

Transforming Education with ChatGPT: Applications, Opportunities and Challenges

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Abstract: Nowadays, large language models such as ChatGPT are rapidly developing. Its powerful capabilities have led to widespread discussions about its applications in specific fields. This study explores the huge transformation of education with the deep integration of ChatGPT, with a focus on analyzing the changes it brings, technological foundations, typical application cases, and challenges it faces. Through case studies such as AsasaraBot, JeepyTA, and ChatGPT Edu, the enormous potential of ChatGPT in educational scenarios such as roles of online course assistants and language teaching robots was evaluated. ChatGPT can be made into an online course teaching assistant, answering students' questions, or a foreign language teaching teacher, improving students' language proficiency and understanding of foreign cultures. ChatGPT can also be put into use to effectively support the education industry by achieving automatic grading, instant feedback, personalized learning and so on which will accelerate the intelligent transformation of educational resources. However, this article also points out the limitations of ChatGPT and the challenges it faces concerning educational applications, such as bias issues in generating content and ethical concerns such as academic deception that Artificial Intelligence (AI) may bring. This article suggests that the education industry and technology developers work closely together to optimize the application models of AI in education and promote responsible use of AI. Through continuous efforts, ChatGPT is expected to promote a more intelligent, personalized, and equitable education system for the world.

Keywords: ChatGPT, AI, AI educational applications, education, AI language teacher.

1. Introduction

At the end of 2022, OpenAI released ChatGPT's chatting website. Its registered users quickly skyrocketed thereafter. Since the emergence of ChatGPT, major companies around the world have invested heavily in this field, and this new AI model has sparked a global wave of innovation in large language models. After OpenAI, Google released its model Gemini, Anthropic released its model Claude, and Alibaba also released Tongyi Qianwen.

The functionality of large language models such as ChatGPT is very powerful. Not only can it chat with users, but it can also answer their questions, summarize article content, expand text, and even generate code for specific functions. Its ability to understand human natural language is outstanding, making it have great potential for educational application. At present, its excellent capabilities in text analysis (including summarization and comprehension), logical reasoning, and code generation make

it applied in many fields such as autonomous vehicles, voice recognition, image recognition, robots, smart home, medical care, financial risk control, etc.

The excellent capabilities of ChatGPT can undoubtedly be applied in the field of education, empowering education with intelligent solutions and solving many problems that cannot be avoided in traditional education. It can reconstruct the curriculum system by making personalized training possible, innovating the learning evaluation system, and generating more intelligent teaching resources.

In China, there have been many trial projects combining AI and education, and many universities are conducting pilot projects. According to a notice document issued by the Chinese Ministry of Education, the ministry has released the first batch of 18 typical projects of "artificial intelligence+higher education" application scenarios, attempting to explore the combination of artificial intelligence and education. Tsinghua University in Beijing has its AI Empowered Teaching Pilot. Southeast University in Nanjing has also established an intelligent AI teaching assistant system for university physics courses [1].

The first part of this study discusses the background of the integration of ChatGPT in education. In the second part, a comprehensive literature review will be conducted to introduce the relevant literature on the application of ChatGPT in the field of education. Then in the third part, this study will introduce the groundbreaking paper of large language models, Attention is all you need. Transformer model, its formulation, how it works and its characteristics will be discussed in part three. In the fourth part, this study presents and comprehensively evaluates two representative AI models, AsasaraBot language teacher, and the JeepyTA teaching assistant models. The author will introduce the construction of these two models, explain the experimental results of the research team, and finally evaluate the two models based on the data in the paper. In the fifth part, this article will introduce the prospects and challenges for ChatGPT in educational applications. Finally is the conclusion and recommendation part.

2. Literature review

Currently, there is much literature discussing the application of ChatGPT in education. A research paper called "Application and Prospects of Generative Artificial Intelligence in Education - Taking ChatGPT System as an Example" explores the application of generative artificial intelligence in education, and mentions that ChatGPT's core abilities include generating inspiring content, understanding dialogue contexts, executing sequential tasks, and parsing programming languages. These abilities can be applied in many teaching processes [2].

Another study titled "Exploring the integration of ChatGPT in education: adapting for the future" discusses the potential applications of ChatGPT in education and the ethical issues of using ChatGPT to help students learn. This article argues that although ChatGPT has some limitations, as long as ChatGPT is integrated with education with a sense of security, it can enhance the learning experience, improve the productivity and efficiency of education, and promote students' learning and future development [3].

