably elevated levels of intrinsic motivation, with perceived choice and perceived value emerging as central determinants of the motivation (Yin et al., 2021). However, there is a scarcity of studies that provide a comprehensive analysis of the impact of learner motivation within the ChatGPT teaching context. The authors presented the research questions:

RQ5: Could learners' motivation positively influence learners' outcomes in ChatGPT-assisted educational environment?

RQ6: What is the future for instructors and learners in ChatGPT-assisted educational contexts?

While prior research has delved into various educational domains enhanced by ChatGPT, there exists a scarcity of studies that have comprehensively examined the potential determinants of ChatGPT's impact within the educational domain. Hence, the study aims to elucidate potential determinants of ChatGPT-assisted education in four aspects: Acceptance, accessibility of communication, digital literacy, motivation, and further elaborated subcategories, as depicted in Figure 2. The performance of ChatGPT-assisted education will manifest in the context of both the learning and teaching processes.

METHOD

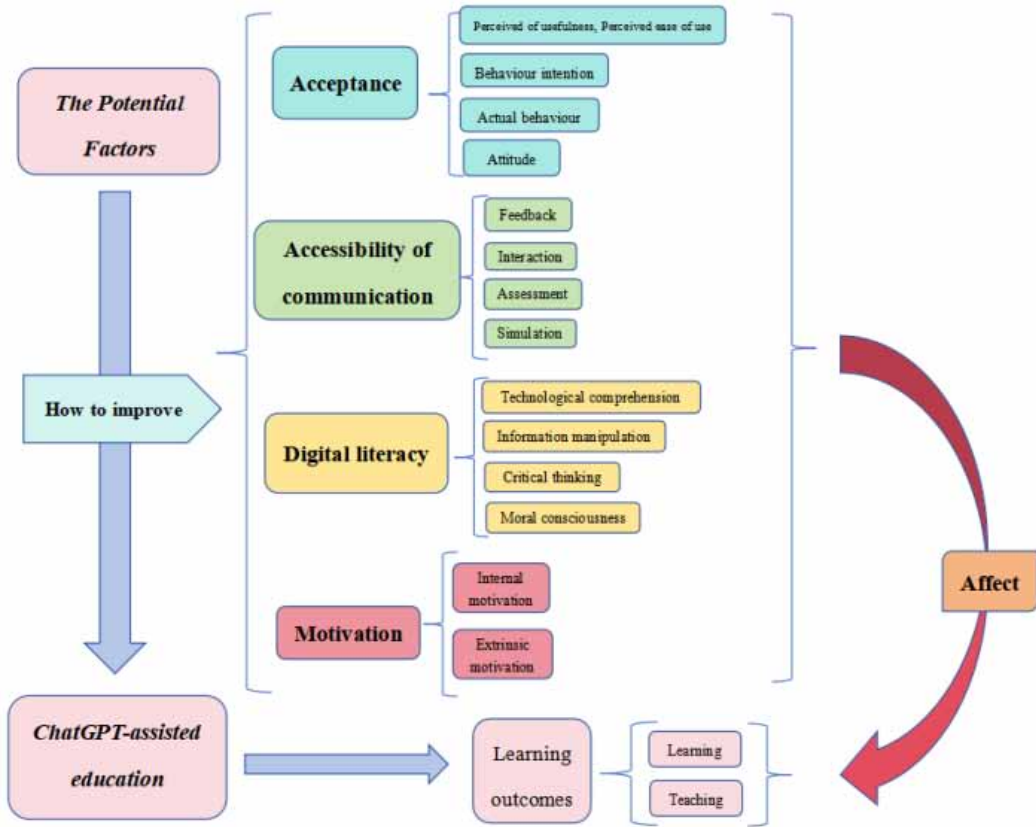
Research Design

This review study employed a swift evidence assessment methodology utilizing the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocol (PRISMA-P). Four stages were undertaken to identify and synthesize preceding literature, aiming to attain a thorough comprehension of potential factors influencing ChatGPT-assisted education. Initially, the investigators performed a literature search on the Web of Science in accordance with the suggested research questions. Secondly, they discerned prevalent research themes and devised multiple research questions by employing clustering and mapping process within VOSviewer. Thirdly, the authors systematically assessed the articles in accordance with predefined inclusion and exclusion criteria. Eventually, the authors examined and synthesized the articles to develop a comprehensive understanding of potential factors influencing ChatGPT-aided education.

Search Strategy

Two seasoned researchers systematically explored various databases by inputting search terms in accordance with the relevant syntactic rules, spanning from the inception of the databases to October 21, 2023. The authors found 2029 results from Web of Science Core Collection. The search word encompassed topic: (ChatGPT OR chatbot*) and topic: ("language*" OR "educat*" OR "learn*" OR "teach*"). The accessible database comprised Science Citation Index Expanded (SCI-EXPANDED) (from 2013 to 2023), Social Science Citation Index (SSCI) (from 1998 to 2023), Arts & Humanities Citation Index (A&HCI) (from 1998 to 2023), Conference Proceedings Citation Index-Science

Figure 2. A Flow diagram of the research framework

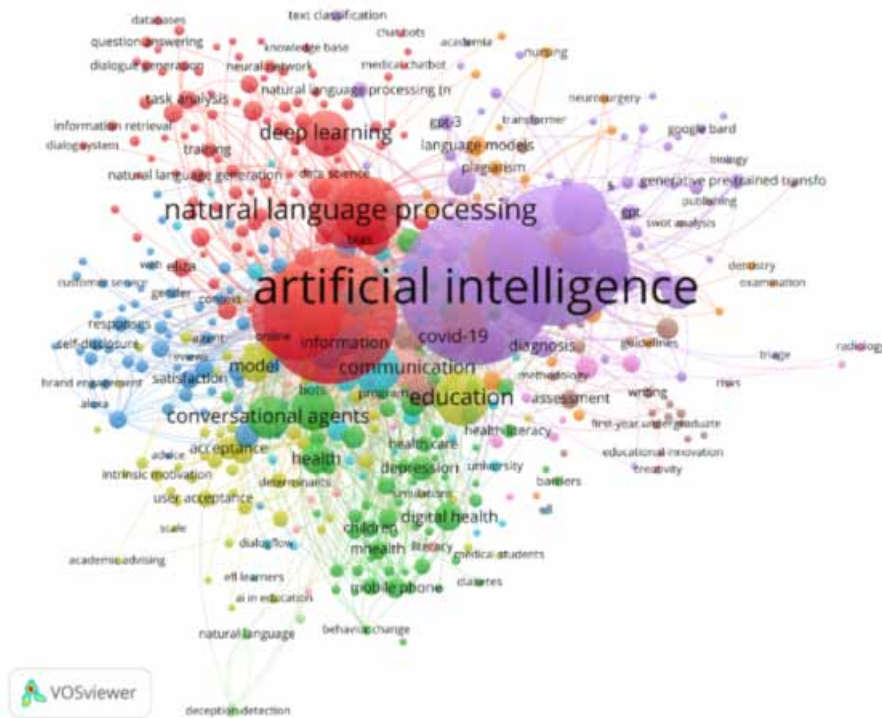


(CPCI-S) (from 1998 to 2023), Conference Proceedings Citation Index-Social Science & Humanities (CPCI-SSH) (from 1998 to 2023), Emerging Sources Citation Index (ESCI) (from 2017 to 2023), Current Chemical Reactions (CCR-EXPENED) (from 1985 to 2023), and Index Chemicus (IC) (from 1993 to 2023).

