

Research Progress and Prospect of Large Language Models in Educational Intelligent Auxiliary Teaching

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Received: 3 May 2026; Accepted: 6 June 2026; Published: 24 June 2026

Abstract:

With the rapid development of artificial intelligence technology, digital transformation has become an inevitable trend in the global education industry. Traditional intelligent teaching systems are limited by fixed algorithms and rigid interactive modes, which cannot meet the personalized, flexible and intelligent needs of modern teaching. In recent years, Large Language Models (LLMs) represented by GPT series, Llama and Claude have achieved breakthroughs in natural language understanding, contextual reasoning and generative interaction, providing a new technical carrier for intelligent auxiliary teaching. This paper adopts the literature review method, systematically sorts out the latest research progress and practical application scenarios of LLMs in educational intelligent auxiliary teaching from domestic and foreign literature, and summarizes the application value of LLMs in teachers' teaching assistance, students' autonomous learning and educational teaching management. At the same time, this study analyzes the existing challenges including model hallucination, academic integrity risks, data privacy security and insufficient teacher digital literacy in the current application process. On this basis, it prospects the future development direction of educational LLMs from the aspects of professional model iteration, scenario integration, ethical supervision and system construction. The research aims to provide theoretical references and practical enlightenment for the in-depth integration of large language models and intelligent education, and promote the high-quality and sustainable development of digital teaching.

Keywords:

Large Language Models, Intelligent Teaching, Educational Auxiliary, Digital Education, Teaching Reform

1. Introduction

1.1. Research Background

In the era of global digital economy, intelligent education has become a core direction of educational reform in various countries. Governments and educational institutions have successively promoted the integration of artificial intelligence and basic education and higher education, aiming to break through the limitations of traditional classroom teaching and realize the transformation from standardized

indoctrination teaching to personalized adaptive teaching. Traditional computer-aided teaching tools mainly rely on preset templates and fixed databases, which can only realize simple functions such as resource push and automatic question answering [1]. These tools lack deep contextual understanding and flexible interactive capabilities, resulting in low user fitting degree and limited practical teaching effect.

The emergence and rapid iteration of Large Language Models have completely changed the development mode of intelligent educational technology. Different from traditional natural language processing models, LLMs have powerful capabilities of multi-turn dialogue, knowledge reasoning, text generation and content optimization, which can simulate professional teachers to complete diversified teaching auxiliary work [1]. Since 2022, with the open access of a variety of high-performance large language models, LLMs have been widely applied in teaching design, learning tutoring, teaching evaluation and other educational scenarios [2], gradually becoming an important intelligent auxiliary tool for modern education. Therefore, it is of great practical value to systematically sort out the research progress, practical problems and future development trends of LLMs in intelligent auxiliary teaching.

1.2. Research Significance

Theoretical Significance: At present, the research on the application of LLMs in education is still in the stage of rapid development, and most existing studies focus on single scenario application and technical effect verification, lacking systematic sorting and theoretical summary. This paper combs the overall research framework of LLMs empowering intelligent teaching, summarizes the technical advantages and application logic of LLMs in education, and enriches the theoretical research system of artificial intelligence education, which can provide theoretical reference for subsequent related academic research.

Practical Significance: This paper summarizes the mature application modes and existing practical obstacles of LLMs in teaching scenarios, analyzes the actual risks in the promotion process, and puts forward targeted optimization strategies and development prospects. The research conclusions can provide operable practical suggestions for school teaching reform, teachers' intelligent teaching application and educational management decision-making, and help promote the standardized and popularized application of LLMs in the education field.

1.3. Domestic and Foreign Research Status

Foreign research on educational application of LLMs started earlier and has formed relatively rich practical achievements [3]. Foreign scholars mainly focus on personalized learning intervention, intelligent tutoring system development and learner behavior analysis. Many studies have verified that LLMs can effectively improve students' autonomous learning efficiency and classroom interaction quality. Some foreign universities have tried to apply LLMs in academic writing guidance, language teaching and professional course tutoring, and achieved good teaching feedback. However, most foreign studies focus on western educational environments, and the applicability of relevant conclusions in domestic educational scenarios needs to be further verified.

