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The impact of ChatGPT on blended learning: Current trends and future research directions

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C H R O N I C L E

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A B S T R A C T

Designing sustainable and scalable educational systems is a challenge. Artificial Intelligence (AI) offers promising solutions to enhance the effectiveness and sustainability of blended learning systems. This research paper focuses on the integration of the Chat Generative Pre-trained Transformer (ChatGPT), with a blended learning system. The objectives of this study are to investigate the potential of AI techniques in enhancing the sustainability of educational systems, explore the use of ChatGPT to personalize the learning experience and improve engagement, and propose a model for sustainable learning that incorporates AI. The study aims to contribute to the body of knowledge on AI applications for sustainable education, identify best practices for integrating AI in education, and provide insights for policymakers and educators on the benefits of AI in education delivery. The study emphasizes the significance of AI in sustainable education by addressing personalized learning and educational accessibility. By automating administrative tasks and optimizing content delivery, AI can enhance educational accessibility and promote inclusive and equitable education. The study's findings highlight the potential benefits of integrating AI chatbots like ChatGPT into education. Such benefits include promoting student engagement, motivation, and self-directed learning through immediate feedback and assistance. The research provides valuable guidance for educators, policymakers, and instructional designers who seek to effectively leverage AI technology in education. In conclusion, the study recommends directions for future research in order to maximize the benefits of integrating ChatGPT into learning systems. Positive results have been observed, including improved learning outcomes, enhanced student engagement, and personalized learning experiences. Through advancing the utilization of AI tools like ChatGPT, blended learning systems can be made more sustainable, efficient, and accessible for learners worldwide.

1. Introduction

Blended learning systems refer to a combination of traditional face-to-face instruction and online learning (Kizilcec & Halawa, 2015). This approach to education has gained popularity in recent years due to its flexibility and ability to cater to diverse learning needs (Alqurashi, 2019). However, designing effective blended learning systems can be challenging, especially sustainability and scalability.

Artificial Intelligence (AI) has emerged as a promising solution for enhancing the effectiveness and sustainability of blended learning systems (Kizilcec et al., 2015). AI techniques such as machine learning (ML), natural language processing (NLP), and chatbots can be used to automate various aspects of the learning process, such as content delivery, assessment, and

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feedback (Khosravi & Heidari, 2019). AI can also help personalize the learning experience for each student, thereby improving engagement and learning outcomes.

Sustainable learning refers to an educational system that is designed to be environmentally, socially, and economically sustainable. Such a system should be able to adapt to changing circumstances, support the needs of all learners, and minimize its impact on the environment. By incorporating AI into blended learning systems, it is possible to create an education system that is both effective and sustainable. AI has been increasingly used to support education and blended learning by providing personalized learning experiences and optimizing course delivery (Alsaleem & Alghalith, 2019; Lee et al., 2020). Blended learning systems have become popular in recent years due to their ability to enhance student engagement, flexibility, and efficiency. Blended learning systems can take many forms, such as flipped classrooms, hybrid courses, and mixed-mode learning, but all involve the integration of digital learning components with face-to-face instruction. AI technology can be used in blended learning systems to analyse student performance data and customize the learning experience, resulting in a better match for the individual student's strengths, weaknesses, and interests (Liu et al., 2021). AI can also help optimize instructional methods and increase efficiency by automating administrative tasks and improving content delivery. By using AI tools like ChatGPT to support sustainable blended learning, educators can help reduce environmental impact (e.g. reduce the use of papers, reduce Carbon Dioxide resulting from the need of physical meetings, etc.). Furthermore, they can improve educational effectiveness and accessibility, thus enabling students to acquire the knowledge and skills needed to build a sustainable future (Racine & Moore, 2020).

This study focuses on the case of ChatGPT and blended learning systems. It explores the potential of AI-powered tools to improve the sustainability and effectiveness of blended learning systems. By investigating the impact of AI technology within blended learning systems, the study aims to identify best practices and highlight recommended strategies for integrating AI to enhance the learning experience and improve the sustainability of education delivery. The study also contributes to the body of knowledge on the applications of AI for sustainable education and provides insights for policymakers and educators on the potential benefits of using AI within blended learning systems for sustainable education delivery. Finally, the study could help address the challenges of resource optimization, personalized learning, and educational accessibility and pave the way for a more sustainable learning future.

The study's objectives include the following: to investigate the potential of AI techniques in enhancing the sustainability of blended learning education, explore how ChatGPT can be used to personalize the learning experience and improve engagement, and finally to propose a sustainable blended learning model that incorporates AI. By achieving these objectives, this study can contribute to the development of sustainable blended learning systems that can adapt to changing circumstances, support the needs of all learners, and minimize their environmental impact.