In order to derive search directions from the gathered literature, the researcher acquired the records (N = 2029) in plain texts and scrutinized them through VOSviewer. The data were subsequently analyzed through VOSviewer, with the choice of “co-occurrence” as the analysis type, “all keywords” as the unit of analysis, and “full counting” as the counting method. The minimum number of occurrences of a key word was set at 4, and of the 5969 keywords, 507 met the threshold. For each of the 507 keywords, the total strength of the co-occurrence links with other keywords would be calculated. The keywords with the greatest total link strength would be selected. Figure 3 provided a comprehensive depiction of the bibliographic graph.

The chosen keywords were then categorized into 11 clusters using VOSviewer. Cluster 1 included 97 items, e.g., chatbot, conversation. Cluster 2 included 69 items, e.g., acceptability, digital technology. Cluster 3 included 65 items, e.g., attitude, social presence. Cluster 4 included 60 items, e.g., acceptance, feedback, motivation and user acceptance. Cluster 5 included 51 items, e.g., challenges, opportunities. Cluster 6 included 46 items, e.g., affordances, digital learning. Cluster 7 included 29 items, e.g., ai ethics, risks. Cluster 8 included 26 items, e.g., assessment, testing. Cluster 9 included 15 items, e.g., digital literacy, higher education. Cluster 10 included 15 items, e.g., communication, comprehension. Cluster 11 included 6 items, e.g., risk assessment.

Figure 3. Clustering key words related to ChatGPT-assisted education



Furthermore, Vosviewer showcased the co-occurrence and link strength of related key words. The keywords with the highest frequency encompassed: ChatGPT (N=514, link strength=1708); Chatbot (N=473, link strength=2080); Education (N=106, link strength=513); Artificial intelligence (N=601, link strength=2487); Language ((N=33, link strength=168); Acceptance (N=27, link strength=190); user acceptance (N=16, link strength=116); Communication (N=60, link strength=364); Evaluation (N=7, link strength=36); Assessment (N=18, link strength=97); Feedback (N=10, link strength=46); Simulation (N=7, link strength=29); Digital literacy (N=4, link strength=16); Intrinsic motivation (N=10, link strength=64); motivation (N=13, link strength=61); learning (N=18, link strength=95); teaching (N=8, link strength=37). Therefore, in light of the co-occurrence, total link strength and research topics, the study directed the investigation to the potential influencing factors for ChatGPT-aided education with respect to acceptance, accessibility of communication, digital literacy and motivation.

Inclusion and Exclusion Criteria

Through a systematic review of articles and adherence to PRISMA-P guidelines, researchers determined the inclusion and exclusion criteria for the compiled literature. The studies would be included if they: (1) were related to at least one research question, (2) focus on the ChatGPT-assisted education domain, (3) have convincing conclusions, (4) were written in English language. The studies would be included if they: (1) were not written in English language, (2) were not relevant to the research topics, (3) duplicates, (4) were not complete articles, (5) were not included in the educational domain, (6) no abstracts, (7) belonged to letters or News items. The literature selection involves both educational and language journals, considering the inclusion of applied linguistics, particularly in foreign language education.

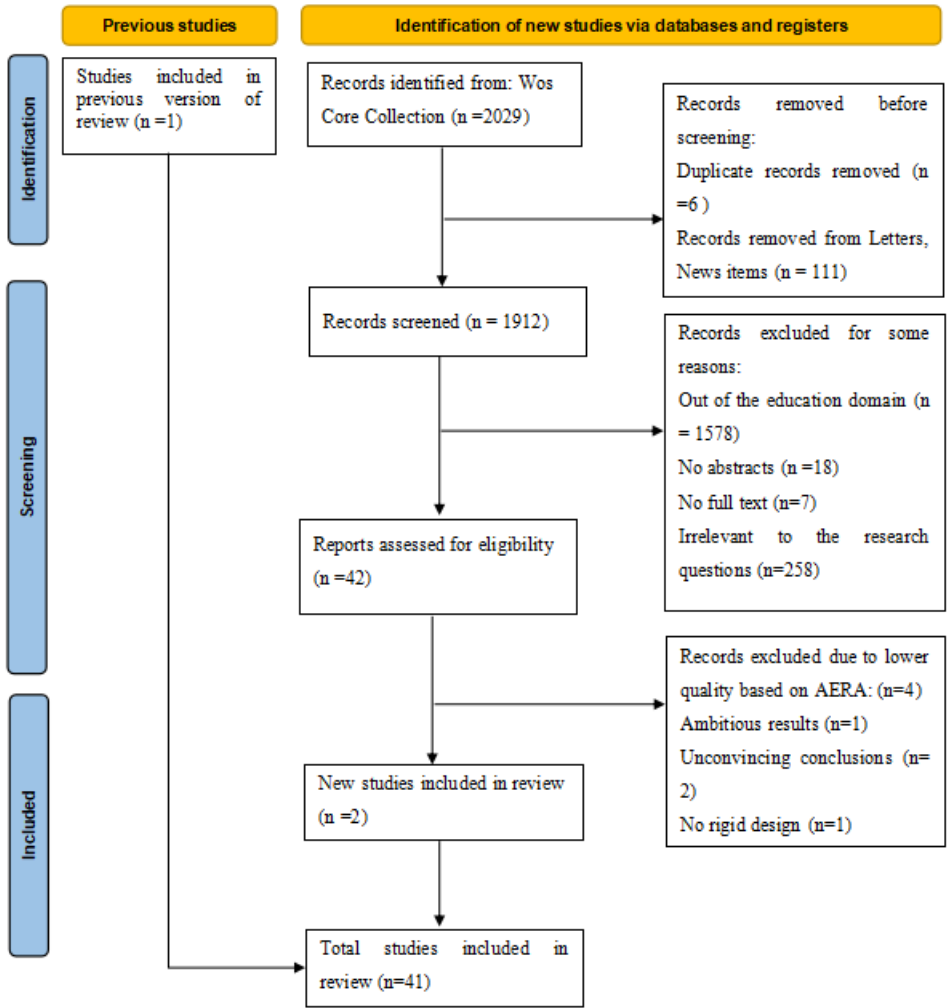
Quality Measurement

To enhance the ultimate study quality, researchers utilized the American Educational Research Association (AERA) framework for a rigorous assessment, refining the results of their investigation. Each study underwent assessment based on the following criteria, with assigned values ranging from 1 to 5 for each standard: a. formulation of question; b. design and logic; c. sources of evidence; d. measurement of classification; e. analysis and interpretation; f. generalization; g. ethics in reporting; h. title, abstract and headings. Two researchers assessed the literature with substantial inter-rater reliability, indicated by a kappa coefficient of 0.724.