Domestic research on LLMs in education has developed rapidly in recent years^[4]. Domestic scholars mainly focus on the localized application of large models, the integration of LLMs and domestic curriculum system, and the construction of smart

campus teaching scenarios. Relevant studies have confirmed the positive role of LLMs in optimizing teaching links and improving teaching efficiency. Nevertheless, current domestic research still has deficiencies: the systematic research on the whole-process teaching application of LLMs is insufficient, the research on application risks and long-term educational impact is not in-depth, and there is a lack of forward-looking prospect analysis for the future development of educational LLMs.

1.4. Research Content and Innovation Points

This paper takes the application of large language models in educational intelligent auxiliary teaching as the core research object. Through sorting out domestic and foreign relevant literature and practical cases, it systematically summarizes the application scenarios and research progress of LLMs in teacher teaching assistance, student autonomous learning and educational management. Combined with the current practical application situation, it deeply analyzes the technical defects, educational risks, ethical problems and promotion limitations of LLMs in teaching. Finally, it puts forward targeted future development prospects and optimization paths from multiple dimensions.

The core innovations of this paper are as follows: First, this paper constructs a systematic application framework of LLMs in intelligent auxiliary teaching covering teaching, learning and management, which makes up for the deficiency of scattered single-scenario research in existing studies. Second, this paper comprehensively sorts out the multi-dimensional challenges of LLMs in educational application, and combines technical problems, educational risks and ethical norms to carry out comprehensive analysis, which improves the depth of research. Third, the proposed future development strategy is combined with the actual needs of domestic intelligent education construction, which has strong practical pertinence and operability.

2. Overview of Core Concepts and Technologies

2.1. Definition and Core Characteristics of Large Language Models

Large Language Models are a kind of pre-trained deep learning model based on transformer architecture, which takes massive text corpus as training data and realizes intelligent processing of natural language through multi-layer neural network training. Different from traditional natural language processing models with single function, LLMs have the core characteristics of strong contextual understanding, logical reasoning, creative generation and multi-scenario adaptation. At present, mainstream large language models include commercial models such as GPT-4 [5], Claude and Gemini, and open-source models such as Llama [6], Mistral and Qwen.

In the field of education, the technical advantages of LLMs are mainly reflected in three aspects [3]. First, LLMs support long-text understanding and multi-turn interactive dialogue, which can simulate real teacher-student communication and realize continuous teaching tutoring. Second, LLMs have powerful knowledge reserves and text generation capabilities, which can quickly generate teaching resources, answer professional questions and optimize teaching content. Third, LLMs have strong adaptive adjustment ability, which can adjust language style and knowledge explanation depth according to different learning objects, so as to meet the personalized teaching needs of students at different levels.

Table 1. *Applicability Comparison of Mainstream LLMs in University Computer Teaching Scenarios.*

Model	Open/Closed Source	Local Deployment Difficulty	Code Debugging Ability	Academic Accuracy	Usage Cost	Educational Adaptability
GPT-4	Closed	High	Excellent	High	High	★★★★☆
Claude 3	Closed	High	Good	Very High	Medium-High	★★★★☆
Llama 3	Open	Medium	Good	Medium	Low	★★★★★
Qwen	Open	Low	Good	Medium	Low	★★★★★
Mistral	Open	Medium	Very Good	Medium	Low	★★★★☆

2.2. Connotation of Educational Intelligent Auxiliary Teaching

Educational intelligent auxiliary teaching [4] refers to a modern teaching auxiliary mode based on artificial intelligence, big data and digital information technology. It takes optimizing teaching links, improving teaching quality and realizing personalized teaching as the core goal, and provides intelligent support for teachers' teaching work and students' learning process. Different from traditional single teaching auxiliary tools, intelligent auxiliary teaching is a whole-process and multi-dimensional service system covering pre-class preparation, in-class teaching interaction, after-class learning tutoring and teaching effect evaluation.

The core dimensions of intelligent auxiliary teaching include teacher teaching assistance, student autonomous learning assistance and educational teaching management assistance. Teacher-oriented auxiliary focuses on reducing teachers' repetitive work pressure and improving teaching design efficiency. Student-oriented auxiliary focuses on solving personalized learning problems and improving autonomous learning ability. Management-oriented auxiliary focuses on realizing data-based teaching monitoring and scientific educational decision-making. The technical characteristics of LLMs are highly compatible with the multi-dimensional and personalized needs of intelligent auxiliary teaching, which makes LLMs the core technical support of current intelligent education construction [7].