Finally, a paper titled "Unlocking the power of ChatGPT: A framework for applying generative AI in education" proposes the "IDEE" framework to guide the use of ChatGPT in education. "I" stands for Identifying Goals: Identifying the purpose and expected outcomes of using ChatGPT. "D" represents the degree of use of automation: selecting the appropriate level of automation based on the goal, such as fully automated teaching or as a supplement to traditional teaching methods. "E" represents ethical considerations: considering ethical issues related to the use of ChatGPT, such as bias, impact on students and teachers, etc. "E" stands for Effectiveness: Evaluating the effectiveness of ChatGPT in achieving goals [4].

3. ChatGPT's key model

Next, this section will briefly introduce the key model of large language models such as ChatGPT - the Transformer model.

In 2017, Vaswani et al. published a paper titled "Attention is All You Need", in which they first proposed the Transformer model. Unlike the sequential processing methods in traditional recurrent neural networks (RNNs) and convolutional neural networks (CNNs), this model adopts a novel parallelization approach to process sequential data, which greatly reduces training time and improves model performance [5].

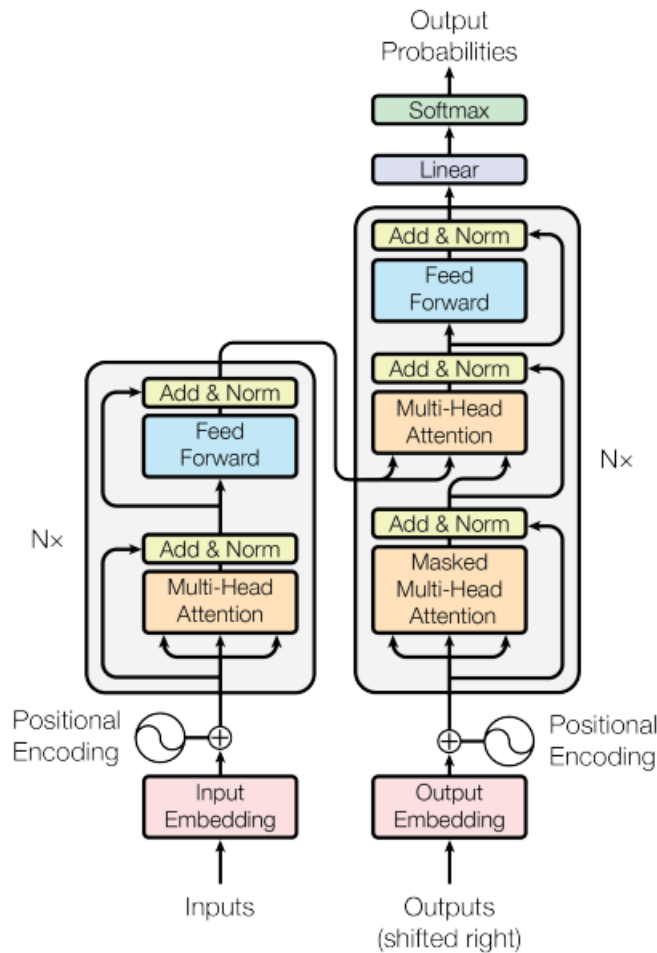


Figure 1: Transformer structure.

The core innovation of the Transformer model is the Self Attention Mechanism. When processing sequence data, this mechanism allows the model to simultaneously focus on all other positions in the sequence while processing various positions in the sequence, and dynamically adjust attention weights based on the correlation of these positions. This means that when translating sentences or generating text, the model can better capture long-distance correlations, such as how information mentioned at the beginning of a sentence affects understanding at the end of the sentence. By calculating the dot product similarity between the query, key, and value, applying the softmax function to obtain the attention score, and then weighting and summing the corresponding values with these scores, a context sensitive representation vector can be finally obtained [5].

In addition to self attention mechanism, the Transformer model also introduces the concept of multi-head attention mechanism, which enables the model to obtain information from different representation subspaces, further enhancing its ability to capture complex patterns. Moreover, in order to maintain the positional information of the input sequence, the Transformer uses what is called positional encoding, which is a fixed or learned vector added to the input along with word embeddings to ensure that the model can also process the sequence based on the order in which words appear [5].

The entire Transformer architecture is typically composed of a series of identical layers stacked together, each layer containing a multi-head self attention mechanism module and a feed-forward neural network. Residual connections and layer normalization have been added between these two parts and between layers to assist gradient flow and accelerate the convergence process [5].

