Proceedings of the 2023 International Conference on Machine Learning and Automation
DOI: 10.54254/2755-2721/35/20230377

# A comprehensive investigation for ChatGPT's applications in education

**Yifei Bao**

Department of Artificial Intelligence, Nanjing Normal University, Nanjing, 210023, China

19200439@njnu.edu.cn

**Abstract.** With the surge in popularity of Chat Generative Pre-trained Transformer (ChatGPT), an artificial intelligence technology, on a global scale, numerous industries have started to take notice of its potential applications in their specific sectors, including the field of education. This document presents a thorough examination of how ChatGPT is being used in the realm of education. The following piece outlines the approaches to integrating ChatGPT into education, viewed from three angles: Educational Assessment, Exercise Generation, and Personalized Learning. It also provides comprehensive guidelines aimed at both teachers and students. Utilizing ChatGPT in education allows for personalized one-on-one assistance to students, addressing challenges posed by uneven distribution of educational resources and individual differences among students. Current research on applying ChatGPT in education mostly revolves around designing prompts to elicit specific responses or using generated content for evaluating its subject-specific capabilities. Given that ChatGPT is a more versatile form of artificial intelligence not limited to any particular domain, the article suggests that future research should focus more on integrating ChatGPT into existing educational systems, ensuring its consistent performance in specific tasks. Furthermore, considering ChatGPT's possibility of generating imprecise information, it is necessary to explore how to fine-tune ChatGPT using specialized databases, enabling it to generate reliable content in professional subject areas.

**Keywords:** ChatGPT, artificial intelligence, education, educational technology.

## 1. Introduction

In recent decades, the swift progress of Artificial Intelligence (AI) technologies has seamlessly blended with and reshaped multiple facets of the world. AI technologies such as facial recognition, autonomous driving, voice recognition, and machine translation have already become integral to people's daily lives. In this context, Natural Language Processing (NLP) is a particularly noteworthy domain within AI dealing with text, with primary tasks including semantic analysis, machine translation, text generation, etc. On November 30, 2022, OpenAI, a U.S.-based AI research institute, unveiled the Chat Generative Pre-Trained Transformer (ChatGPT), an AI conversational agent grounded in the Large Language Model (LLM) framework. ChatGPT demonstrates a profound aptitude in comprehending natural language commands posed by users. Owing to its massive amounts of text data for training and the breadth of its coverage, ChatGPT is capable of providing near-expert responses across multiple domains and tasks. Within the first week of its release, ChatGPT gained

DOI: 10.54254/2755-2721/35/20230377

over one million users. The global popularity and surge in usage of ChatGPT highlight the demand for such artificial intelligence technologies. People utilize ChatGPT to assist them in problem-solving, composing poetry, revising writing, and translating literature. One of the most distinctive features of ChatGPT compared to other AI technologies is its capability to understand one's thoughts through dialogue and generate human-level content in return.

With the rapid proliferation of computer science, technology has seamlessly woven itself into the fabric of daily living for many people. In the realm of education, a myriad of online courses and electronic classrooms, such as MOOC, Coursera etc. have emerged on the internet, providing educational resources to students worldwide. In recent years, the swift advancements in AI have shown its potential in the educational sector and its capacity to address the shortcomings of conventional teaching methods. One challenge traditional education faces is the disparity among students when it comes to grasping and understanding a particular subject [1]. This vast difference in comprehension levels can dilute the quality and efficacy of teaching. However, AI, through personalized learning, can address this issue by tailoring educational plans to fit the unique knowledge levels of individual students [1]. AI also offers a learning method called role-play that can motivate students to act as intelligent tutor's companion and inspire them to ponder on problems [2]. By assuming varied roles, students work harder while being taught by intelligent agents than studying by themselves [2].