3. Research Progress of LLMs in Educational Intelligent Auxiliary Teaching

3.1. Auxiliary Application for Teachers' Teaching Work

In the teacher teaching scenario, LLMs have been widely used in all links of teaching design and teaching implementation, effectively reducing teachers' repetitive work burden and improving teaching efficiency [8]. In terms of pre-class teaching preparation, LLMs can assist teachers in completing curriculum teaching plan design, teaching framework sorting and courseware content compilation. Teachers can input curriculum objectives and teaching key points, and LLMs can quickly generate standardized teaching plans, diversified teaching cases and hierarchical teaching content, which greatly shortens the time of manual teaching preparation. For interdisciplinary and innovative courses, LLMs can also expand frontier knowledge

content and supplement the latest industry cases, so as to enrich the dimension of classroom teaching.

In the in-class teaching link, LLMs can assist teachers in real-time classroom interaction and dynamic teaching adjustment. During classroom teaching, LLMs can sort out students' real-time questions, summarize classroom learning feedback, and help teachers grasp the overall learning situation of students in time. At the same time, LLMs can provide diversified teaching explanation methods for difficult knowledge points, assist teachers in hierarchical teaching for students with different learning levels, and improve the pertinence of classroom teaching.

In the after-class teaching evaluation link, LLMs can realize intelligent correction of homework, automatic analysis of error points and targeted teaching summary [9]. Different from traditional machine correction which only supports objective questions, LLMs can intelligently evaluate subjective assignments such as compositions, short answers and experimental reports, analyze students' knowledge mastery defects according to homework completion situation, and generate personalized teaching improvement suggestions for teachers, which provides an important basis for subsequent targeted teaching adjustment.

3.2. Auxiliary Application for Students' Autonomous Learning

Student autonomous learning is the most mature and widely applied scenario of LLMs in intelligent auxiliary teaching. First of all, LLMs can realize personalized adaptive learning tutoring[10]. According to students' learning foundation, learning progress and knowledge weak points, LLMs can formulate exclusive learning plans, adjust the difficulty and progress of learning content in real time, and solve the problem of inconsistent learning rhythm caused by unified classroom teaching. For students with weak foundation, LLMs can carry out basic knowledge repeated explanation and step-by-step guidance; for excellent students, LLMs can expand innovative and extended knowledge to meet differentiated learning needs.

Secondly, LLMs provide efficient academic guidance and learning problem solving services. Students can carry out real-time Q&A consultation through LLMs for difficult knowledge points in the learning process. Different from traditional search engines which only provide single information, LLMs can conduct logical reasoning and hierarchical explanation according to students' question context, help students understand the internal logic of knowledge, and realize truly heuristic teaching. In addition, LLMs can also provide standardized guidance for students' academic paper writing, literature sorting, thesis framework design and academic specification modification, which effectively improves students' academic literacy.

In addition, LLMs have significant application effects in language learning and skill training. In English listening, speaking, reading and writing training, LLMs can simulate real oral dialogue scenarios, correct pronunciation errors, optimize writing grammar, and provide continuous language interaction training for students. For professional skill courses, LLMs can sort out professional knowledge systems, explain professional operation logic, and assist students in completing autonomous pre-learning and post-class consolidation.

3.3. Auxiliary Application for Educational Teaching Management

In the field of educational teaching management, LLMs realize the transformation of educational management from empirical judgment to data-based scientific

decision-making [9]. First of all, LLMs can assist schools in learning data analysis and student behavior management. By sorting out students' learning duration, learning content, homework completion quality and classroom interaction data, LLMs can summarize students' overall learning status, identify potential learning problems and learning behavior risks, and provide accurate student portrait data for school teaching management.

Secondly, LLMs can assist educational administrators in teaching quality monitoring and curriculum optimization. LLMs can analyze the teaching evaluation data of teachers, student course evaluation feedback and curriculum teaching effect data, summarize the advantages and deficiencies of current curriculum setting and teaching mode, and put forward targeted curriculum optimization suggestions, so as to promote the continuous improvement of school teaching quality.