RESULTS

RQ1: What are the Potential Factors Affecting Learners’ Achievement in ChatGPT-assisted Educational Environment?

Figure 4. A flow diagram of the literature screening



The study indicated that the potential factors significantly affect learners' achievements in ChatGPT-aided education in terms of learners' acceptance, accessibility of communication, digital literacy and motivation. Learners' acceptance could involve various factors in relation to perceived usefulness, perceived ease of use, behavioral intention, actual behavior and attitude (Liu & Ma, 2023). Many studies demonstrated that ChatGPT could increase accessibility of communication and improve students' learning results, which was significantly associated with learners' feedback, interaction, assessment and simulation (Rawas, 2023). What's more, digital literacy was also of concern in chatbot-aided educational context with respect to technological comprehension, information manipulation, critical thinking and moral consciousness (Kohnke et al., 2023). Both extrinsic motivation and internal motivation contributed to learners' improvement in chatbot-assisted environment. The study would analyze the effect of the possible factors on learners' outcomes in ChatGPT-assisted environment.

RQ2: Could Learners' Acceptance Positively Influence Learners' Outcomes in ChatGPT-assisted Educational Environment?

This study demonstrated that the learners' acceptance had a substantial effect on learners' outcomes in ChatGPT-assisted educational environment. Many empirical studies illustrated that learners' acceptance included perceived usefulness, perceived ease of use, attitudes, intentions and actual behaviors (Liu & Ma, 2023). According to one study, learners who had a favorable attitude on the utilization of ChatGPT had a greater degree of behavioral intention, which predicted their actual usage of ChatGPT in English learning outside the classroom (Liu & Ma, 2023). Furthermore, the researchers discovered that effort expectation and performance expectancy had a direct beneficial influence on the likelihood of higher education learners' intention to utilize ChatGPT, which encouraged them to use the technology tool for learning objectives (Duong et al., 2023). An analysis indicated that the strongest predictor of behavioral intention was found to be habit, followed by performance expectation and hedonic motivation (Strzelecki, 2023). When using ChatGPT as a tool in health care education, the findings underlined the necessity of evaluating risk perceptions, usefulness, convenience of use, attitudes toward technology, and behavioral aspects (Sallam et al., 2023).

However, while the promotion of learners' acceptance would exert a greatly significant effect on ChatGPT-aided education, there still existed concerns and unfavorable effects of ChatGPT with respect to the various individual factors and AI characteristics. It was demonstrated that the personal capability of innovation and the precision of information served as negative mediators of the relationships of actual use of ChatGPT and its decisive factors (Foroughi et al., 2023). Research discovered that the significant inconsistency between learners' effort expectancy and performance expectancy would lead to the decrease of learning intention and the intensity of ChatGPT in practical usage. Even worse, students had weaker intention to use ChatGPT for educational purposes if there was a growing discrepancy between the two variables (Duong et al., 2023). On the other hand, technology acceptance for human-AI communication required changes, notably in terms of AI transparency (Greiner et al., 2023). Clarity regarding AI's involvement became critical. Acceptance levels rose when AI assisted educators in a transparent manner. Thus, it was vital for educators to engage in more research on AI as a receiver and the objectivity of AI decision-making without teacher interference (Greiner et al., 2023).

RQ3: Could Accessibility of Communication Positively Influence Learners' Outcomes in ChatGPT-assisted Educational Environment?

The accessibility of communication exerted a crucial significance to the learners' achievement in ChatGPT-assisted educational contexts. ChatGPT could boost students' learning abilities by simulating real communication via interaction and feedback. The evidence suggested that ChatGPT would provide students with personalized recommendations and facilitate interactions in order to boost

students' learning outcomes (Rawas, 2023). For instance, it could recognize the meaning of a word in paragraph, find and correct grammatical errors, and provide dictionary definitions, model sentences, and translations (Kohnke et al., 2023). Many studies backed up the notion that ChatGPT might be a useful tool for giving students with rapid feedback and individualized learning experiences (Xiao & Zhi, 2023). For example, ChatGPT provided learners with feedback on linguistic application and function as a practice companion, giving new language exercises that could help learners reach their goals (Bin-Hady et al., 2023). A study found that teacher feedback was more focused on content and language use, whereas ChatGPT's concentration on content, organization, and language feedback was approximately average in intensity (Guo & Wang, 2023). In addition, ChatGPT might also give students with comments on their writing style and linguistic performance, allowing them to enhance their subjective expression of professional knowledge (Seetharaman, 2023). Students could discover differences in their knowledge and seek to fill them by comparing their answers to ChatGPT's responses (Seetharaman, 2023).

On the other hand, ChatGPT could assist these students to strengthen their language abilities and convey successfully by providing additional language support as assessment and simulation. ChatGPT might be used to mimic patient contacts for medical students (Seetharaman, 2023). Chatbot employed advanced techniques like pattern matching and other techniques, delivering immediate, task-specific formative assessment to students upon detecting errors (Benotti et al., 2018). Furthermore, the incorporation of ChatGPT into the classroom pushed us to consider improved methods of education and assessment. A study indicated that the incorporation of ChatGPT in the classroom inspired us to use it for writing skill assistance and evaluation (Lambert & Stevens, 2023a). Seetharaman (2023) suggested that ChatGPT might be utilized in small team assessments to provide as a standard for students to endeavor towards the medical education. Therefore, ChatGPT provided a tremendous potential for higher education institutions to increase educational quality and accessibility.

Nevertheless, while the accessibility of communication had access to promote learners' attainment by means of diverse processes in general, the quality of feedback and the system of evaluation were still controversial and restricted. The majority of educators and students were incredulous about the accuracy and correctness of ChatGPT's output answers (Cross et al., 2023). Some studies suggested that the chatbot was presently unprepared to offer learners trustworthy explanations or solutions to several regular test problems (Clark, 2023). It had limitations in terms of giving individualized guidance and occasionally produced incongruous or antiquated references (Seth et al., 2023). Even worse, ChatGPT had trouble identifying the correct choices for various item types in medical industry, and it was unable to offer logical justifications. In such circumstances, utilizing ChatGPT in the medical field might lead to more serious medical errors (Huynh et al., 2023). Over and above the threats of unreliable results, the use of ChatGPT raised the chance of escaping plagiarism detection (Lo, 2023). Some instructors voiced supplementary worries about the danger ChatGPT posed to academic honesty and educational equity (Yan, 2023). Writing and evaluation academic integrity were both in jeopardy due to ChatGPT. The effectiveness of ChatGPT as a tool for enhancing medical learning was further constrained by the absence of in-depth comprehension and the applicability of professional communication (Currie et al., 2023).

