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A Review of The Application of Large Language Models in Education

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Abstract. In the wave of global education digital transformation, the technological breakthrough of Large Language Models represented by ChatGPT has triggered profound changes in international education. Various countries have explored applications in improving teaching efficiency and personalized learning. However, in the process of digital transformation, the application of large language models also present a scenario of intertwined opportunities and challenges. Therefore, this paper systematically reviews the application, challenges and countermeasures of LLMs in the field of education through a literature review and case analysis. It is found that the application of large language models can help improve the work efficiency of teachers, liberate teachers from repetitive labor and alleviate the imbalance of educational resources to a certain extent. At the same time, the application of large language models also brings a series of problems, such as academic integrity, technical ethics. The study further points out that the benign integration of education and technology should be promoted through policies regulations and teacher training, which provides reference for the transformation of digital education in China.

Keywords: Large Language Model, Education Transformation, Education Innovation, Education Equity

1. Introduction

In recent years, Large language models (LLMs), represented by ChatGPT, have become a driving force at the core of education informatization due to the strong language processing ability. This kind of technology can not only realize innovative applications such as intelligent QA, personalized learning planning, automatic generation of teaching content, but also provide technical possibilities to address pain points such as uneven resource allocation and single teaching form in traditional education. During the digital transformation of education in China, the application of language models has brought opportunities to promote the efficiency of teaching, (e.g., resource development), but it has also sparked controversies, such as risks of technology dependence and academic integrity. How to find a balance between the technical efficiency and the educational essence, becomes the key proposition of digital education transformation. Most of the current academic research on the LLMs focuses on the deep contradictions such as the improvement of efficiency and the crisis of academic integrity, but lacks the systematic construction of the

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relationship between technology and education, and pays insufficient attention to the educational differences between the central and western regions.

This study employs a literature review and case analysis to systematically examine LLMs application status in education, and to explore the opportunities and challenges generated by technological applications in education, and propose targeted countermeasures. This research helps education workers to grasp the language model in the latest developments in the field of education, and also can promote technology and education to provide theoretical reference for the depth of the interdisciplinary fusion.

2. Literature review

2.1. Large language models technology

The development of large language models has gone through many stages. Early language models, such as Word2Vec and GloVe, mainly learn word vector representation through statistical analysis of text, which lays a foundation for subsequent language model development [1]. With the development of deep learning technology, language models based on recurrent neural network (RNN) and its variants long short-term memory network (LSTM) and gated recurrent unit (GRU) begun to emerge, which can handle more complex language sequences. In 2017, Google made the Transformer architecture the development direction of language model. Based on Transformer architecture, OpenAI has successively launched a series of GPT models, such as GPT-1, GPT-2, GPT-3 and GPT-4. Among them, GPT-3 has attracted wide attention with its 175 billion parameters and powerful language generation capability, while GPT-4 has made further breakthroughs in multimodal processing and other aspects. Google also launched its own LLMs BERT and its subsequent variations, BERT, through its two-way Transformer structure, performs well in natural language understanding tasks [2]. Wenxinyiyan developed by Baidu is a knowledge-enhanced large language model, which can carry out a variety of tasks such as dialogue and interaction, story creation, painting and copywriting. Huawei's Pangu large model has applications in various fields such as natural language processing and computer vision, providing intelligent solutions for different industries. These typical large language models at home and abroad continue to explore in technological innovation and application expansion, promoting the sustainable development of large language model technology.

2.2. Theoretical basis of educational application

2.2.1. Technical applicability of constructivist learning theory

Constructivism emphasizes that learning is a process of learners actively constructing knowledge, and the technical features of LLMs are highly consistent with the theory of constructivism [3]. First of all, LLMs can automatically generate courseware frameworks and interaction design at the teaching assistance level. For example, if the theme of "Han Dynasty" is input, it can output a lesson plan containing historical background and discussion topics in a few seconds. Compared with traditional educational technology, which can only push exercises according to the correct answers, LLMs stimulate students to explain, question and reflect through open dialogue, which is closer to the "meaning generation" core principle of constructivism [4]. In the field of measurement, LLMs can help students analyze semantic structure and logical problem-solving processes by examining

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the composition of their answers. Online education platforms such as Homework have integrated related technologies, such as the hybrid mode of "AI teacher + human tutoring".