This study focuses on the use of ChatGPT as an AI tool for a sustainable blended learning system. The study is significant for five reasons. First, it contributes to the growing body of knowledge on the applications of AI for sustainable education, and it offers insights into the potential benefits of using AI within blended learning systems. Second, the study aids in identifying best practices and strategies for integrating AI into blended learning systems and supporting the development of more sustainable and efficient methods of education delivery. Third, the study demonstrates how AI-powered tools can enhance personalized learning experiences, as well as tailor learning materials and delivery methods to match individual student needs. These aims support inclusive and equitable education. Fourth, we aim to explore the capabilities of AI technology in enhancing educational accessibility by automating administrative tasks and optimizing content delivery. Enhancing accessibility will make education widely available to people around the world regardless of location, socio-economic background, or other factors. Last, this study provides insights that could strengthen policymaking and educational decision-making, informing the development of policies, programmes, and funding that promote sustainable and accessible education delivery.

Overall, this study aims to promote the goal of sustainable education and support the development of more efficient, effective, and equitable education delivery methods. The methodology of this study consists of the following: First, we will review the literature on the use of AI in blended learning. Second, we will identify the gaps in current techniques and explore the potential of AI to address these gaps. Third, we will examine the effectiveness of ChatGPT in delivering personalized learning experiences in blended learning education. Fourth, we will evaluate the impact of AI on learning outcomes and engagement. Finally, we will provide recommendations for future research on the use of AI in blended learning education.

The remainder of the paper is organized as follows: Section 2 introduces background information on blended learning and ChatGPT. Section 3 analyses works related to the use of AI in blended learning. Section 4 discusses the research findings and introduces future research directions. The conclusion is presented in section 5.

2. Background

2.1 Blended Learning

Blended learning has become increasingly popular in recent years. While the benefits of blended learning are well-documented in terms of improving student achievement and engagement, there is also evidence to suggest that it can play a role in building sustainable communities. This is particularly relevant in the context of the 21st century, as communities face challenges related

to climate change, economic inequality, and social fragmentation. Sustainable development encompasses three dimensions: social, economic, and environmental. Blended learning can contribute to each of these dimensions by enhancing educational access, quality, and equity; improving learning outcomes and employability; and reducing the environmental impacts of educational activities (Ramalingam et al., 2022). Figure 1 presents the primary components of the blended learning educational system.

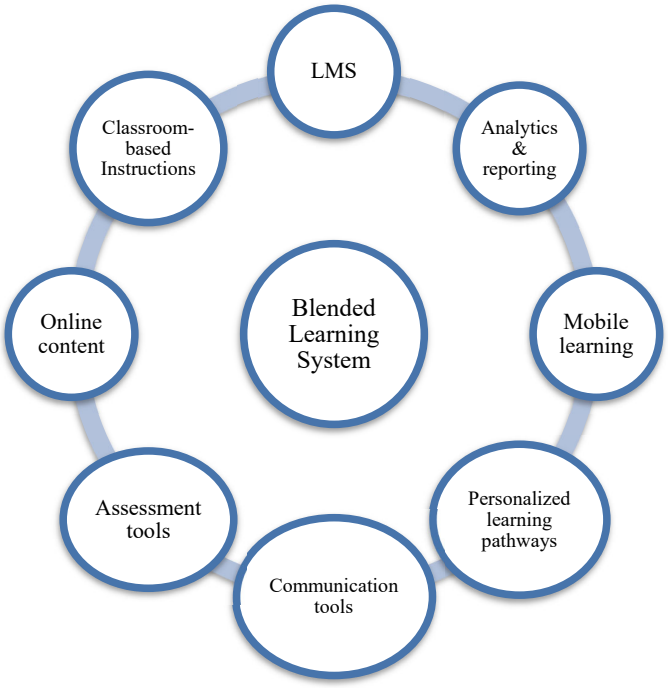

Fig. 1. Blended Learning System Components

The main components of a blended learning system typically include:

1. Learning Management System (LMS): This is a digital platform that helps teachers and instructors deliver online learning content. It can provide a variety of tools, such as course creation, student enrolment, progress tracking, and grading. Examples of LMS platforms include Moodle (Moodle 2023), Blackboard (Blackboard 2023), Google Classroom (Google Classroom 2023), and Canvas (Canvas Network 2023).
2. Classroom-based instruction: This refers to traditional face-to-face teaching, in which instructors provide direct instruction and guidance to students in a physical classroom setting. This component is important, as it allows for personal interaction between the teacher and the student. The necessary tools to enhance classroom instruction may include interactive whiteboards, projectors, and tablets.
3. Online content: This includes digital resources such as videos, interactive multimedia, and other web-based materials that complement classroom instruction. Online content can be accessed through an LMS or other web-based platforms, and it can be used for self-paced learning, review, or to supplement classroom instruction. Online content can be prepared locally and shared on the LMS with students, or an instructor can refer the students to external links available on YouTube or other sites.
4. Assessment and evaluation tools: These tools help instructors measure student progress, and they provide feedback to both students and instructors. Assessments can take the form of quizzes, exams, or other types of assignments, and they can be delivered through an LMS or other online platforms. In addition, the instructor can evaluate the students' professional and ethical skills through different tools, including Turnitin, Urkund (Ouriginal 2023), Unicheck (Unicheck 2023), and others.
5. Communication tools: Tools such as email, discussion forums, chat rooms, and other online platforms facilitate communication between students and instructors. These tools can be used for asking questions, sharing ideas, and providing feedback. Examples of well-known tools include Microsoft Teams (Microsoft Teams 2023) and Zoom.
6. Personalized learning pathways: Personalized learning pathways are customized plans designed to meet the specific learning needs of individual students. Teachers can use data from assessments, student feedback, and other sources to tailor learning pathways to the abilities and interests of individual students.
7. Mobile learning: Mobile learning enables students to access materials on their mobile devices, anytime and anywhere. This component is important for increasing accessibility and flexibility, allowing students to learn on the go.