RQ4: Could Digital Literacy Positively Influence Learners' Outcomes in ChatGPT-assisted Educational Environment?

This study demonstrated that the role of digital literacy was conducive to enhance the learners' achievements in ChatGPT-aided educational contexts. The influence of digital literacy was contingent upon various factors as technological comprehension, information manipulation, critical thinking and moral consciousness. A study suggested that it was necessary for educational institutions to assist learners to promote technological comprehension, helping them to use digital tools and improve their capacity to do activities efficiently in a digital context (Kohnke et al., 2023). It was also reported that

individuals needed to possess a variety of AI-related knowledge and abilities, such as a computing mindset, which was identified as a major factor of AI literacy and aids in the usage, identification, and assessment of AI-based technology (Bin-Hady et al., 2023). In addition, the ability to comprehend and apply information in various forms from substantial sources was indispensable for the education. A model analysis demonstrated that in order to enhance the development of digital literacy, combining integration, multimodality, and interaction into language instruction was critical (Munoz-Basols et al., 2023). Moreover, educators should examine and plan how to utilize ChatGPT to carry out language teaching activities efficiently, such as building various types of interaction and assessment mechanisms with Chatbot, leading learners to apply ChatGPT's functionalities for self-directed learning (Kohnke et al., 2023).

On the other hand, many studies emphasized that the importance of digital literacy in universities was to encourage critical thinking and to realize ethical issues (Dianova & Schultz, 2023). The arise of artificial intelligence-based chatbots, such as ChatGPT, contributed to advancements in traditional education to give priority to critical thinking (Munoz-Basols et al., 2023). Incorporating ChatGPT in education enhanced critical thinking, aiding learners in adeptly navigating AI and discerning accurate information from misinformation (Rusandi et al., 2023). Furthermore, the ethical hazards connected with AI-based technology should also be evaluated in terms of digital literacy (Dempere et al., 2023). Many studies indicated that it was decisive to adopt acceptable procedures in order to maintain academic integrity and make certain that the use was ethical (Jarrah et al., 2023). Therefore, it was of significance for learners to leverage the benefits of ChatGPT while becoming responsible users and understanding their duties in educational settings (Kohnke et al., 2023).

RQ5: Could Learners' Motivation Positively Influence Learners' Outcomes in ChatGPT-assisted Educational Environment?

The learners' motivation had the potential to strengthen learners' improvement in ChatGPT-assisted educational contexts. Chatbots were gradually being used in EFL instruction and was proven to be advantageous in terms of knowledge and motivation (Zhang et al., 2023). Most of the current studies focused on the learners' internal motivation and extrinsic motivation. Students employing chatbot in learning showed considerably more intrinsic motivation than students with the conventional learning (Yin et al., 2021). Some studies revealed that ChatGPT-assisted intelligence gave significant benefits in mixed learning environments in terms of amotivation, intrinsic motivation, and behavioral engagement, while also enhancing self-driven progress and knowledge creation (Wu et al., 2023). An experimental study also indicated that postgraduates applying chatbot in learning were more motivated and acquired knowledge in a more cognitive and metacognitive manner, facilitating their learning progress effectively (Al-Abdullatif et al., 2023). Moreover, learner motivation was substantially associated with chatbot traits such as social presence and human-likeness, which would increase learners' motivation, enthusiasm, and confidence in learning English (Ebadi & Amini, 2022). Both instructor support and student knowledge, such as self-regulated learning and digital literacy, were also necessary for students to be intrinsically motivated and competent to study with the chatbot (Chiu et al., 2023).

On the other hand, learners' extrinsic motivation also influenced the achievements in educational environment. A study indicated that the learners adopting chatbot considerably surpassed the traditional group in terms of learning accomplishments, extrinsic motivation, group inspiration, cognitive engagement, affective involvement, and satisfaction with the learning strategy (Iku-Silan et al., 2023). There was also evidence suggested that the use of AI-based chatbots in course reviews could enhance learners' academic achievement, sense of self-efficacy, approach to learning, and motivation through external stimulus (Lee et al., 2022). For example, giving students enough feedback throughout the review process could help them feel appreciated and create a relaxed environment that boost them

perform better in class (Lee et al., 2022). To sum up, learners' motivation was of the essence in ChatGPT-aided educational contexts.

RQ6: What is the Future For Instructors and Learners in ChatGPT-assisted Educational Contexts?

Many studies provided various suggestions on usage of ChatGPT in teaching and learning, and the study would introduce the future of ChatGPT in educational context in terms of opportunities and challenges. It was concluded that research pertaining to the integration of chatbots in education was still in its nascent phase (Hwang & Chang, 2023). Some previous findings revealed that ChatGPT could be used to enhance language learners' efficiency by giving feedback on their language use and creating individualized activities for additional language practice (Bin-Hady et al., 2023). ChatGPT could aid students in enhancing their learning efficiency with its high output quality, conversational and interactive features, and tremendous speed (Lambert & Stevens, 2023). Students frequently used GPT to locate, summarize, and assess articles and the data needed for writing, and thus complete challenging tasks (Birenbaum, 2023). What's more, lecturers had access to providing assessment and prompts for learners in accordance with ChatGPT's instructions, which showcased directions for personalized learning (Lambert & Stevens, 2023).