Large language models and machine translation models that use Transformers have powerful expressive abilities and efficient training speed. Transformer and its variants have been widely applied in various tasks, such as machine translation, text summarization, question answering systems, and so on. Especially with the development of pre-trained models such as Bidirectional Encoder Representations from Transformers (BERT) and Generative Pre-trained Transformer (GPT) series, Transformer has become one of the most core technologies in current natural language processing (NLP) research and applications. These pre-trained models obtain rich knowledge through unsupervised learning using large-scale corpus training sets, and can then adapt to specific tasks with a small amount of fine-tuning [5].

In summary, the Transformer model provides an efficient and effective new approach for solving sequence modeling problems, greatly advancing the research progress of the entire deep learning community on the ability to generate human language.

4. Two application models of ChatGPT in education

In the following two parts, two classic applications of ChatGPT in will be introduced and evaluated.

4.1. AsasaraBot

In foreign language teaching, Content and Language Integrated Learning (CLIL) is an efficient teaching method that emphasizes teaching both the language and its relevant culture to achieve better foreign language learning results. The researchers of this paper used ChatGPT as the NLP engine to build an educational chatbot called AsasaraBot and explored its application in Content and Language Integrated Learning. Through field experiments in language schools in Greece, the research has shown that AsasaraBot can effectively support students in learning about Minoan civilization culture while improving their English and French abilities, and has demonstrated its effectiveness compared to human teachers [6].

Because Snatchbot is able to provide simple and intuitive visual design tools, as well as powerful functional modules and integration tools which saves development time, so the research team chose to develop based on the Snatchbot platform. The main components of AsasaraBot included a natural language understanding engine, a dialogue manager, and a knowledge repository. The team used customized NLP models as natural language engine to analyze user messages and convert them into a processable format, which would then be processed to identify users' intentions and emotions and generate corresponding responses. Dialogue manager connects natural language understanding engines and information retrieval components, responsible for managing the flow of conversations. The knowledge repository is in charge of storing the information required by the chatbot, including cultural background knowledge, language learning materials, predefined answers, and solutions to typical problems[6].

The specific dialogue content of this educational robot focused on the Minoan Civilization and the Snake Goddess in Greece culture. It included multiple activities and questions such as brainstorming, watching engaging videos, reading texts about the Minoan Civilization and Snake Goddess, etc. The course designed specific tasks to promote interaction. During the process, it would also raise questions and guide students to think about cultural content which will enhance language skills [6].

To test the effectiveness of this language teaching robot, researchers evaluated the model's performance in a public school and two private language schools in Greece. According to the questionnaire surveying the students, 91% of them believe that cultural content can be learned through chatbots, and 48% of students have a positive attitude towards using chatbots to learn foreign languages. While 93% of students think that conversations with chatbots are very engaging, and 98% of students think that chatbots have a friendly interface. In terms of cultural content learning, the chatbot group performed slightly better than the control group, while in terms of language learning, the control group performed slightly better than the chatbot group [6].

The research results indicate that AsasaraBot can effectively support the simultaneous learning of foreign languages and cultural content in the CLIL teaching method. However, there is still room for improvement in language learning.

4.2. JeepyTA teaching assistant

Sections should be numbered with a dot following the number and then separated by a single space: In a private university in the northeastern United States, a graduate course, data mining, uses an online course website to manage course resources and as a forum for students to post questions. Due to the inability of teachers to provide answer services to students 24/7 on the learning forum, a research team from the University of Pennsylvania developed an online course assistant called JeepyTA. It was capable of answering questions raised by students on the forum 24/7. The assistant model used OpenAI text embedding to pre embed prepared questions and solutions as well as related course information [7].

To build a teaching assistant model, the research team first collected opinions from students to understand their main needs in online forum and their expectations for teaching assistant functions including answering course-related questions fast, providing learning resources, and supporting programming tasks. The team chose OpenAI's GPT model as the basis for the model. In order to improve its adaptability in specific courses, the team collected course-related data such as course outlines, lecture notes, assignment descriptions, common questions and solutions, etc, which were then converted into text embeddings. When students ask questions, JeepyTA would generate answers based on the matched answers using ChatGPT. These answers would be adjusted according to the forum style, making the language style of the answers more natural and fluent. Finally, the generated answers were not to be immediately posted on the forum but will be reviewed and approved by the teacher or teaching assistant first to ensure the accuracy and quality of the answers [7].