8. Analytics and reporting: These tools provide insight into student performance, engagement, and progress, allowing instructors to make data-driven decisions. This component is important, as it provides valuable information that can be used to improve instruction and student outcomes.

Blended learning can contribute to building sustainable communities by increasing access to education (Caird & Roy, 2019). In many communities, particularly those in rural or low-income areas, traditional schools may be limited in their capacity to provide high-quality education. Blended learning, which allows students to access educational resources and interact with teachers and peers online, can help bridge this gap by providing access to a wider range of educational opportunities (Chen, 2022). Another way blended learning can contribute to building sustainable communities is by fostering collaboration and community-building among students. Using online tools and platforms, students can collaborate on projects and assignments regardless of their physical location. This can foster a sense of community and connection among students, which can enhance their academic and social outcomes.

Finally, blended learning can contribute to building sustainable communities by reducing education's environmental impact. By reducing the need for students to travel to physical classrooms, blended learning can help reduce carbon emissions and other environmental impacts associated with transportation. Additionally, by using online resources and digital tools, blended learning can help reduce paper waste and other forms of resource consumption associated with traditional classroom-based education.

2.2 ChatGPT

ChatGPT is a state-of-the-art NLP model developed by OpenAI. The model is capable of generating human-like responses to a wide range of text-based inputs (Hassani & Silva, 2022). ChatGPT has been trained on massive amounts of text data and can understand the context, tone, and intent of user input to provide accurate and helpful responses. ChatGPT is a chatbot designed to provide educational information and guidance to users. Chatbots are computer programs that simulate conversation with human beings through chat interfaces (Haleem et al., 2022). They can be used to provide a variety of services, including customer support, personal assistance, and educational support.

The main components of ChatGPT are the following: an NLP engine to understand and interpret user input, a knowledge base to provide relevant responses to users, ML algorithms to improve the accuracy and effectiveness of responses over time, and a user interface or chatbot platform for users to interact with it (Javaid, 2023). Fig. 2 presents the main components of ChatGPT.

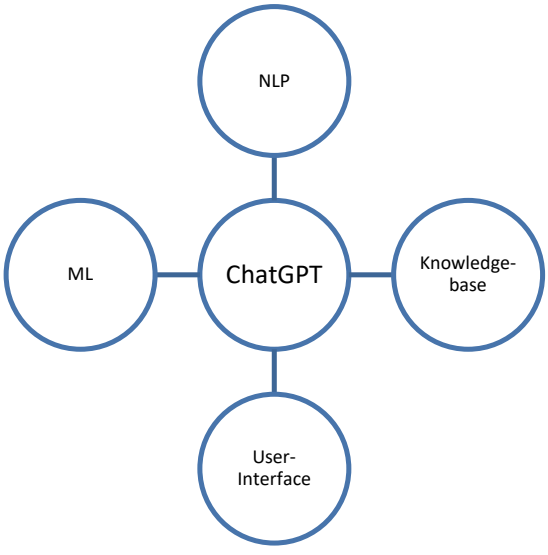

Figure 2. ChatGPT Components

ChatGPT demonstrates how chatbots can be used in the context of education. It uses NLP technology to understand and respond to user queries in a conversational manner. This technology allows ChatGPT to provide personalized and adaptive learning experiences to users, which can enhance educational effectiveness. ChatGPT can deliver a variety of educational services, such as answering questions, providing feedback on assignments, recommending learning resources, and even delivering lectures. It can be integrated with LMS or other educational platforms, making it accessible to a wide range of users. One of the main advantages of using chatbots like ChatGPT in education is that they can provide instant feedback and support to users. This can help to improve engagement, motivation, and retention rates among learners. Chatbots can also be

programmed to adapt to individual learning styles and preferences, which can further enhance their educational effectiveness. Overall, ChatGPT is an example of how technology can be used to enhance the educational experience.

3. Literature Review

In November 2022, Open AI released ChatGPT. This chatbot, which is based on OpenAI's language model, allows users to talk to AI by entering instructions. ChatGPT is useful for creating stories, poems, music, essays, and more, but it has limitations. The bot answers inquiries with relevant, persuasive responses. Most administrators recommend using the tools in task teams and institution-wide sessions. Low teacher–student ratios in higher education might make it difficult for educators to provide students with rapid and direct aid. Chatbots utilized in customer service, productivity, and healthcare may assist educators in addressing student demands.

Research presented in (Ciolacu & Svasta, 2021) explains the fourth industrial revolution-driven paradigm shift in education (Education 4.0's) teaching approach, which incorporates multimodal learning analytics, technology, health, AI, and education. AI technologies such as adaptivity, user modelling, ML, chatbots, and semantic text recognition are used in smart blended learning for Education 4.0. These technologies are used to improve learning and reduce the number of students who fail tests. Students' subjective perceptions of their well-being, emotional state, anxiety, and health may be improved via the use of multimodal data collected through online courses and wearables. Twelve separate experiments were conducted, each using real-time data from wearables. Each experiment consisted of a learning scenario, control questions, four different learning resources, and three levels of difficulty.