ChatGPT possesses the capability to be applied in the educational sector. Based on the Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis of ChatGPT, it has the following four distinct strengths: Generating plausible replies, Continuous self-enhancement, Offering tailored responses, and Delivering instant feedback [3]. These strengths of ChatGPT suggest it has significant potential advantages in the educational domain. Its prowess lies in crafting plausible responses pertinent to queries, enabling it to furnish feedback aligning with a student's learning needs and uncertainties. More crucially, through sustained interaction and user feedback, ChatGPT exhibits a self-improving capability, continuously refining its responses to better conform to diverse learning styles and needs. While seasoned teachers possess a profound knowledge base, their expertise may be limited by their specialization or experience. ChatGPT, built upon vast amounts of data and literature, can proffer interdisciplinary knowledge and comprehensive answers. Current research indicates that implementing ChatGPT in various educational fields can effectively aid students in acquiring knowledge, though it also brings some challenges. The prevailing conclusions about the benefits of using ChatGPT in education primarily revolve around its ability to communicate with students. This teacher-student-based interactive learning model can efficiently provide ideas and guidance for students [3]. Another advantage of applying ChatGPT in education is its ability to tailor teaching strategies according to the different learning styles of students [4]. Furthermore, it can enhance student engagement, thereby enriching their learning outcomes [4]. Given that ChatGPT is a comprehensive language model trained with extensive datasets, it possesses the capability to integrate intricate concepts from multiple disciplines and holds an exhaustive grasp of terms across diverse areas [5]. Hence, when students encounter unfamiliar technical terms, ChatGPT can explain them in a more understandable way to aid comprehension. Overall, ChatGPT's adaptability and scalability can be harnessed to create interactive study materials, assist in homework, and even offer supplementary lessons on complex subjects. Given that ChatGPT is a rapidly emerging technology and research on its application in the educational field is scattered and diverse, it is essential to provide a structured and comprehensive review to guide new studies in this domain.

In the following sections, this paper summarizes the applications of ChatGPT in the educational field from three aspects: Educational Assessment, Exercise Generation, and Personalized Learning. Based on current research on the application of ChatGPT in this field, a summary of the prevailing research methods has been provided, along with the proposal of potential directions for future investigation. An overall summary and future work is provided in the last section.

DOI: 10.54254/2755-2721/35/20230377

## 2. Methods

### *2.1. ChatGPT*

A year prior to ChatGPT was released, OpenAI introduced InstructGPT, a model that operates by generating responses based on a single user request [6]. ChatGPT, developed using Reinforcement Learning from Human Feedback (RLHF), utilizing techniques akin to InstructGPT, facilitates enhanced interactive dialogues and maintains awareness of prior context [7]. Built upon the generative pretraining model GPT-3, ChatGPT utilizes the Transformer architecture, incorporating techniques such as multi-head self-attention, residual connections, and layer normalization [8]. The strength of the Transformer architecture is its capacity to manage sequences of varying lengths, which is apt for the domain of natural language processing. Unsupervised pre-training techniques are a key technology for training the model GPT-3 which can automatically learn the rules and features of the language from a vast amount of unlabeled text data, thereby enhancing the model's generalization and expressiveness [9]. After the training, the raw language model still needs supervised fine-tuning where desired output is demonstrated by the labeler to help generate dialogues [7]. To enhance the model's dialogue capabilities and the reliability of its output, labelers rank multiple outputs generated from the same prompt to train a reward model, and then optimize the model through RLHF [7]. The resulting model is ChatGPT, characterized by a robust capability for semantic understanding and interactive dialogue, coupled with a multidisciplinary knowledge base and the ability to summarize and analyze.

### *2.2. Educational assessment*

The ability of ChatGPT to understand, generate, and evaluate textual content makes it an apt candidate for tasks related to educational assessment, assisting teachers in various grading tasks and improving teaching quality [10].

#### *2.2.1. Intelligent interpretation of grading rubrics*

Teachers can interact with ChatGPT to better understand the nuances and applications of specific grading criteria. For instance, for a particular writing assignment, a teacher could ask about how to evaluate "clarity of argumentation".

During the grading process, if teachers are uncertain about how to grade a particular answer, they can immediately consult the model for guidance on grading standards because ChatGPT can offer a rudimentary grading system [11].