The implementation of JeepyTA in the course forum has significantly shortened the time students received responses to questions. According to the data in the paper, the response time for each question to be replied has been reduced from an average of 14.74 hours to 10.43 hours. The existence of JeepyTA also encouraged professors and teaching assistants to post more replies on weekends. The proportion of posts replied by teachers on weekends has increased from 10% to 29% of the total number of posts. JeepyTA generated replies in an average of 39.95 seconds, while manual review took an average of 38.23 minutes. All these data indicated that JeepyTA has improved the instantaneity and interactivity of online support [7].

The research results indicate that the implementation of JeepyTA in the forum significantly reduces the response time compared to the old way where human professors and teaching assistants responded. It performed similarly to human teaching assistants in course content and communication.

However, according to students' feedback, JeepyTA still had significant shortcomings in motivating students and supporting learning strategies. Moreover, if the embedded course information did not include the answers to students' questions, the answers generated by JeepyTA may be inaccurate or even incorrect, which means that students needed to critically discern the generated answers themselves.

4.3. ChatGPT Edu

OpenAI has officially announced the launch of the ChatGPT Edu version designed specifically for university campus users on May 30th. ChatGPT Edu integrates the latest GPT-4o model, which can provide services in multiple modalities such as text, video, audio, and so on, aiming to provide more intelligent and diverse learning support for university campuses. For example, in voice mode, GPT-4o can provide detailed guidance on solving advanced mathematical problems just like a private tutor, gradually analyzing the problem-solving process [8].

5. The prospects and challenges of ChatGPT in education

There are many opportunities for ChatGPT in education, and this study summarizes some possible application scenarios.

5.1. Personalized learning

For traditional education models, teachers cannot provide personalized learning to a whole class. However, the quick development of cutting-edge AI models provides new ideas for solving this problem. AI teachers with big language models integrated as the core will be able to customize course materials, teaching content, and exercises of appropriate difficulty for a specific student, and students can freely choose their class time [3].

5.2. Renewal of coursework evaluation

In traditional education systems, grading homework often relies on regular exams and manual grading by teachers. However, this method is time-consuming, subjective, and contains feedback lag. This burdens teachers with a heavy workload. The application of AI technology can bring revolutionary changes to the course evaluation system. In the future, even subjective evaluation tasks can be entrusted to AI, making this process more efficient and accurate [9].

5.3. Reforming traditional ways of teaching

The introduction of ChatGPT is expected to revolutionize the vast majority of curriculum systems. Most traditional courses do not have powerful tools like AI, but with AI, a large amount of intelligent teaching resources can be produced for classroom teaching.

5.4. Improving language skills

ChatGPT can be used to create virtual language tutors, helping students with foreign language learning and improving their language skills in listening, speaking, reading, and writing [10].

5.5. Assistance in research

ChatGPT can assist students in academic research, such as answering academic questions, suggesting relevant resources and summarizing tedious documents.

Despite the great potential of AI in education, generative AI still faces challenges. Due to the inability to guarantee the quality of the data used for training, the content generated by generative AI is biased, which may bring misleading and false information to students. Secondly, the current functionality of ChatGPT is still not powerful enough for complex tasks. Developers need to continuously improve its functionality, and more research needs to be conducted to evaluate its effectiveness in different scenarios. Moreover, the ownership of AI intellectual property rights and the definition of academic misconduct and deception are also ethical issues that need to be addressed at present.

6. Conclusion

This study explores in detail the deep integration of ChatGPT in education and the changes it brings, the technological foundation, typical application cases, and the challenges it faces. By analyzing specific cases that combined ChatGPT with education (such as AsasaraBot, JeepyTA, and ChatGPT edu) and specific application possibilities, the report assessed the advantages and disadvantages of online course teaching assistants and language teacher robots and demonstrated their enormous potential. Overall, ChatGPT can provide various and intelligent support for the education system. From educational robots and course assistants to personalized learning and automated homework evaluation, all of these will accelerate the intelligent transformation of education.

At the same time, the paper also pointed out some challenges that AI faces in practical applications. With the continuous advancement of artificial intelligence technology, AI such as ChatGPT is gradually changing traditional teaching models. But it also requires continuous exploration and improvement by developers and teachers in terms of technology, ethics, and teaching strategies. In future developments, the education industry and technology developers should work together to optimize the application mode of ChatGPT in education in order to achieve a more intelligent, humane, and sustainable education system. This not only helps students better grasp knowledge, but also promotes a more equitable distribution of educational resources, contributing to the improvement of global education levels.

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