At the same time, LLMs can also provide intelligent public service consultation for campus education. It can answer students' and parents' consultation questions about campus management system, curriculum arrangement, examination arrangement and scholarship policies, reduce the repetitive consultation work of educational management personnel, and improve the efficiency of campus public service operation.

4. Current Challenges of LLMs in Educational Teaching Application

4.1. Technical Defects of Large Language Models

Model hallucination is the most prominent technical problem restricting the educational application of LLMs [11]. In the face of professional, in-depth and niche educational knowledge, LLMs are prone to generate false content, wrong data and inaccurate professional explanations, which cannot be effectively distinguished by ordinary teachers and students. Once the wrong knowledge is applied to teaching and learning, it will lead to wrong knowledge cognition and affect the teaching effect. In addition, LLMs have poor stability in long-text teaching interaction and multi-round continuous knowledge reasoning. For complex professional knowledge systems, the model is easy to have logical confusion and content deviation in continuous dialogue.

At the same time, the existing general large language models lack educational pertinence. Most LLMs are trained based on universal public corpus, lacking targeted training of domestic curriculum system, professional knowledge points and educational teaching norms. The explanation of professional discipline knowledge is not detailed enough, and the fitting degree with domestic teaching scenarios is low, which leads to limited practical teaching auxiliary effect.

4.2. Educational Teaching Risks

The widespread application of LLMs brings obvious academic integrity risks and learning habit problems[12]. On the one hand, some students rely on LLMs to complete homework, papers and learning tasks directly, resulting in plagiarism and academic fraud, which seriously affects the construction of academic atmosphere. On the other hand, long-term dependence on LLMs' intelligent tutoring will make students lack independent thinking and problem-solving exercise, resulting in the decline of autonomous thinking ability and problem-solving ability, which is not conducive to the long-term cultivation of students' comprehensive literacy.

In addition, the personalized teaching effect of LLMs is uneven. Affected by model algorithm differences and student operation differences, some students cannot obtain accurate adaptive learning guidance in the process of using LLMs. At the same time, excessive intelligent auxiliary will weaken the interaction between teachers and students, reduce the temperature of classroom teaching, and affect the construction of teacher-student emotional relationship.

4.3. Data Privacy and Ethical Risks

Educational application of LLMs involves a large amount of private data of students and teachers, including students' learning records, academic performance, personal learning habits and teachers' teaching design content. In the process of model interaction and data transmission, there are potential risks of data leakage and illegal collection. Once the private educational data is leaked, it will threaten the personal information security of teachers and students [13].

In terms of educational ethics, the popularization of LLMs brings the problem of educational resource inequality. Students with good digital equipment and learning conditions can make full use of LLMs for efficient auxiliary learning, while students in underdeveloped educational areas lack corresponding technical and equipment support, which further widens the educational gap between different regions. At the same time, there is a lack of unified educational ethical norms and application standards for LLMs, resulting in irregular application behaviors in the teaching process.

4.4. Practical Promotion Limitations

The popularization and application of educational LLMs are restricted by cost and technical conditions. High-performance large language models have high application and maintenance costs, and it is difficult for most primary and secondary schools and grassroots colleges to carry out full-scale popularization and application. In addition, teachers' digital literacy is uneven. Many teachers lack professional application skills of LLMs and cannot flexibly use large model tools to optimize teaching links, resulting in the idle value of intelligent teaching tools [14].

At present, schools have not formed a standardized LLM teaching application system and management mechanism. There are no clear application norms, usage standards and supervision mechanisms for the application scenarios, application scope and usage specifications of LLMs in teaching, which leads to random application in the teaching process and cannot guarantee the standardized and orderly development of intelligent auxiliary teaching.

5. Future Development Prospect and Optimization Strategies

5.1. Technical Optimization: Construct Educational Professional Customized LLMs

In view of the technical defects of general large language models, the future development direction is to build educational professional customized large language models. First of all, it is necessary to carry out targeted training and fine-tuning of LLMs based on domestic curriculum standards, discipline knowledge system and teaching norms, optimize the model's recognition ability and explanation accuracy of educational professional knowledge, and effectively solve the problem of model hallucination in teaching scenarios. Secondly, optimize the model's long-text

reasoning and multi-round interactive ability, improve the stability and pertinence of continuous teaching tutoring, and adapt to the needs of systematic curriculum teaching.