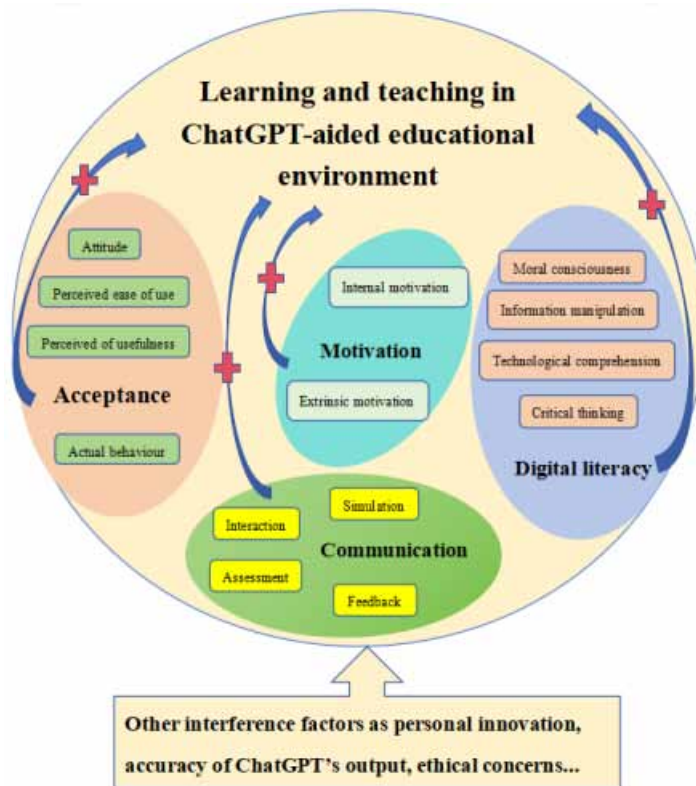
However, there existed many risks and challenges of the utilization of ChatGPT in educational environments. Some studies revealed that ChatGPT has plenty of disturbing issues like cheating, erroneous information, bias, abuse and misuse, as well as privacy and security concerns (Lambert & Stevens, 2023). The risks associated with individualization emerged, such as violating students' privacy, treating them unfairly, triggering unhealthy habits, etc. It could expose educators to academic dishonesty and plagiarism (Birenbaum, 2023). Numerous scholars examined challenges in identifying and preventing academic dishonesty, offering recommendations for universities to foster ethical and responsible tool utilization (Cotton et al., 2023). Another drawback of chatbots was its inability to effectively collect, comprehend, and respond to users' emotions and moods. At the same time, it was dependent on other devices during operation, thus its validity was controversial (Birenbaum, 2023). To summarize, educators should develop strategies and guidelines for using ChatGPT, fully utilizing the strengths of chatbot to optimize their teaching and evaluation, and encouraged students to use it more efficiently and reasonably in their learning (Kohnke et al., 2023). The authors summarized the results as a diagram in figure 5.

DISCUSSION

This review comprehensively scrutinized antecedent researches endeavors concerning the integration of ChatGPT in educational settings, elucidating findings across acceptance, accessibility of communication, digital literacy and motivation. RQ1 sought to investigate the potential determinants within the domain of ChatGPT-assisted education. The findings indicated that a more in-depth investigation is warranted for the four identified factors, and subsequent inquiries will be formulated in alignment with the initial research question.

RQ2 endeavors to ascertain the impact of learners' acceptance on the efficacy of teaching and learning facilitated by ChatGPT. Many previous literatures have concentrated on traditional acceptance models (TAM), analyzing the interconnections among various factors. Several studies posited that the favorable perception of using ChatGPT in an educational setting was influenced by its perceived usefulness, social presence, legitimacy, as well as the elements of enjoyment and motivation (Tiware et al., 2023). Nevertheless, some researches proposed that the perceived impact of advisory chatbots' acceptance was not substantially supported by perceived usefulness, autonomy, and trust (Bilquise et al., 2023). The outcomes may be attributed to individual variances, including their previous encounters with technology, comfort levels regarding chatbots, and preferences in learning, which can affect their

Figure 5. Learning and teaching in ChatGPT-aided education



level of acceptance. The expectations of users may vary based on the definition and implementation of autonomy in the educational chatbot. Some users may be more open to autonomous systems, while others may prefer more control.

Additionally, the perceived ease of use was not identified as a noteworthy element in the students' availability and use of ChatGPT (Tiwari et al., 2023). The variance in outcomes may be attributed to the misalignment between expectations and reality, as well as the integration of TAM models with distinct cognitive conceptual theories across diverse backgrounds. Users may find misalignment between their expectations of ChatGPT's ease of use and its actual capabilities. When a disparity exists between user expectations and system performance, the perceived ease of use may not emerge as a substantial determinant. Through the lens of cognitive appraisal theory, age demonstrated a notable adverse influence on the inclination to refuse ChatGPT (Ma & Huo, 2023). The findings might be attributed to variations in digital literacy and educational backgrounds. Younger individuals, having been exposed to technology from an early age, may have encountered similar technologies in their academic experiences, making them more receptive. These insights offer practical implications for the design and development of AI-based chatbots, contributing to the evolving landscape of AI technology acceptance.

RQ3 aims to investigate learners' accessibility of communication in ChatGPT-assisted educational environments. Studies have indicated that ChatGPT has the potential to enhance learners' efficacy through interactive engagement, diverse feedback mechanisms, simulations, and assessments. In contrast to feedback from teachers, which primarily centers on content and language-related concerns, ChatGPT generated a greater volume of feedback and allocates its attention comparatively evenly across the three feedback dimensions—content, organization, and language (Guo & Wang, 2023).

Furthermore, EFL instructors expressed favorable and unfavorable attitudes toward incorporating feedback generated by ChatGPT to complement their own feedback (Guo & Wang, 2023). Various factors could account for the results. The affirmative viewpoints may arise due to the assortment and diversity of feedback, the efficiency and time-saving attributes, and the immediate responsiveness that aids instructors in teaching process. While dissenting perspectives may stem from apprehensions regarding authenticity, inaccuracies or misinterpretations in feedback, and a deficiency in contextual understanding for learners. Teachers may also be concerned that an augmented dependence on automated feedback could diminish opportunities for direct teacher-student interaction, potentially influencing the overall quality of the learning experience.

Thus, the synergistic association between ChatGPT and educators could more effectively foster educational advancement (Jeon & Lee, 2023). ChatGPT assumed roles such as converser, content provider, and teaching aider, while teachers orchestrated resources, engage students, and promote AI ethics (Jeon & Lee, 2023). To mitigate plagiarism risks in ChatGPT-assisted education, educators could create unique and dynamic assessments, including critical thinking and personalized responses. Moreover, it is necessary for educators to incorporate ChatGPT-generated content in educational materials that underscore the significance of academic integrity.

RQ4 emphasized the importance of digital literacy in ChatGPT-aided education. Digital literacy played a pivotal role in facilitating the utilization of instructional tools, organizing academic communication, assessing learning accomplishments, and distributing information (Yu, 2022). Some factors shape digital literacy in ChatGPT-supported education. Those with experience and a technology-related background may exhibit greater proficiency. Continuous digital literacy training ensures educators and learners remain current on AI advancements. Moreover, positive attitudes toward technology enhance digital literacy, fostering openness to integrating ChatGPT into learning and teaching practices. Cognizance of ethical aspects concerning AI, data privacy, and responsible technology usage can influence digital literacy. Certain investigations indicated that it was imperative for learners to acknowledge the limitations of ChatGPT and employ it formally and honestly. (Kohnke et al., 2023). Learners who understand and prioritize ethical considerations are more likely to use ChatGPT responsibly. Consequently, educators must incorporate digital literacy skills into the curriculum, instructing learners in ethical usage. Seamless integration of ChatGPT and AI into educational programs enhances digital literacy and academic achievements.

RQ5 attempts to explore the role of motivation in ChatGPT-assisted education. Motivation is integral to learners' advancement in ChatGPT-assisted education for various reasons, with motivational levels susceptible to diverse factors. Collaboration with peers using ChatGPT can enhance learner motivation, and teachers should facilitate such activities. Motivated learners are receptive to feedback, actively participate in collaborative tasks, and demonstrate autonomy in learning. Tasks that are overly complex or monotonous may decrease motivation, thus educators should design varied and appropriately challenging assignments. Clear communication about ChatGPT's role is vital to prevent confusion and maintain motivation. Teachers could clearly convey the purpose of using ChatGPT, its role in the curriculum, and how it aligns with learning objectives. By fostering a goal-oriented and persistent approach among learners, ultimately enhancing learners' achievement.