The pros, cons, efficacy, and ethics of employing chatbots in business education are examined in (Chen et al., 2023). In this two-study experiment, the authors used a chatbot to interview 215 undergraduate students about the pros and cons of utilizing chatbots as intelligent assistants for students. The results demonstrate how chatbots might assist young people in learning fundamental topics in a responsive, engaging, and confidential manner. The second experiment suggests that chatbots may teach fundamental concepts and provide educational materials in a conversational manner. The experiments reveal that many students view chatbots as intelligent helpers and have positive perceptions of chatbots' interactive, reactive, and conversational approach.

The utilization of ChatGPT is also discussed in (Cooper, 2023). The study focuses on examining how ChatGPT handles scientific questions and how science teachers can use ChatGPT. ChatGPT risks becoming the ultimate epistemic authority and making assumptions without sufficient evidence or qualifications. AI's environmental impact, content regulation, and potential for copyright infringement may pose ethical problems. Educators must model ChatGPT usage, prioritize critical thinking, and establish expectations. ChatGPT may help teachers create scientific lessons, rubrics, and quizzes. However, teachers should analyze and adapt AI-generated resources to their instructional environments.

AI may enhance learning and facilitate new education methods like blended teaching (Zhao & Yang, 2021). Accordingly, the author of this study recommends using AI technology to apply blended teaching to English reading courses to improve teaching and learning for instructors and students. In conclusion, blended teaching may be used to improve English reading courses via pre-class preparation, in-class instruction, post-class review, and evaluation. Reading course pedagogy was improved through the integration of instructional resources, task-releasing, pre-class check-in, learning and engagement in the classroom, after-class review, practice tests, reflection, and evaluation.

The authors in (Dwivedi et al., 2023) discuss the debate about whether ChatGPT usage should be prohibited or regulated. The paper uses these contributions as a starting point to identify three categories of concern that must be investigated further: teaching, learning, and scholarly work; openness, information, and morality; and the digital transformation of organizations and societies.

In (Kasneci et al., 2023), the researchers discuss the pros and cons of utilizing big language models in education from the viewpoints of students and teachers. The writers briefly explore big language models' present status and applications. AI in education faces other issues, such as output bias, human monitoring, and abuse. They suggest ways to overcome these obstacles and utilize such models ethically in teaching. In spite of the many issues, the dangers that have been highlighted are controllable and must be addressed in order to provide reliable and equal access to big language models for educational purposes. This study's mitigating techniques may help in achieving this.

A SWOT analysis is utilized in (Farrokhnia et al. 2023) to describe the strengths, weaknesses, educational possibilities, and threats of ChatGPT. The authors provide an overview of the educational practice and research throughout the ChatGPT inception. Further empirical study is needed because ChatGPT is still in its infancy, especially since research has already identified some positive and negative impacts on education. The findings of a SWOT analysis might point researchers in a variety of directions. First, ChatGPT can help educators personalize learning. Second, ChatGPT can provide credible, real-time feedback, according to the research. Third, ChatGPT has demonstrated the ability to enhance learning about complicated topics (Susnjak, 2022). Future research might discover beneficial instructional designs for this new AI tool that support complex learning in higher education. Fourth, because the quality of ChatGPT-generated essays depends on users' prompts and limits,

it is advised that appropriate guidelines and suggestions should be supplied on how to formulate such questions to develop essays that are suitable for a range of circumstances.

Since the COVID-19 outbreak, integrating technology into education has received increased attention. In order to determine its potential influence on learning and assessment, researchers investigated ChatGPT's functionality in responding to chemical assessment questions. A pharmaceutical science programme's first and second years of two chemistry-focused modules were utilized to research and appraise ChatGPT-generated answers in connection with end-of-year assessments (Fergus et al., 2023). ChatGPT produced answers to queries using "describe" and "discuss" verbs that targeted knowledge and comprehension. Where available, the ChatGPT-generated answers to the chemical assessment questions were well written. This investigation's replies ranged in quality, and ChatGPT exhibited difficulties with applicability and interpretive queries and non-text data. ChatGPT struggles to handle the application and interpretation of information that requires intricate analysis.

Chong (2021) studied a university English major during a 19-week teaching experiment that utlized an AI-powered blended education technique for English writing. The goal of the experiment was to improve the student's writing in English. The benefits enhanced the conventional English writing education method and built a combined AI method. The study's findings demonstrate how rapidly a student's English writing proficiency may be increased through a combined teaching approach based on AI. This approach can successfully aid students in honing their English writing abilities and pique their interest in the subject. This example demonstrates how the education model may be realized and utilized in regular classroom instruction in the future. Further in-depth discussion of this teaching model's value should continue in future studies.

