A Summary of the Research Methods of Artificial Intelligence in Teaching

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Abstract. With modern technology developing rapidly, "Artificial Intelligence" becomes a hot word of the times. The integration of the development of information technology and artificial intelligence provides an opportunity for education optimization. This article briefly reviews the application of artificial intelligence in teaching from four aspects: learning environment creation, learning data analysis, learning resource matching, and learning path intervention. Through the creation of learning environment, it can broaden the learning dimension and help students to learn immersive. Through intelligent analysis such as multimodal data mining and affective computing learning analysis, it can identify students' emotional feedback for a certain content and help teachers adjust teaching content and progress with strong pertinence. Learning resource matching technology helps to match learning resources according to students' personality characteristics and appearance differences. Teachers can carry out learning path intervention for different students and help students to adjust their learning paths and consolidate knowledge learning. Some future research directions are proposed for some research methods. This will help relevant researchers to grasp the research in this field as a whole and play an important role in promoting the application and development of artificial intelligence in the field of education.

Keywords: Artificial intelligence · Education · Virtual Reality (VR) · Affective computing · Resource matching · Learning path

1 Introduction

Artificial intelligence (AI) is an emerging science and technology that researches and develops for simulating, extending, and expanding human intelligence [1]. Since its birth, AI has undergone continuous evolution and development, and has been valued and applied in more and more fields [2]. For example, medical treatment [3], transportation [4], logistics [5], etc. As a powerful science and technology, artificial intelligence will also promote the deepening of curriculum reform in the field of education, promote the continuous optimization of education structure, and better empower the formation of high-quality education system [6].

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2 Application Scenarios of Artificial Intelligence in Education

2.1 Learning Environment Creation

Virtual Reality (VR) technology and augmented reality (AR) technology have developed rapidly in recent years and have become mature. It also has a very wide range of applications in teaching. For example, through VR and AR teaching, you can freely travel through the universe, from small molecular movements to vast galaxies. VR and AR teaching can realize the specific presentation of affairs that are difficult to be directly observed by the human eye. The scene is strong and interesting, which can stimulate learners' interest. Not only that, but also the cost of the experiment can be saved. In the process of experimental teaching environment, VR and AR technology can be used to simulate experiments, which can not only make students familiar with the operation process, but also save the cost of experiments, which is obvious in flight attendant teaching [7]. The cost of flight attendant teaching to deal with emergencies is very high, and the required materials are expensive and cannot be reused. The use of AR and VR technology can save costs to a certain extent, although it can't completely replace the actual experiment, but it can play the effect of strengthening operation and accumulating experience.

Creation of specific teaching situation development cannot leave the scene. According to the research results of Zhong et al. [8], they designed a VR technology-based experiential learning environment that follows the principles of authenticity, convenient guidance, appropriate content, and reflection. In creating specific teaching scenarios, we can not only use the first-person perspective to enhance students' immersive experience but also employ the third-person perspective to reinforce the sense of reflection, dialogue operation, and other learning experiences.

Based on the application of AR, Qian et al. [9] combined 5G technology with AR to propose the joint application of 5G + AR for an immersive learning experience. The experience mode of 5G+ AR provides new features and opportunities for immersive learning. AR brings a "mind-body-environment" learning experience to immersive learning, while 5G offers a broader development space. The combination of 5G and AR overcomes the technical barriers of AR. Low latency, precise positioning, and high-quality communication constitute the basic infrastructure of 5G+ AR. They enable sensory interconnectivity, polymorphic simulation interaction, and personalized learning analysis, which facilitates the transformation of 5G+ AR.

Related to this, Guangdong Province has implemented the "Gigabit Optical Network + Cloud VR Education" [10] program in 2021, which will cover basic disciplines such as art, aesthetics, history and culture. The program will be implemented from the 12th school in Guangdong Province, with 40 s-grade students wearing VR equipment and following the teacher's guidance. Immerse yourself in the poetic world described by the poet. The effectiveness of AR and VR education has been confirmed in various ways. For example, Ruan et al. [11] take the environmental education courses for college students as an example and make a quantitative comparative analysis through experiments, concluding that the use of AR and VR environmental education courses can enhance students' awareness of environmental protection in colleges, promote teaching efficiency, and help shape a positive personality, cultivating college students' awareness of environmental protection and sustainable development.

The integration of AR, VR, and 5G broadens the spatial dimension of learning, creating a new learning environment for learners and broadening teachers' teaching methods, providing new ideas for teaching. While 5G technology solves the pain points of VR, such as slow loading times and low resolution, the current development scale of the 5G industry is still small, the cost is high, and the terminal is not mature enough. Therefore, the popularization of the joint application of 5G and AR requires continuous development of science and technology to solve the bottleneck problem of 5G.