RQ6 stressed that the future and opportunities for the ChatGPT-assisted education. ChatGPT could facilitate interdisciplinary learning by generating content and insights across various subjects, encouraging a holistic educational experience. Continued improvements in language capabilities may lead to ChatGPT supporting a wider range of languages, making it more accessible to diverse global populations. ChatGPT might evolve into more advanced teaching assistants, supporting educators in tasks such as lesson planning, content creation, and student engagement. ChatGPT could be integrated into adaptive learning platforms, providing real-time feedback and adapting content based on students' performance and progress. Future iterations of ChatGPT may introduce more advanced personalization, tailoring learning experiences to individual students' needs, preferences, and learning styles. However, it was essential for educators to be cautious in overseeing the ethical problems of

incorporating ChatGPT into language education and other domains (Vaccino-Salvadore, 2023). The educational prospects of ChatGPT are promising, yet meticulous attention to ethical, privacy, and bias-related challenges is necessary. Concerns may arise regarding the credibility of assessments and feedback from ChatGPT. Consequently, collaborative efforts among educators, developers, and policymakers are indispensable to optimize the advantages of AI tools in the education domain.

CONCLUSION

Conducting a swift evidence assessment following the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) protocol, this review endeavors to analyze prior research on the influencing factors of ChatGPT-supported education. The factors involve learners' acceptance, communication accessibility, digital literacy, motivation, as well as the future and opportunities of integrating ChatGPT into teaching and learning. The learners' acceptance includes other elements of perceived usefulness, perceived ease of use, behavioral intention, actual behavior and attitude. Accessibility of communication contains feedback, interaction, assessment and simulation. Digital literacy incorporates technological comprehension, information manipulation, critical thinking and moral consciousness. Motivation consists of internal motivation and extrinsic motivation. The four potential influencing factors could improve learners' achievements in ChatGPT-aided educational environment.

Limitations

There are still several limitations in this study. Firstly, because of the limitations in library resources, the study could not include all relevant literature. Secondly, the study could not cover all factors relevant to ChatGPT-assisted education, and there may exist additional factors beyond its scope. Thirdly, most selected papers for research have been published for nearly three years, as ChatGPT emerged in 2022.

Future Research Implications

From the perspective of theoretical significance, ChatGPT-aided education lie in its transformative potential for personalized and adaptive learning experiences. Integrating AI technologies like ChatGPT can reshape traditional educational paradigms, offering tailored content and fostering diverse learning styles. In view of the practical implications, ChatGPT introduces a paradigm shift in educational practices. ChatGPT had the capacity to enhance educators' efficiency, offering instant support, generating content, and aiding assessment (Chang et al., 2023). The practical implications extend to assessment methods, where the tool's ability to generate varied and timely feedback enhances the evaluation process.

However, challenges include addressing biases, ensuring data privacy, and different levels of acceptance among learners. To realize its full potential, it was crucial for educators to perfect the pressing requirement for well-defined policies, guidelines, and frameworks to prudently incorporate ChatGPT into higher education (Michel-Villarreal et al., 2023). As ChatGPT-aided education evolves, theoretical frameworks need to adapt to capture the dynamic interaction between AI technology and pedagogical practices, fostering an inclusive and ethically grounded educational landscape. Continuous research and development will play a key role in shaping the evolution of ChatGPT and similar technologies in education.

REFERENCES

- Agathokleous, E., Saitanis, C. J., Fang, C., & Yu, Z. (2023). Use of ChatGPT: What does it mean for biology and environmental science? *The Science of the Total Environment*, 888, 164154. doi:10.1016/j.scitotenv.2023.164154 PMID:37201835
- Al-Abdullatif, A. M., Al-Dokhny, A. A., & Drwish, A. M. (2023). Implementing the Bashayer chatbot in Saudi higher education: Measuring the influence on students' motivation and learning strategies. *Frontiers in Psychology*, 14, 1129070. doi:10.3389/fpsyg.2023.1129070 PMID:37255522
- Benichou, L., & Chat, G. P. T. (2023). The role of using ChatGPT AI in writing medical scientific articles. *Journal of Stomatology, Oral and Maxillofacial Surgery*, 124(5), 101456. doi:10.1016/j.jormas.2023.101456 PMID:36966950
- Benotti, L., Cecilia Martinez, M., & Schapachnik, F. (2018). A Tool for Introducing Computer Science with Automatic Formative Assessment. *IEEE Transactions on Learning Technologies*, 11(2), 179–192. doi:10.1109/TLT.2017.2682084
- Bilquise, G., Ibrahim, S., & Salhie, S. M. (2023). Investigating student acceptance of an academic advising chatbot in higher education institutions. *Education and Information Technologies*. Advance online publication. doi:10.1007/s10639-023-12076-x
- Bin-Hady, W. R. A., Al-Kadi, A., Hazaea, A., & Ali, J. K. M. (2023). Exploring the dimensions of ChatGPT in English language learning: A global perspective. *Library Hi Tech*. Advance online publication. doi:10.1108/LHT-05-2023-0200
- Birenbaum, M. (2023). The Chatbots' Challenge to Education: Disruption or Destruction? *Education Sciences*, 13(7), 711. doi:10.3390/educsci13070711
- Chang, D. H., Lin, M. P.-C., Hajian, S., & Wang, Q. Q. (2023). Educational Design Principles of Using AI Chatbot That Supports Self-Regulated Learning in Education: Goal Setting, Feedback, and Personalization. *Sustainability (Basel)*, 15(17), 12921. doi:10.3390/su151712921
- Chen, L., Chen, P., & Lin, Z. (2020). Artificial Intelligence in Education: A Review. *IEEE Access : Practical Innovations, Open Solutions*, 8, 75264–75278. doi:10.1109/ACCESS.2020.2988510
- Chiu, T. K. F., 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. Advance online publication. doi:10.1080/10494820.2023.2172044
- Clark, T. M. (2023). Investigating the Use of an Artificial Intelligence Chatbot with General Chemistry Exam Questions. *Journal of Chemical Education*, 100(5), 1905–1916. doi:10.1021/acs.jchemed.3c00027
- 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
- Cotton, D. R. E., Cotton, P. A. A., & Shipway, J. R. (2023). Chatting and cheating: Ensuring academic integrity in the era of ChatGPT. *Innovations in Education and Teaching International*, 1–12. Advance online publication. doi:10.1080/14703297.2023.2190148
- Cross, J., Robinson, R., Devaraju, S., Vaughans, A., Hood, R., Kayalackakom, T., Honnavar, P., Naik, S., & Sebastian, R. (2023). Transforming Medical Education: Assessing the Integration of ChatGPT Into Faculty Workflows at a Caribbean Medical School. *Cureus Journal of Medical Science*, 15(7), e41399. 10.7759/cureus.41399
- Currie, G., Singh, C., Nelson, T., Nabasinja, C., Al-Hayek, Y., & Spuur, K. (2023). ChatGPT in medical imaging higher education. *Radiography*, 29(4), 792–799. doi:10.1016/j.radi.2023.05.011 PMID:37271011
- Dempere, J., Modugu, K., Hesham, A., & Ramasamy, L. K. (2023). The impact of ChatGPT on higher education. *Frontiers in Education*, 8, 1206936. doi:10.3389/feduc.2023.1206936
- Dianova, V. G., & Schultz, M. D. (2023). Discussing ChatGPT's implications for industry and higher education: The case for transdisciplinarity and digital humanities. *Industry and Higher Education*, 37(5), 593–600. Advance online publication. doi:10.1177/09504222231199989