An investigation and analysis of ChatGPT's operation and its effects on many academic disciplines is conducted in (Kalla and Smith, 2023). The study investigates ChatGPT's capabilities, as well as its pros, cons, and potential limitations. The study discusses the implications of ChatGPT for education, software development, information technology, employment, and customer service, in addition to the potential benefits it might have for researchers and academics in the future. Although ChatGPT has several drawbacks, such as the possibility of prejudice, a lack of emotional intelligence, and a small knowledge base, these may be minimized with proper training, data selection and further programming. The study concludes that ChatGPT has had a substantial influence on a variety of industries, including academia, cybersecurity, customer service, and software development. It has enormous potential to increase output, effectiveness, and user enjoyment, and researchers are just now beginning to examine its prospective uses.

Another discussion explores the potential effects of generative artificial intelligence (GAI) text-based systems on the chemical community (Emenike & Emenike, 2023). Concerns about academic integrity and the evaluation of students at all levels of education have arisen with the recent release of ChatGPT. GAI systems may support students, professors, and administrators in educating, teaching, research, and engaging in professional activities, including those outside the field of chemistry. The authors discuss the implications of GAI system utilization by students and teachers, including its possible advantages and hazards and concerns regarding fairness and accessibility. The author concludes that GAI text has several uses beyond learning. Teachers, mentors, researchers, and professionals may employ AI-generated text. There is no question of whether the chemical community will embrace text-based GAI technology into its activities—rather, the challenge lies in how it is implemented. Many issues will arise when ChatGPT and comparable technologies become mainstream.

In (Tlili et al., 2023), the authors make use of a qualitative instrumental case study to investigate ChatGPT in the educational setting among early adopters. The study was carried out in three stages, and the first stage reveals that the public debate taking place in social media is generally positive, and that there is enthusiasm around the deployment of this technology in educational settings. The case of ChatGPT is investigated via the perspectives of response quality, educational change, personality and emotion, utility, and ethics. This evaluation revealed several issues, some of which were cheating, the honesty and validity of ChatGPT, deceptive privacy, and manipulation. The outcomes of this study point to a number of different research avenues that need to be investigated in order to allow a secure and accountable deployment of chatbots, particularly ChatGPT, in educational settings. The results showed that ChatGPT is a strong educational tool, but it should be utilized more carefully and accompanied with safety recommendations.

The purpose of the study presented in (Essel et al., 2022) is to examine the significance of a chatbot that immediately responds to a student's question. In order to gather data, an academic achievement test and focus groups were employed. This made it possible to conduct an in-depth analysis of the students' interactions with the chatbot. The research outcomes revealed that the academic performance of those students who engaged with the chatbot was much higher than that of students who engaged with the course teacher. The outcomes of the study support earlier findings that demonstrated how chatbot usage increases learner success and self-efficacy. Educational technology centres directed by subject matter specialists should be established at universities to assist educators with the integration of teaching assistant chatbots to foster student engagement (Essel et al., 2022). In order to provide accurate results, educators with low levels of digital literacy must receive the necessary training and mentorship.

Researchers can produce articles that are systematic, cohesive, and (partially) correct with the help of ChatGPT, as shown by the findings of one study (Zhai, 2023). The author relied on work knowledge to a small extent when writing the essay, which was finished in two to three hours. Based on this user experience, the writers explore the possible consequences of ChatGPT,

as well as related AI technologies, on education. The report suggests modifying learning objectives, with an emphasis on enhancing students' creative and critical thinking rather than focusing on broad skill development. Students should be able to employ AI tools to carry out subject-domain activities. Numerous options exist for AI to promote innovation and advancement in education. AI can change the way people think about schooling and how it is delivered by providing students with tailored and engaging learning experiences, thus increasing the effectiveness of teaching and learning and boosting research and development in the field of education.

Another paper (Baidoo-Anu & Ansah, 2023) synthesizes previous studies to suggest some possible advantages of ChatGPT in fostering teaching and learning. ChatGPT has numerous benefits, some of which include encouraging individualized and interactive learning and creating proposals for formative assessment activities that offer continual feedback. The research provides recommendations for making improvements to classroom instruction by adopting ChatGPT. Students will be better prepared to succeed in an AI-dominated workplace after graduation if they are exposed to generative AI tools in the classroom and instructed on how to use them in a responsible and productive manner. Given the rise of AI in workplaces and other settings, this trend will continue. Consequently, instructors may employ ChatGPT and other technologies based on generative AI models to aid in educating their students.

In (Mhlanga, 2023), the researcher aims to provide a comprehensive examination of the acceptable and ethical use of ChatGPT in education and stimulate further research and debate on this vital issue. The research demonstrates that respect for privacy, transparency in the use of ChatGPT, fairness and non-discrimination, and several other factors are required for the implementation of ChatGPT in educational settings. The study recommends that each of the principles be adhered to in order to preserve ethics and accountability in the field of global education. The rapid pace of technological development and the increasing level of global interconnection have significantly impacted society, the economy, and the environment.