2.2 Learning Emotional Data Analysis

This text is discussing the importance of learning emotion in relation to learners' efficiency, perception, and thinking ability. Facial expressions are a significant measure of one's emotional state, as they are often reflected through the movement of facial muscles. As a result, the latest research focus is on face recognition technology based on dynamic face portraits. The research methods generally include optical flow method [12], feature point tracking method [13], modeling method [14], difference method [15] and deep learning method, among which deep learning method is also a research hotspot in recent years. Zhang et al. [16] used deep learning method for micro-expression detection for the first time. Compared with traditional machine learning, the accuracy of detection has been improved, but only vertex frames can be detected. Tran et al. [17] proposed a sequential model based micro-expression detection method. Ding [18] used sliding window to segment long video clips of micro-expressions into several short videos, and combined optical flow with Long Short-Term Memory (LSTM) recurrent neural network. The improved low-complexity optical flow algorithm is used to extract the feature curve in order to predict the occurrence of micro-expressions using LSTM. However, the start and end frames are not precisely determined. Lei et al. [19] proposed a two-stream Graph Temporal Convolutional Network (Graph-TCN) for micro-expression recognition by acquiring motion features of local muscles of micro-expressions. Zhao et al. [20] proposed the Spatio Temporal AU Graph Convolutional Network (STA-GCN) as a deep learning-based emotion recognition method. Firstly, the spatiotemporal AU motion information of AU-related regions is extracted by a three-dimensional Convolutional Neural Network (3DCNN). Then, the dependence of AU is captured by Graph Convolutional Network (GCN). Finally, the activation features are multiplied with full face features for micro-expression recognition.

Wang et al. [21] combined AU with facial key points to construct four key regions of eyes, nose, cheeks, and mouth, weighted the corresponding regions, and finally combined the proposed MER-AMRE (MER framework with attention mechanism and region). The network extracts features and improves the ability of the network to extract local information.

While deep learning methods are widely used, the performance of deep learning is always low when the model is overfitting. It is worth noting that Ren et al. [22] proposed the Lung Cancer Data Augmentation Integration (LCDAE) framework, which has successfully overcome the overfitting problem in lung cancer classification tasks and has the best effect at present. This study may provide new ideas for related research on emotional data analysis.

Based on the deep learning technology of information fusion and the calculation method of data fusion, Zhai et al. [23] established the two-dimensional data model of middle school students' facial expression and facial pose emotion for online education, and established the learning emotion calculation mode of single-source data and multi-source data fusion, and obtained the optimal mode through comparison. Its main innovation lies in the establishment of multi-source data model and the integration of deep learning algorithms and data fusion algorithms. They organized a sample of 36 students for the experimental test. After the steps of data collection and screening, data labeling, division and selection of learning emotions, and data set division, the specific analysis pictures were determined, and four emotional labels of happy, confused, calm, and bored were labeled. The four emotions are analyzed, and the face pose feature points are focused. They chose the VGG-16 and ResNet-50 convolutional neural networks of the visual geometric network as the analysis models for emotional depth perception. They assigned different weights to the total outputs of the model and simulated the overall output for different emotions, assigning two kinds of weight to achieve weight assignment. Then, they integrated information about facial emotions and facial state to obtain the final emotion fusion model. According to their experimental results, the facial expression model was best at recognizing boredom, followed by happiness. The face pose model had the best recognition ability for boredom, followed by happiness. In selecting the optimal emotion model, the multi-source data model was considered the optimal emotion recognition model based on the fusion comparison results of the unit data model and the multi-source data model.

2.3 Learning Resource Matching

Resource recommendation technology has been widely used in various fields, including shopping, news, entertainment, and more. Different resource recommendation methods have been developed, such as collaborative filtering [24], content filtering [25], user experience level checking [26], association rules [27], and user feedback analysis [28]. Other recommended methods include Markov chain [29], resource ontology [30], hybrid model [31], Bayesian model [32], and so on. However, personalized recommendation in the field of education currently still faces challenges. Educational resources have unique characteristics and need to meet both learners' needs and their characteristics. Han et al. [33] proposed an effective matching principle-based recommendation method for educational resources to solve this issue. User modeling and resource modeling's characteristic information were used to construct a corresponding model. Because primary and secondary school students comprise the majority of users, the user model considered aspects of students' learning background, style, and ability. The resource model was constructed based on the learner model, using teaching resource background information, type, and difficulty level as the construction points, and digitizing the relationship model between each user and teaching resource. Then, the matching degree between students and teaching resources was calculated. The effectiveness of similar application learning resources, as well as the effect of users on teaching resources, were evaluated, and the matching efficiency of teaching resources and users was comprehensively assessed. Finally, teaching resources were suggested to users based on a numerical system of matching efficiency. This scheme fully considers students' learning backgrounds, personalized differences, and the effects of various resources on learners, thus meeting individual requirements and achieving efficient personalized recommendation. The Top-k learning resource selection algorithm, provided by Liang et al. [34], is based on content filtering and PageRank semantic similarity replacement. The algorithm adopts content filtering technology, which is mainly used to filter teaching materials similar to the files that users query and configure. The whole computational research design process can be summarized as follows: 1. Constructing the selection mode of teaching materials based on the vector filter of information content, and 2. Through PageRank operation, realizing the matching between various resources, establishing the Markov convergence matrix of the characteristics, and refining the recommendation results of various resources using Top-k operation. In addition to the theoretical design, they also used an open learning resource dataset to conduct experimental tests. According to the experimental results, their solution effectively solves the problem of polysemy and synonymy in text information processing in network teaching support IT, greatly improving the statistical accuracy of the algorithm.