- Duong, C. D., Bui, D. T., Pham, H. T., Vu, A. T., & Nguyen, V. H. (2023). How effort expectancy and performance expectancy interact to trigger higher education students' uses of ChatGPT for learning. *Interactive Technology and Smart Education*. Advance online publication. doi:10.1108/ITSE-05-2023-0096
- Ebadi, S., & Amini, A. (2022). Examining the roles of social presence and human-likeness on Iranian EFL learners' motivation using artificial intelligence technology: A case of CSIEC chatbot. *Interactive Learning Environments*, 1–19. Advance online publication. doi:10.1080/10494820.2022.2096638
- Foroughi, B., Senali, M. G., Iranmanesh, M., Khanfar, A., Ghobakhloo, M., Annamalai, N., & Naghmeh-Abbaspour, B. (2023). Determinants of Intention to Use ChatGPT for Educational Purposes: Findings from PLS-SEM and fsQCA. *International Journal of Human-Computer Interaction*, 1–20. Advance online publication. doi:10.1080/10447318.2023.2226495
- Greiner, C., Peisl, T. C., Hoepfl, F., & Beese, O. (2023). Acceptance of AI in Semi-Structured Decision-Making Situations Applying the Four-Sides Model of Communication-An Empirical Analysis Focused on Higher Education. *Education Sciences*, 13(9), 865. doi:10.3390/educsci13090865
- Guo, K., & Wang, D. (2023). To resist it or to embrace it? Examining ChatGPT's potential to support teacher feedback in EFL writing. *Education and Information Technologies*. Advance online publication. doi:10.1007/s10639-023-12146-0
- Hung, J., & Chen, J. (2023). The Benefits, Risks and Regulation of Using ChatGPT in Chinese Academia: A Content Analysis. *Social Sciences-Basel*, 12(7), 380. 10.3390/socsci12070380
- Huynh, L. M., Bonebrake, B. T., Schultis, K., Quach, A., & Deibert, C. M. (2023). New Artificial Intelligence ChatGPT Performs Poorly on the 2022 Self-assessment Study Program for Urology. *Urology Practice*, 10(4), 408. 10.1097/UPI.0000000000000406
- Hwang, G.-J., & Chang, C.-Y. (2023). A review of opportunities and challenges of chatbots in education. *Interactive Learning Environments*, 31(7), 4099–4112. doi:10.1080/10494820.2021.1952615
- Iku-Silan, A., Hwang, G.-J., & Chen, C.-H. (2023). Decision-guided chatbots and cognitive styles in interdisciplinary learning. *Computers & Education*, 201, 104812. doi:10.1016/j.compedu.2023.104812
- Jarrah, A. M., Wardat, Y., & Fidalgo, P. (2023). Using ChatGPT in academic writing is (not) a form of plagiarism: What does the literature say? *Online Journal of Communication and Media Technologies*, 13(4), e202346. doi:10.30935/ojcm/13572
- 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*, 28(12), 15873–15892. Advance online publication. doi:10.1007/s10639-023-11834-1
- Jeon, J., Lee, S., & Choe, H. (2023). Beyond ChatGPT: A conceptual framework and systematic review of speech-recognition chatbots for language learning. *Computers & Education*, 206, 104898. doi:10.1016/j.compedu.2023.104898
- Johinke, R., Cummings, R., & Di Lauro, F. (2023). Reclaiming the technology of higher education for teaching digital writing in a post-pandemic world. *Journal of University Teaching & Learning Practice*, 20(2). Advance online publication. doi:10.53761/1.20.02.01
- Kohnke, L., Moorhouse, B. L., & Zou, D. (2023). ChatGPT for Language Teaching and Learning. *RELC Journal*, 54(2), 537–550. doi:10.1177/00336882231162868
- Lambert, J., & Stevens, M. (2023). ChatGPT and Generative AI Technology: A Mixed Bag of Concerns and New Opportunities. *Computers in the Schools*, 1–25. Advance online publication. doi:10.1080/07380569.2023.2256710
- Lee, Y.-F., Hwang, G.-J., & Chen, P.-Y. (2022). Impacts of an AI-based *chabot* on college students' after-class review, academic performance, self-efficacy, learning attitude, and motivation. *Educational Technology Research and Development*, 70(5), 1843–1865. 10.1007/s11423-022-10142-8
- Liu, G., & Ma, C. (2023). Measuring EFL learners' use of ChatGPT in informal digital learning of English based on the technology acceptance model. *Innovation in Language Learning and Teaching*, 1–14. Advance online publication. doi:10.1080/17501229.2023.2240316

Lo, C. K. (2023). What Is the Impact of ChatGPT on Education? A Rapid Review of the Literature. *Education Sciences*, 13(4), 410. doi:10.3390/educsci13040410

Ma, X., & Huo, Y. (2023). Are users willing to embrace ChatGPT? Exploring the factors on the acceptance of chatbots from the perspective of AIDUA framework. *Technology in Society*, 75, 102362. doi:10.1016/j.techsoc.2023.102362

Michel-Villarreal, R., Vilalta-Perdomo, E., Salinas-Navarro, D. E., Thierry-Aguilera, R., & Gerardou, F. S. (2023). Challenges and Opportunities of Generative AI for Higher Education as Explained by ChatGPT. *Education Sciences*, 13(9), 856. doi:10.3390/educsci13090856

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*. Advance online publication. doi:10.1007/s10639-023-11917-z

Montenegro-Rueda, M., Fernandez-Cerero, J., Fernandez-Batanero, J. M., & Lopez-Meneses, E. (2023). Impact of the Implementation of ChatGPT in Education: A Systematic Review. *Computers*, 12(8), 153. doi:10.3390/computers12080153

Munoz-Basols, J., Neville, C., Lafford, B. A., & Godev, C. (2023). Potentialities of Applied Translation for Language Learning in the Era of Artificial Intelligence. *Hispania-A Journal Devoted to the Teaching of Spanish and Portuguese*, 106(2), 171–194.