Research published in (Lin, 2023) highlights ChatGPT's five primary features, which include its analytical strength, feedback reaction, adaptive instruction, contextual talking, and multilingual capabilities. This discussion of ChatGPT in education ends with a look at issues that may emerge as a result of its implementation, but the overall tone of the study is one of cautious optimism about ChatGPT's potential. The integration and utilization of ChatGPT in Moodle provide several promising opportunities for enhancing teaching and learning activities. ChatGPT may serve as a virtual tutor, provide tailored and flexible feedback to students, and it may also promote learning outside of the traditional classroom setting. ChatGPT has much to offer in terms of prospective advantages, despite some implementation difficulties. With the advancement and evolution of AI technologies, it is expected that they will become increasingly prevalent in education. ChatGPT represents a significant step in this process.

In conclusion, the release of ChatGPT has engendered significant discussions and research on its potential impact on education. While ChatGPT has proven to be a valuable tool for generating content and assisting students, it also poses some limitations and ethical concerns. The studies mentioned here highlight the benefits of using chatbots like ChatGPT, which include personalizing learning, improving student engagement, and providing real-time feedback. However, they also address the need for cautious implementation, critical thinking, and teacher guidance to mitigate potential risks. As AI technology continues to evolve, it is crucial to explore further research avenues and ensure responsible usage of tools like ChatGPT in educational settings. Table 1 presents a summary of existing studies related to the utilization of ChatGPT in education.

Table 1
Summary of research on ChatGPT in education

Reference	Topic of Discussion	Findings
(Ciolacu & Svasta, 2021)	• Introduces Education 4.0 teaching approach, which incorporates ideas from a variety of fields, including electronic technology, health, multimodal learning metrics, and AI. • Presents novel concepts, techniques, and a model of an adaptable educational system.	• Educator should assist students in becoming qualified and trained for Industry 4.0. • Students should be encouraged to improve their performance and pass the test by using AI and ML techniques. • Students should increase self-assurance in their ability to utilize new technology. • A multimodal learning analytics approach, including data from wearables and sensors, is introduced to evaluate the quality of learning and the behaviour of many students. • Learning outcomes can be improved with Education 4.0's smart blended learning process that incorporates AI techniques into each phase, including user modelling, the ability to adapt, ML, virtual assistants, and tools for semantic text recognition.
(Chen et al., 2023)	• A survey of non-technical students is conducted to examine the students' opinions on chatbots. • Identifies the advantages and drawbacks that students perceive in their use of chatbots in learning.	• Findings indicate that the resources must be closely related to the integrated quiz questions in order to guide students to other resources. • It is possible that students lack the knowledge and experience necessary to anticipate how chatbots might supplement conventional educational approaches or to comprehend their difficulties, risks, and limitations.

Table 1
Summary of research on ChatGPT in education (Continued)

Reference	Topic of Discussion	Findings
(Cooper, 2023)	• Records user experiences using ChatGPT and considers the potential ramifications. • The output of ChatGPT related to science education is critically examined and contrasted with significant topics from the study. • Explains how educators use ChatGPT to generate ideas. • Utilizes ChatGPT as a research instrument to examine the study's capabilities.	• The study serves as initial exploratory research for a larger debate. Further studies are needed to cover several aspects in different regions and include more samples of various populations.
(Dwivedi et al., 2023)	• Examine the debate about whether ChatGPT usage should be prohibited or regulated. • Identify concerns that must be investigated further in three categories: teaching, learning, and scholarly work; openness, information, and morality; and digital transformation of organizations and societies.	• The study clarifies the potential, difficulties, and effects that generative AI technologies like ChatGPT can have on society, business, and education. • Identifies the most crucial problems that must be addressed regarding generative AI technologies like ChatGPT in the context of society, commerce, and education.
(Kasneci et al., 2023)	• This article presents, from the viewpoints of both students and teachers, the possible advantages and problems that might result from educational uses of big language models. • Provides a succinct overview of the present status of big language models and the applications that they are used for. • Demonstrates how these models may be utilized to promote student engagement and interaction and to customize learning experiences for each student.	• Incorporating big language models into educational settings requires adherence to stringent privacy and security standards, as well as sustainable scaling, environmental, legal, and ethical criteria. • This process must be carried out in combination with continual human supervision and direction, as well as critical thinking.
(Farrokhnia et al. 2023)	• Discusses ChatGPT's prospects for and its dangers to education while outlining its strengths and shortcomings using the SWOT analysis paradigm.	• ChatGPT underwent a SWOT analysis, which demonstrated that although it has many potential uses in the field of education, it also has several drawbacks. • The advantages include leveraging an advanced natural language framework to provide believable replies, a self-improving capacity, and offering customized and immediate solutions. • Empirical investigations using quantitative methods, like the best–worst technique, are required. • The weights and relevance of the opportunities and vulnerabilities may be determined by conducting in-depth discussions with relevant specialists.
(Fergus et al., 2023)	• The study focuses on how educators can use assessment design to effectively challenge students and their level of study by highlighting the importance of assessment design. • Studies and evaluates ChatGPT-generated replies in connection to the end-of-year evaluations throughout the first two years of a pharmaceutical science programme.	• It was feasible for ChatGPT to create responses to some of the chemistry assessment questions; however, this functionality was not available for all the chemistry questions. • The replies were stated in a satisfactory manner. • There were several questions that could not be answered since they included a graphical representation of a chemical structure. • It is necessary to research the functionality of ChatGPT for answering chemistry test questions in order to determine the possible influence that this functionality may have on learning and evaluation.
(Chong, 2021)	• The significance of AI-based chatbots is investigated in the context of English writing.	• 75% of students selected the English writing mixed teaching model as their preferred instructional approach. • 89% of the students felt that the instructional model may be used in day-to-day classroom instruction. • 75% of the students said that they had increased their level of engagement in the class. • The vast majority of students expressed a favourable opinion of the blended teaching model of artificially intelligent English writing. • A mixed teaching model for English writing based on AI can rapidly improve pupils' English writing levels by effectively assisting them in improving their skills and increasing their involvement in English writing. • This instructional paradigm may not be flawless, and there are certainly concerns that need specific attention.
(Kalla & Smith, 2023)	• Investigates ChatGPT's operations and its influence on a variety of academic disciplines. • The benefits and drawbacks of ChatGPT, as well as its capabilities and restrictions, are dissected.	• ChatGPT has revolutionized how humans communicate using technology. • Scalability and application support of ChatGPT are both necessary as well.
(Emenike & Emenike, 2023)	• Introduces issues with academic integrity that emerge when utilizing ChatGPT in the classroom.	• The study does not disclose the bias in the responses produced by AI techniques.