2.2.2. Education equity theory

Education equity means that members of society have equal access to enjoy educational rights and resources, covering the fairness of opportunities, processes and results [5]. LLMs, as digital education management tools, help to break geographical restrictions through online platforms, provide standardized curriculum resources for remote areas, and theoretically narrow the gap in access to educational resources. However, the current research focuses on technical efficiency, ignoring the human complexities of the education context, such as the resource gap between the east and the west. In fact, the application of LLMs may exacerbate the uneven distribution of resources between urban and rural areas [6]. On the one hand, weak digital infrastructure in rural areas (such as insufficient network coverage and equipment shortage) may lead to a higher threshold for the use of LLMs compared to urban areas. Urban schools, by contrast, are more likely to get maintenance, teacher training, and other support to give full play to the function of LLMs. In rural areas, however, insufficient resources allocation may create a "technology divide". widening the essence of the gap between urban and rural education resources. This contradiction can be mitigated through policy inclination and infrastructure.

3. Path of technology empowerment in educational scenarios

3.1. Efficiency optimization of teaching processes

LLMs can reconstruct the teaching preparation and evaluation process through automatic process, significantly enhancing teacher productivity. For example, in the course preparation process, teachers may spend 4-5 hours integrating materials in traditional course preparation, while the large language model can generate a complete lesson plan containing teaching objectives, case studies, and examples in less than 10 minutes. Taking the chapter of "electromagnetic induction" of high school physics as an example, the model simultaneously provides a video script for experimental demonstration and the analysis of common errors, and the efficiency of lesson preparation increased by 80% [7]. In terms of homework correction, the efficiency of Chinese composition correction has been substantially improved. The model can not only grade compositions, but also identify specific issues like " overuse of metaphor and rhetoric" and recommend examples of constructive modification. This allows teachers to focus more on innovating teaching methods and interacting with students.

3.2. Data-driven personalized learning adaptation

Constructivism emphasizes that learning is a process in which learners actively construct knowledge in social interaction. According to this theory, the large language model can dynamically adjust the learning paths through interactive data tracking, generate personalized learning path that adapts to the students' current cognitive level, and provide personalized construction support. For example, in mathematics learning, when students solve quadratic function problems, the model pushes customized micro-lessons according to their error types (such as symmetry axis calculation errors), and generates three varied training questions of the same type. For those who demonstrate advanced learning capabilities, the large language model will recommend advanced content such as "combination of function image and inequality" to individualized learning schemes for diverse

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learners. The model constructs virtual learning partners through natural language interaction, which is significantly superior to the traditional adaptive system, and verifies the effectiveness of LLMs in supporting personalized meaning-making through dialogue

3.3. Intelligent expansion of educational resources

LLMs breaks through the temporal and spatial limitations of traditional educational resources through the dual path of content generation and scene construction, and its intelligent expansion ability presents significant education equity enabling value in the stage of basic education. For example, the large language model can break through the space limitation of textbooks, such as adding historical climate change cases, satellite cloud image analysis and other expanded contents that are not available in books for junior high school geography “monsoon climate” knowledge points. More innovatively, LLMs can create virtual scenarios. For example, in English teaching, they generate immersive dialogue scenes like “airport check-in” or “ordering a meal in a restaurant”, where students interact with virtual customer service. The model corrects grammar errors in real-time correct , suggests adjustments and dynamically adjusts the scene and task difficulty based on conversation fluency , enhaning students’ cross-cultural communication confidence and, making up for the lack of practice in traditional classroom. But in technical applications, stakeholders need to be mindful “formal” digital resources trap, such as excessive dependence on the standardization of model generation courseware and other issues need to be further management.

4. Challenges and measures

4.1. Academic integrity crisis and governance

A survey of universities finds that papers generated by models have a repetition rate below 15%, with their innovation index dropping by 42%, while their arguments how cheating techniques erode academic competence [8]. At the technical level, institutions can develop AI text generation detection algorithm. These algorithms use semantic coherence and reference pattern recognition to creates cross-platform academic content than libraries, enabling real-time tagging of suspicious paragraph. At the same time, an intelligent monitoring system for the writing process can be developed to identify “non-personal creation” behaviors by means of IP address tracking and device usage pattern analysis. Promote the reform of examination ways, increase weight of process evaluations (e.g., classroom discussions, experiment reports, field investigations), and weaken the single-weighting of paper scores. Meanwhile, an “credit system” can be established, integriting AI tool compliance training into the required content. By maintaining archives of student’ academic behaviors through positive incentive and punishment mechanism double-track system, institutions can guide technology back to its academic integrity roots.