#### *2.2.2. Preliminary evaluation of subjective answers*

For open-ended student responses, ChatGPT can offer an initial evaluation, pointing out potential grammatical mistakes, content gaps, and suggesting modifications for the teacher [12]. The model can suggest a preliminary score for each answer, allowing teachers to fine-tune, ensuring fairness and consistency in grading, decreasing teaching workload [3,13].

#### *2.2.3. Efficiency enhancements in grading*

The model can automatically categorize and sort student answers based on a teacher's requirements, helping them quickly identify answers that need a detailed evaluation [14].

#### *2.2.4. Personalized feedback generation*

As an automatic evaluation tool, ChatGPT can analyze students' homework, questions, answers and produce tailored feedback, helping students grasp their mistakes and provide suggestions for improvement [10,13]. When a student faces difficulty with a specific topic, the model assists educators in pinpointing the areas of confusion and producing pertinent examples or clarifications to enhance their comprehension [14,15].

DOI: 10.54254/2755-2721/35/20230377

### *2.3. Exercise generation*

#### *2.3.1. Generating exercises based on reference content*

ChatGPT can also extract essential information and main points from the provided reference materials, forming a foundation for exercise question generation. Based on the source material, different kinds of practice questions can be formulated, including true/false, multiple-choice and fill-in-the-gap. For instance, reading exercises suitable for students' knowledge level and corresponding answers can be generated for given passages [16]. There are several aspects to determine the high quality of the exercise based on reference content generated by ChatGPT [16]: 1) The generated exercise aligns contextually and semantically with the original reference content to avoid misleading students. 2) The generated content does not appear to be generated by a non-human. 3) The generated exercise matches the knowledge level of the students.

#### *2.3.2. Generating tasks solely based on instructions*

Educators can leverage ChatGPT to craft hands-on problem-solving exercises for learners [14]. For instance, ChatGPT-created case scenarios can assist medical students in honing their clinical reasoning abilities [17]. Also, ChatGPT can be utilized to generate questions in specific exams like GRE as an aid for students preparing tests [11].

### *2.4. Personalized learning*

Personalized Learning refers to customizing learning and instructions based on individual needs and goals [18,19]. Personalized learning is a significant trend in contemporary education, and ChatGPT, along with other chatbots, holds immense potential in driving this trend forward. By offering real-time support, tailored feedback, and study plans, ChatGPT can aid students in achieving a more individualized and efficient learning experience, which is difficult for teachers to accomplish for individual students [1,17,20]. Leveraging ChatGPT's capabilities, students from diverse cultural backgrounds worldwide can access a wealth of educational resources through the internet and obtain remote and personalized learning tailored by ChatGPT [10].

#### *2.4.1. Recommendation of learning material*

ChatGPT, through its interactions with students, can gauge their learning preferences, interests, and proficiencies. Students can receive instructional suggestions about suitable learning resources by simply asking ChatGPT to give them a list of recommended resources based on their current skill level and preferences [14,19]. Moreover, students can acquire knowledge by asking ChatGPT to generate innovative teaching resources to cater to their personalized learning needs [10].

#### *2.4.2. Assisting in understanding complex concepts*

ChatGPT cater to a student's need to comprehend intricate academic notions by explaining concepts in way that students can understand in their knowledge level. For example, ChatGPT enables students without any mathematical expertise to comprehend intricate mathematical concepts [21]. Thanks to ChatGPT's superb language processing ability, it can offer students cross-linguistic communication and promote cross-cultural understanding, helping students comprehend materials in foreign languages, expanding their horizens of knowledge [10].

#### *2.4.3. Aid for assignment*

Frequently, students encounter challenging problems while working on their assignments or during revision. In such cases, they can present their queries to ChatGPT to receive solutions or guidance on the methodology. For instance, for writing tasks, ChatGPT can create writing in human level, thus facilitating in enhancing students' writing skills by polishing up their essays, correcting syntactic and grammatical mistakes or generating whole passages [3, 14, 15]. With the assistance of ChatGPT,

DOI: 10.54254/2755-2721/35/20230377

students no longer need to dwell on complex writing techniques but can instead focus more on the content itself, thus enhancing their critical thinking skills and problem-solving skills [10,15].