Piccolo, S. R., Denny, P., Luxton-Reilly, A., Payne, S. H., & Ridge, P. G. (2023). Evaluating a large language model's ability to solve programming exercises from an introductory bioinformatics course. *PLoS Computational Biology*, 19(9), e1011511. doi:10.1371/journal.pcbi.1011511 PMID:37769024

Rawas, S. (2023). ChatGPT: Empowering lifelong learning in the digital age of higher education. *Education and Information Technologies*. Advance online publication. doi:10.1007/s10639-023-12114-8

Romero-Rodriguez, J., Ramirez-Montoya, M., Buenestado-Fernandez, M., & Lara-Lara, F. (2023). Use of ChatGPT at University as a Tool for Complex Thinking: Students' Perceived Usefulness. *Journal of New Approaches in Educational Research*, 12(2), 323–339. 10.7821/naer.2023.7.1458

Rusandi, M. A., Ahman, I., Saripah, I., Khairun, D. Y., & Mutmainnah, . (2023). No worries with ChatGPT: Building bridges between artificial intelligence and education with critical thinking soft skills. *Journal of Public Health (Oxford, England)*, 45(3), e602–e603. Advance online publication. doi:10.1093/pubmed/fdad049 PMID:37099761

Sallam, M. (2023). ChatGPT Utility in Healthcare Education, Research, and Practice: Systematic Review on the Promising Perspectives and Valid Concerns. *Health Care*, 11(6), 887. doi:10.3390/healthcare11060887 PMID:36981544

Seetharaman, R. (2023). Revolutionizing Medical Education: Can ChatGPT Boost Subjective Learning and Expression? *Journal of Medical Systems*, 47(1), 61. doi:10.1007/s10916-023-01957-w PMID:37160568

Seth, I., Cox, A., Xie, Y., Bulloch, G., Hunter-Smith, D., Rozen, W., & Ross, R. (2023). Evaluating Chatbot Efficacy for Answering Frequently Asked Questions in Plastic Surgery: A ChatGPT Case Study Focused on Breast Augmentation. *Aesthetic Surgery Journal*, 43(10), 1126–1135. Advance online publication. doi:10.1093/asj/sjad140 PMID:37158147

Strzelecki, A. (2023). To use or not to use ChatGPT in higher education? A study of students' acceptance and use of technology. *Interactive Learning Environments*, 1–14. Advance online publication. doi:10.1080/10494820.2023.2209881

Tiwari, C. K., Bhat, M. A., Khan, S. T., Subramaniam, R., & Khan, M. A. I. (2023). What drives students toward ChatGPT? An investigation of the factors influencing adoption and usage of ChatGPT. *Interactive Technology and Smart Education*, 708854. Advance online publication. doi:10.1108/ITSE-04-2023-0061

Vaccino-Salvadore, S. (2023). Exploring the Ethical Dimensions of Using ChatGPT in Language Learning and Beyond. *Languages (Basel, Switzerland)*, 8(3), 191. doi:10.3390/languages8030191

Wu, T., He, S., Liu, J., Sun, S., Liu, K., Han, Q.-L., & Tang, Y. (2023). A Brief Overview of ChatGPT: The History, Status Quo and Potential Future Development. *IEEE-CAA Journal of Automatica Sinica*, 10(5), 1122–1136. 10.1109/JAS.2023.123618

- Wu, T.-T., Lee, H.-Y., Li, P.-H., Huang, C.-N., & Huang, Y.-M. (2023). Promoting Self-Regulation Progress and Knowledge Construction in Blended Learning via ChatGPT-Based Learning Aid. *Journal of Educational Computing Research*. Advance online publication. doi:10.1177/07356331231191125
- Xiao, Y., & Zhi, Y. (2023). An Exploratory Study of EFL Learners' Use of ChatGPT for Language Learning Tasks: Experience and Perceptions. *Languages (Basel, Switzerland)*, 8(3), 212. doi:10.3390/languages8030212
- Yan, D. (2023). Impact of ChatGPT on learners in a L2 writing practicum: An exploratory investigation. *Education and Information Technologies*, 28(11), 13943–13967. Advance online publication. doi:10.1007/s10639-023-11742-4
- Yazon, , A., Ang-Manaig, K., Buama, C. A. C., & Tesoro, J. F. B. (2019). Digital Literacy, Digital Competence and Research Productivity of Educators. *Universal Journal of Educational Research*, 7(8), 1734–1743. doi:10.13189/ujer.2019.070812
- Yin, J., Goh, T.-T., Yang, B., & Xiaobin, Y. (2021). Conversation Technology With Micro-Learning: The Impact of Chatbot-Based Learning on Students' Learning Motivation and Performance. *Journal of Educational Computing Research*, 59(1), 154–177. doi:10.1177/0735633120952067
- Yu, Z. (2015). Indicators of satisfaction in clickers-aided EFL class. *Frontiers in Psychology*, 6. Advance online publication. doi:10.3389/fpsyg.2015.00587 PMID:25999898
- Yu, Z. (2022). Sustaining Student Roles, Digital Literacy, Learning Achievements, and Motivation in Online Learning Environments during the COVID-19 Pandemic. *Sustainability (Basel)*, 14(8), 4388. doi:10.3390/su14084388
- Yu, Z. (2023). A meta-analysis of the effect of virtual reality technology use in education. *Interactive Learning Environments*, 31(8), 4956–4976. doi:10.1080/10494820.2021.1989466
- Yu, Z., Yu, L., Xu, Q., Xu, W., & Wu, P. (2022). Effects of mobile learning technologies and social media tools on student engagement and learning outcomes of English learning. *Technology, Pedagogy and Education*, 27(3), 721–732. doi:10.1080/1475939X.2022.2045215
- Zhang, D., Hennessy, S., & Perez-Paredes, P. (2023). An investigation of Chinese EFL learners' acceptance of mobile dictionaries in English language learning. *Computer Assisted Language Learning*, 1–25. Advance online publication. doi:10.1080/09588221.2023.2189915
- Zhang, R., Zou, D., & Cheng, G. (2023). Chatbot-based learning of logical fallacies in EFL writing: Perceived effectiveness in improving target knowledge and learner motivation. *Interactive Learning Environments*, 1–18. Advance online publication. doi:10.1080/10494820.2023.2220374
- Yu, Z., & Yu, X. (2019). An extended technology acceptance model of a mobile learning technology. *Computer Applications in Engineering Education*, 27(3), 721–732. doi:10.1002/cae.22111
- Yu, Z., Zhu, Y., Yang, Z., & Chen, W. (2019). Student satisfaction, learning outcomes, and cognitive loads with a mobile learning platform. *Computer Assisted Language Learning*, 32(4), 323–341. doi:10.1080/09588221.2018.1517093