In addition, the compulsory education stage should add “intelligence tool application” course, which deconstruct the working principle and “content credibility evaluation modules ” to cultivate students’ critical technology use skills. Students should be guided to gradually use models as research tools rather than alternatives, and their ability should be continuously cultivated to promote the systematization of digital literacy education.

4.2. Digital divide and imbalance in resource allocation

The coverage rate of AI labs in middle schools in eastern developed regions has reached 78%, and students can use professional-large language models through campus cloud platforms [9]. However,

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only 12% of rural schools in central and western China have basic network conditions. From the family level, 85% of middle school students in major cities have smart learning devices, and the proportion in counties is less than 30%, the differences of technology acquisition are likely to lead to widen the education gap [9-10]. To solve this problem, the Ministry of Education should publish relevant policy, clarifying the model shall be forbidden to use in specific scenarios, and require assignments links to be marked "AI auxiliary" with specific specification. At the same time, the Ministry of Education can also set up special funds to help achieve full network coverage and basic AI terminals in rural schools in central and western China by 2030. The "East Data, West Computing" project transfers eastern data computing tasks to western data centers, leveraging the west's abundant energy and low land costs to alleviate eastern computing pressure and energy consumption whil promoting the economic development of digital [11].

4.3. Dilemma of teachers' role transformation

The application of the large language model in education leads to the systematic reconstruction of the role of teachers, forming the dual challenges of "technical ability gaps" and "professional identity crisis". Among teachers over 45 years old, 67% reported being familiar with the application scenarios of model teaching. A survey of a normal university showed that only 23% of in-service teachers can independently design the "model-assisted inquiry learning" scheme [9]. Some teachers experience " technology dependence anxiety", fearing replaced by AI. They overlook educational functions like emotional connection, value guidance, etc. The education function of cannot be replaced by AI "AI + education" is implemented to build teachers' AI competencies. The training content includes modules such as model principle and teaching scene design. For example, referring to the "double-teacher classroom" mode carried out by a middle school in Beijing, the collaborative lesson preparation mechanism between subject teachers and AI technical specialists is constructed [12-13]. The former is responsible for the control target of teaching, which is responsible for call guidance model function and promotes teachers' transformation from "knowledge transmitters" to "learning designers".

4.4. Data security protection mechanism

Education platforms can refer to international standards of information security management system (such as ISO 27001) to carry out certification work. By adopting learning technologies that implement the "data at rest, model in motion" paradigm, personal information security can be protected. Students' composition data is encrypted locally, with only feature vectors transferred to the model [13]. Establish a cross-border data white list system, involves the transmission of personal information security evaluation center.

The influence of LLMs on education is both subversive and constructive. Only through the multi-dimensional synergy of policy regulation, teacher transformation and quality cultivation, can the technology potential energy be transformed into education kinetic energy. In the future, all parties need to find a balance between "technical efficiency" and "essence of education", and make the large language model become an enabling tool to promote education equity and improve teaching quality, rather than a risk source of differentiated education goals. This process is not only an innovation in the application of LMs, but also a catalyst for transforming China's educational philosophy from "knowledge indoctrination" to "ability cultivation".

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5. Conclusion

This paper systematically discusses the technology empowerment paths, potential challenges and countermeasures of LLMs in the field of education. Based on the constructivist learning theory and education equity theory, this paper analyzes the technology adaptation of LLMs in teaching assistance and personalized learning, as well as the problems existing in resource allocation.This paper points out that LLMs can achieve technology empowerment by optimizing teaching process, driving data-oriented personalized learning and expanding intelligent educational resources. At the same time, this study faces up to the academic integrity crisis, the imbalance of educational resources allocation, the dilemma of teachers' role transformation and the risk of data security caused by LLMs, and puts forward countermeasures from the dimensions of technology development, system design and teacher training.

There are also Limitations of this study.First, case analyses primarily focus on K-12 and higher education scenarios; discussions of vocational education, special education, and other subfields are insufficient, with a lack of cross-stage comparative research. Second, existing data mostly rely on secondary literature and some college surveys, lacking fully exploration of LLMs integrationwith other educational technologies. In the future, exploring LLMs' application in special education (e.g., language intervention for autistic children) and elderly education can deepen technology universality verification and facilitate exploration of interdisciplinary integration path.

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