## 3. Applications and discussion

Based on current progress of studies, whether it is assisting teachers in evaluating students' learning progress, generating corresponding practice questions, or aiding students in personalized learning, ChatGPT has limitless application prospects in the education field. In the contemporary social context, due to limited teaching resources and a large student population, artificial intelligence like ChatGPT, which is knowledgeable and capable of one-on-one extended dialogues, can meet students' tutoring requirements. Dissimilar to traditional, complex, and targeted online education systems, ChatGPT itself is a more mature and universal system. Students can rely on directly chatting with it and giving instructions to have it answer questions and complete tasks. Therefore, from the learners' perspective, learning how to ask questions to ChatGPT more effectively and selectively filtering valuable content from the answers is important. From the perspective of education professionals, ChatGPT can assist and enhance their teaching; designing prompts that elicit the desired responses is equally important. This article offers an exhaustive overview of studies concerning the utilization of ChatGPT, summarizing potential methods for its utilization within the field of education. These applications are fundamentally based on engaging in direct dialogue with the existing ChatGPT to obtain feedback. This mode of application capitalizes on ChatGPT's abilities in extended text dialogue, comprehension, and expression, providing users with an experience akin to conversing with a human polymath.

Present literature pertaining to ChatGPT's application within the educational sector predominantly investigates the methodologies for crafting prompts, enabling ChatGPT to generate content that fulfills requirements, or evaluates its competencies within certain academic domains, thus exploring its potential applications. However, this review paper posits that future research into ChatGPT's application in education ought to concentrate more on integrating it with the existing educational systems. Given that ChatGPT is inherently a more generalized form of artificial intelligence, to implement it in the education field in a targeted manner, it is necessary to provide more specific methods, such as how to embed ChatGPT into current automatic grading systems. Moreover, due to the fact that the current version of ChatGPT may generate incorrect information, and that it does not necessarily provide consistent responses to the same question, users in many fields cannot wholly rely on ChatGPT's answers [22]. The establishment of a prospective avenue for future scholarly inquiry involves the refinement of methodologies pertaining to the training of a ChatGPT tailored to a specific domain, underpinned by the utilization of a substantiated and dependable database of a more professional nature.

## 4. Conclusion

This paper sets out to offer a thorough and methodical review of studies centered on ChatGPT's application within educational contexts, thus providing direction to this emerging research area. This paper summarizes the application methods of ChatGPT in education from three different perspectives. Additionally, it examines the existing mainstream research methods based on current application studies, identifies existing issues, and proposes directions for future research emphasis. Overall, ChatGPT has the capability to amplify the instructional efficacy for educators and boosting learning efficiency for students, presenting limitless possibilities in educational domain. Undoubtedly, powerful tools like ChatGPT are poised to shine brightly in the field of education, and they might even have the potential to revolutionize the education industry. However, the appropriate utilization of ChatGPT is also a crucial consideration. In future papers, a more comprehensive overview of the precautions associated with using ChatGPT will be provided. Individuals have the potential to optimize their efficacy through the application of this tool, all the while upholding a lucid comprehension of judicious restraint. This affords them the opportunity to cultivate a discerning aptitude in the selection of inquiries conducive to the augmentation of their faculties for cogent analysis, as opposed to impeding the same.

DOI: 10.54254/2755-2721/35/20230377

## References


[1] Chassignol M Khoroshavin A Klimova A and Bilyatdinova A 2018 *Artificial Intelligence trends in education: a narrative overview* Procedia Computer Science *136* pp 16-24.