2.4 Learning Path Intervention

The intervention of learning paths is mainly aimed at teachers. Through artificial intelligence technology, teachers can fully grasp learners' cognitive situation and implement interventions on their cognitive behavior by conducting portrait research [35], group stratification suggestion [36], learning diagnosis research, and personalized learning path recommendations. One of the most widely used methods is the "intervention-response" [37] method (RTI). The RTI method hierarchy consists of three levels, with nested multiple interventions. The first level of the RTI model is aimed at all learners, as the least targeted intervention effective for the majority of students in the class. The second-level intervention focuses on some students, monitoring and strengthening interventions for those who are still unqualified after the first-level intervention. The third-level intervention is a closely monitored method of intervention for individual learners. The RTI model has shown efficacy in precision teaching, as evidenced by domestic scholars' research. However, most of the studies have been conducted in traditional classroom environments that rely primarily on human intervention. These interventions are limited in effect, timeliness, and accuracy. To overcome these limitations, researchers can examine the model in non-traditional classroom environments and incorporate external interventions to test its effectiveness in different directions.

Yang et al. [38] proposed a cognitive intervention model based on cognitive analysis and supported by knowledge environments. Their model consists of learning data and behavior measurement data, analysis of learning states and characteristics, learning diagnostic behaviors, and assessments of learning process effectiveness. Intervention strategies for various learning difficulties, such as difficulty understanding knowledge, lack of interest in learning, and lack of concentration, were proposed. These targeted strategies can provide finely tailored interventions for students with different conditions, which is crucial for teachers to carry out successful interventions catered towards different student types.

In summary, the RTI model has the potential for precision teaching, and by considering the model in different learning environments and incorporating external interventions, it can promote more effective learning interventions. The cognitive intervention model proposed by Yang, W et al. serves as an excellent starting point for considering how to tailor interventions to specific types of students' learning difficulties.

3 Conclusion

This article discusses the application of artificial intelligence in four areas related to teaching methods, as listed in Table 1. These areas include creating a conducive learning environment, analyzing learning data, matching learning resources to students, and providing personalized learning paths. By broadening students' learning horizons, recognizing their emotional feedback for specific learning content, assisting teachers with organizing teaching content holistically, and matching resources to their individual characteristics, AI can help teachers and students interact more positively. This, in turn, can improve the overall quality of teaching and foster the development of a high-quality education system.

Table 1. Summary table of main references.

Reference	Year	Description	Heading level
[7]	2022	In-depth discussion of the positive role of VR/AR technology in teaching	Creation of a learning environment
[8]	2018	Explore immersive learning using 5G + AR	Creation of a learning environment
[9]	2022	Build an immersive learning environment with VR technology	Creation of a learning environment
[17]	2019	Improve the performance of localizing micro-expressions (MEs)	Creation of a learning environment
[18]	2019	Previous work on microexpression detection mainly focused on finding peak frames from video sequences containing microexpressions, and the computational amount is usually very large	Creation of a learning environment
[19]	2020	Address the low intensity problem of muscle movement associated with facial microexpressions (MEs)	Learn emotional data analysis
[20]	2021	An FME recognition framework called spatiotemporal action unit (AU) graph convolutional network (STA-GCN) is proposed	Learn emotional data analysis

(*continued*)

Table 1. (*continued*)

Reference	Year	Description	Heading level
[21]	2015	A new color space model, tensor independent color space (TICS), is proposed to help identify microexpressions	Learn emotional data analysis
[22]	2022	A lung cancer data enhancement integration (LCDAE) framework was proposed to solve the overfitting and low performance problems in lung cancer classification	Learn emotional data analysis
[23]	2022	Multi-source data fusion provides a model basis for effective learner affective computing, and an effective technical path for learning affective computing in online education environments	Learn emotional data analysis
[33]	2018	Based on the evaluation of the matching degree between resources and users and the prediction effectiveness of resources to users, a precise recommendation scheme of educational resources based on matching effectiveness is designed	Learning resource matching
[34]	2017	Top-k learning resource recommendation algorithm based on content filtering PageRank semantic similarity replacement is proposed	Learning resource matching
[37]	2014	This paper expounds on the intervention response model and its application theory in early education, and summarizes its enlightening effect on the development of preschool education in China	Learning path intervention
[38]	2022	To study and explore the effective intervention model to solve the learning difficulties of students with learning difficulties under the condition of intelligent technology	Learning path intervention

Artificial intelligence is a strategic, general-purpose technology, and the combination of artificial intelligence algorithms and models with educational scenarios will promote the leapfrog development of educational research [39]. It is believed that by the driving force of artificial intelligence, education modes and learning styles will gradually change, leading to the realization of educational modernization.

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