Table 1
Summary of research on ChatGPT in education (Continued)

Reference	Topic of Discussion	Findings
(Tlili et al., 2023)	• The research employs ChatGPT as an example of a sophisticated chatbot used by early adopters in order to explore chatbots in education. • Explains the many issues that should be taken into account while creating chatbots, including a focus on how human relationships grow.	• The study emphasizes the necessity for a new educational philosophy to accommodate the new chatbot-based education reform. • From a practical standpoint, the topic of 'upskilling' underscores the necessity of building curriculum to improve educators' and students' abilities to accommodate the present and future progress of chatbots.
(Essel et al., 2022)	• Discussion on the impact of a virtual teaching assistant (chatbot) that provides an automated response to a student's query. • A zero-coding strategy is examined, which supplies vital information on the use of virtual teaching assistants and the creation of these assistants.	• It is not apparent whether a chatbot can promote learning by primarily responding to technical inquiries or whether it can assist learners in better understanding the conceptual material. • It was possible to compare the academic achievement of students who had the greatest interaction with the chatbot to that of students who had the least interaction with the chatbot. • Further research must be conducted to determine the chatbot's long-term impact on students' levels of interest and motivation.
(Zhai, 2023)	• This investigation focuses on ChatGPT, an effective instrument for working alongside humans.	• The research investigated ChatGPT's inventiveness in order to understand the role it plays in educational reform.
(Baidoo-Anu and Ansah, 2023)	• Analyzes previous studies to provide a summary of the possible advantages that ChatGPT may bring to the process of advancing education. • The study focuses on different areas, including educator training on AI technologies, using generative AI tools in teacher education programmes, and the role of AI tools in reducing or widening the digital gap.	• ChatGPT promotes customized and interactive learning and generates prompts for formative assessment activities that provide continuous feedback to enhance teaching and learning. • Policymakers, academics, educators, and technology experts should discuss how these growing generative AI technologies may be utilized securely and constructively to enhance education and promote children's learning. • ChatGPT might generate incorrect information. There may be biases in data training that exacerbate already-present biases, as well as privacy concerns.
(Mhlanga, 2023)	• The use of ChatGPT in educational settings is presented and discussed.	• Encourages further research and discussion on this vital topic. • Provides a comprehensive examination of the appropriate and ethical use of ChatGPT in educational settings.
(Lin, 2023)	• Discusses difficulties that could emerge as a result of using ChatGPT in the classroom.	• The author emphasizes five crucial features of ChatGPT that are likely to impress users. These features include contextual chatting, feedback responsiveness, analytical power, adaptive teaching, and multilingual capabilities. • The author maintains an upbeat and positive outlook towards ChatGPT's potential to improve educational practices going forward.

4. Discussion and Future Research Directions

The release of ChatGPT by Open AI in November 2022 sparked significant discussion and research on its potential impact in the field of education. In higher education, where low teacher–student ratios can make it challenging to provide rapid and direct assistance to students, chatbots like ChatGPT have the potential to address student demands.

ChatGPT has demonstrated promise in education, particularly in addressing student demands, providing personalized assistance, and enhancing learning experiences. However, the ethical implications, limitations, and appropriate usage of ChatGPT and similar AI technologies must be carefully considered. Further research and collaboration between educators, administrators, and AI developers will be necessary to fully explore its potential and establish guidelines that promote effective and responsible use in educational settings.