[2] Zhai X Chu X Chai C S Jong M S Y Istenic A Spector M Liu J B Yuan J and Li Y 2021 *A Review of Artificial Intelligence (AI) in Education from 2010 to 2020* Complexity 2021 pp 1-18

[3] Farrokhnia M Banihashem S K Noroozi O and Wals A 2023 *A SWOT analysis of ChatGPT: Implications for educational practice and research* Innovations in Education and Teaching International pp 1-15

[4] Sallam M Salim N Barakat M and Al-Tammemi A 2023 *ChatGPT applications in medical, dental, pharmacy, and public health education: A descriptive study highlighting the advantages and limitations* Narra J 3(1) pp e103-e103

[5] Bubeck S Chandrasekaran V Eldan R Gehrke J Horvitz E Kamar E Lee P Lee Y T Li Y Lundberg S and Nori H 2023 *Sparks of artificial general intelligence: Early experiments with gpt-4* arXiv preprint arXiv:*2303.12712*

[6] Ouyang L Wu J Jiang X Almeida D Wainwright C Mishkin P Zhang C Agarwal S Slama K Ray A and Schulman J 2022 *Training language models to follow instructions with human feedback* Advances in Neural Information Processing Systems *35* pp 27730-27744

[7] OpenAI 2023 https://openai.com/blog/chatgpt

[8] Vaswani A Shazeer N Parmar N Uszkoreit J Jones L Gomez A N Kaiser Ł and Polosukhin I 2017 *Attention is all you need* Advances in neural information processing systems *30*

[9] Brown T Mann B Ryder N Subbiah M Kaplan J D Dhariwal P Neelakantan A Shyam P Sastry G Askell A and Agarwal S 2020 *Language models are few-shot learners* Advances in neural information processing systems 33 pp 1877-1901

[10] Zhai X 2023 *Chatgpt and ai: The game changer for education* Available at SSRN

[11] Sakai N 2023 *Investigating the Feasibility of ChatGPT for Personalized English Language Learning: A Case Study on its Applicability to Japanese Students*

[12] Sok S and Heng K 2023 *ChatGPT for education and research: A review of benefits and risks* Available at SSRN 4378735

[13] Baidoo-Anu D and Owusu Ansah L 2023 *Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning* Available at SSRN 4337484

[14] Javaid M Haleem A Singh R P Khan S and Khan I H 2023 *Unlocking the opportunities through ChatGPT Tool towards ameliorating the education system* BenchCouncil Transactions on Benchmarks Standards and Evaluations 3(2) p 100115

[15] Kasneci E Seßler K Küchemann S Bannert M Dementieva D Fischer F Gasser U Groh G Günnemann S Hüllermeier E and Krusche S 2023 *ChatGPT for good? On opportunities and challenges of large language models for education* Learning and Individual Differences 103 p 102274

[16] Xiao C Xu S X Zhang K Wang Y and Xia L 2023 July *Evaluating Reading Comprehension Exercises Generated by LLMs: A Showcase of ChatGPT in Education Applications* In Proceedings of the 18th Workshop on Innovative Use of NLP for Building Educational Applications (BEA 2023) pp 610-625

[17] Khan R A Jawaid M Khan A R and Sajjad M 2023 *ChatGPT-Reshaping medical education and clinical management* Pakistan Journal of Medical Sciences *39*(2) p 605

[18] Shemshack A and Spector J M 2020 *A systematic literature review of personalized learning terms* Smart Learning Environments *7*(1) pp 1-20

[19] Atlas S 2023 *ChatGPT for higher education and professional development: A guide to conversational AI*

DOI: 10.54254/2755-2721/35/20230377

[20] Qureshi B 2023 *Exploring the use of chatgpt as a tool for learning and assessment in undergraduate computer science curriculum: Opportunities and challenges* arXiv preprint arXiv:2304.11214
[21] Wardat Y Tashtoush M A AlAli R and Jarrah A M 2023 *ChatGPT: A revolutionary tool for teaching and learning mathematics* Eurasia Journal of Mathematics, Science and Technology Education 19(7) p em2286
[22] Qadir J 2023 May *Engineering education in the era of ChatGPT: Promise and pitfalls of generative AI for education* In 2023 IEEE Global Engineering Education Conference (EDUCON) pp 1-9 IEEE