In addition, it is necessary to develop lightweight educational LLMs to reduce model operation and application costs. Through model pruning, quantization and optimization technology, the threshold of model application is reduced, so that grassroots schools and ordinary teachers and students can easily use intelligent teaching auxiliary tools, and lay a technical foundation for the comprehensive popularization of educational LLMs.

5.2. Scenario Integration: Realize Deep Whole-Process Teaching Integration

The future development of LLMs in education will move towards full-scenario and whole-process deep integration. It is necessary to build a closed-loop intelligent teaching system covering pre-class preview assistance, in-class interactive teaching, after-class personalized tutoring and whole-process teaching evaluation. In the pre-class stage, LLMs assist teachers in personalized teaching design and assist students in targeted pre-learning; in the in-class stage, realize real-time interactive teaching and dynamic learning situation monitoring; in the after-class stage, complete personalized homework guidance, knowledge consolidation and learning effect evaluation.

At the same time, it is necessary to combine the learning characteristics of different disciplines and different student groups to develop differentiated application modes of LLMs. For liberal arts courses such as language and literature, focus on cultivating students' innovative thinking and literary literacy through model interaction; for science and engineering courses, focus on assisting logical reasoning and problem-solving training, so as to realize the precise integration of model technology and disciplinary teaching.

5.3. Risk Prevention: Improve Educational Ethics and Supervision Mechanism

Aiming at the academic integrity and ethical risks brought by LLMs, it is necessary to establish a perfect risk prevention and supervision system. First, schools should formulate clear LLM teaching application norms, clarify the usable scenarios and prohibited behaviors of large models in teaching, standardize students' use habits, and guide students to take LLMs as auxiliary learning tools rather than substitutes for independent thinking. Secondly, develop intelligent detection technology of LLM-generated content, strengthen the supervision of academic papers and homework, and curb academic fraud behaviors.

In terms of data security, it is necessary to establish a special protection mechanism for educational data, standardize the collection, transmission and storage of teaching data, strictly prevent the leakage of teachers and students' private information, and ensure the safe and standardized application of LLMs in education. At the same time, increase the investment of educational resources in underdeveloped areas, popularize lightweight intelligent teaching tools, and narrow the digital education gap.

5.4. System Construction: Improve Teachers' Intelligent Teaching Literacy

Schools and educational institutions should carry out systematic intelligent teaching training for teachers, popularize the application methods, technical advantages and risk prevention strategies of LLMs, and improve teachers' ability to integrate large model technology and curriculum teaching. Guide teachers to change their teaching

concepts, make rational use of LLMs to reduce repetitive work, and focus on optimizing teaching design, paying attention to students' thinking cultivation and emotional education, so as to realize the complementary advantages of intelligent technology and traditional teaching.

In addition, educational departments should formulate unified industry standards and development plans for the application of LLMs in education, improve the institutional system of intelligent education construction, standardize the development and application of educational large models, and promote the sustainable and standardized development of intelligent auxiliary teaching.

6. Conclusions

Large language models, as the core technological achievement of current artificial intelligence development, have unique technical advantages in educational intelligent auxiliary teaching, and have been widely applied in teacher teaching assistance, student autonomous learning and educational management. The integration of LLMs and education effectively optimizes the traditional teaching mode, improves teaching efficiency, and provides new possibilities for personalized and intelligent educational reform. However, the practical application of LLMs in education still faces many challenges, including technical defects such as model hallucination, educational risks such as academic integrity problems, data privacy and ethical risks, and practical promotion limitations such as insufficient teacher literacy and imperfect system norms.

In the future, the development of educational LLMs will focus on professional technical optimization, in-depth scenario integration, standardized risk supervision and supporting system construction. Through building professional educational large models, improving application norms and ethical supervision mechanisms, and strengthening teachers' digital literacy training, the positive value of LLMs in intelligent education can be maximized, and the sustainable and high-quality development of digital teaching reform can be promoted. With the continuous iteration of artificial intelligence technology and the continuous improvement of educational application systems, LLMs will become an indispensable core auxiliary tool in modern education, and further promote the comprehensive transformation and upgrading of the global intelligent education industry.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

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