The findings discussed in this paper have significant implications for blended learning. Blended learning, which combines face-to-face instruction with online resources and activities, has become increasingly popular in educational settings. The integration of AI-based chatbots like ChatGPT can further enhance the effectiveness of blended learning models. Here are some implications:

- Personalized assistance: The use of AI chatbots in blended learning allows for personalized assistance to students. ChatGPT can provide responsive and engaging interactions, offering individualized support based on students' specific needs. This personalized approach can help students navigate complex concepts and improve their learning outcomes.
- Enhanced engagement and learning outcomes: Integrating AI technologies into blended learning can enhance student engagement and learning outcomes. ChatGPT's interactive and conversational capabilities render the learning experience more interactive and enjoyable, increasing students' motivation to participate actively in their learning process. This engagement could lead to improved learning outcomes and a deeper understanding of the subject matter.
- Access to educational resources: AI chatbots can serve as valuable resources in blended learning environments by providing access to a wide range of educational materials. ChatGPT can assist in creating lessons, quizzes, and rubrics, saving teachers time and effort in curriculum development. Additionally, the AI-generated resources can be

adapted to suit the instructional needs and preferences of the students, making the learning experience more flexible and inclusive.

- Teacher–student ratio: In higher education, where large class sizes can make it challenging for teachers to provide individual attention to students, AI chatbots can address the demand for personalized support. ChatGPT can offer real-time responses and assistance to students, reducing the pressure on educators and enhancing the learning experience in a resource-constrained environment.
- Empirical research and guidelines: The findings underscore the need for further empirical research and the development of guidelines for the integration of AI chatbots in blended learning. More research is needed to understand the full potential of ChatGPT, identify its limitations, and address ethical concerns. Collaboration between educators, administrators, and AI developers is crucial to establishing guidelines that promote the effective and responsible use of AI-based chatbots in educational settings.

Overall, the implications of the findings highlight the potential of AI chatbots for enhancing blended learning education. However, careful consideration must be given to ethical issues, proper usage, and the role of teachers in facilitating critical thinking and guiding students' learning journeys. Here are some recommendations for future research on the topic of integrating AI chatbots in blended learning:

- Long-term impact on learning outcomes: Extensive studies are needed to examine the long-term impact of AI chatbots on student learning outcomes. It is necessary to explore whether the initial benefits observed in short-term studies are sustained over time and how they influence students' academic performance and retention rates.
- Learning analytics: Researchers should explore the use of learning analytics in conjunction with AI chatbots to gain insights into students' learning patterns, preferences, and areas of improvement. Additionally, it is necessary to investigate how data collected from AI chatbot interactions can be used to inform personalized instruction and adaptive learning approaches.
- Student motivation: More studies should measure students' perceptions of and attitudes towards AI chatbots in blended learning. Further investigation into how students perceive the chatbot's role, their motivation levels, and the impact on their self-efficacy and engagement is needed. Understanding student perspectives can help shape the design and implementation of AI chatbots in ways that align with student needs and preferences.
- Ethical considerations and bias: Further analysis of the ethical issues associated with AI chatbots in blended learning is needed. Studies should investigate potential biases in AI-generated content, ensuring that the chatbot's recommendations are appropriate for diverse student populations.
- Training and support: Researchers should identify the skills and competencies required for instructors to integrate AI chatbots into their practices. Professional development programmes should be designed to provide educators with the necessary knowledge and guidance to leverage AI chatbots in their teaching.
- Accessibility to all students: More studies are needed to investigate the potential of AI chatbots in supporting students with disabilities or diverse learning needs. It is necessary to ensure that the chatbot's interfaces and responses are accessible to all students.
- Comparative studies: Future studies should compare the effectiveness of different AI chatbot models. It is necessary to compare the outcomes of different chatbot interventions to identify best practices and areas for improvement in their design and implementation in blended learning.
- Cross-disciplinary applications: Further research on the application of AI chatbots in various disciplines and educational levels should be considered. Researchers should further investigate how AI chatbots can be tailored to specific subjects, such as mathematics, science, or language learning, and their effectiveness should be examined across different educational contexts and age groups.

Overall, ChatGPT offers a valuable tool for blended learning by providing personalized support, feedback, and motivation to students. By addressing these areas of research, it will be possible to better understand the integration of AI chatbots in blended learning and uncover new insights that can inform the design, implementation, and ethical use of AI technologies in educational settings.

5. Conclusion

This research studied the utilization of ChatGPT in a blended learning system. The current research presented in this study indicates that the integration of ChatGPT in blended learning has promise for promoting student engagement, motivation, and self-directed learning by providing immediate feedback and assistance.

The significance of this study lies in its exploration of the potential benefits and challenges associated with integrating AI chatbots into blended learning. By providing insights into how AI chatbots can enhance student learning experiences, the study offers valuable guidance for educators, policymakers, and instructional designers seeking to leverage technology effectively in education. Furthermore, ChatGPT's knowledge base enables it to draw upon a wide range of educational resources and adapt to diverse learning needs.

ChatGPT can provide personalized and contextually relevant responses to students' inquiries, offering support akin to that of an AI chatbot. Its ability to understand and generate human-like text makes it a valuable tool for enhancing student engagement, promoting critical thinking, and providing on-demand assistance in blended learning environments.

In conclusion, several future research directions should be considered to enhance the integration of ChatGPT in blended learning. The primary goal of these aims is to maximize the benefits that the learners and educators derive from the integration. Current studies indicate that the learning process can be improved in the following ways: achieving learning outcomes, enhancing student engagement, improving instructor performance, and delivering personalized learning experiences for students across the globe.

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