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On Practical Paths and Realistic Dilemmas of AI Intelligent Analysis in Classroom Teaching

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ABSTRACT: The core value of AI intelligent analysis in the classroom lies in its ability to achieve intelligent diagnosis and dynamic feedback on the teaching process through a three-dimensional collaborative mechanism of "objectives/features/algorithms". By leveraging multimodal data collection and analysis, it assists teachers in optimizing instructional design and adjusting teaching strategies, while simultaneously monitoring students' learning states and emotional changes in real-time, providing personalized learning support. However, in practice, AI intelligent analysis faces three major challenges: the lack of standardization in multimodal data integration, the limited interpretability of analysis results, and the ambiguity in the compliance of data collection. To address these issues, it is necessary to optimize the application of AI intelligent analysis in teaching from three perspectives—technology, education, and governance—thereby achieving a deeper transformation from "common adaptability" to "precise empowerment".

KEYWORDS: AI intelligent analysis, Classroom teaching, Realistic dilemmas

1. INTRODUCTION

As AI integrates into education, generative AI is advancing the automation, intelligence, and human-computer collaboration of classroom teaching, reshaping the core logic of teaching diagnosis and optimization. AI intelligent analysis leverages artificial intelligence to collect, process, and analyze classroom data, enhancing learning outcomes, enriching student experiences, and improving teaching efficiency. Using natural language processing and computer vision, it monitors students' focus and emotions in real time, providing precise feedback for personalized teaching and efficient classroom management. This approach moves beyond shallow behavior recognition, delving into the content and impact of teaching activities. Driven by data, AI supports teachers, students, and administrators, fostering a shift from "teacher-centered" to "student-centered" education. AI intelligent analysis represents the inevitable fusion of "AI + education" and the future of classroom digitization and intelligence.

2. DEVELOPMENT STAGES OF AI INTELLIGENT ANALYSIS IN CLASSROOM TEACHING

The development process of AI intelligent analysis in the classroom is the comprehensive result of the iteration of educational technology, the innovation of data collection methods, and the update of educational concepts. From the perspective of technological empowerment, as the traditional classroom teaching space progresses towards the intelligent space supported by the new - generation artificial intelligence, the development of classroom AI intelligent analysis can be roughly divided into four stages: traditional analysis based on manual methods, classroom analysis based on information technology, analysis supported by junior artificial intelligence, and analysis supported by generative artificial intelligence.

In the stage of traditional analysis based on manual methods, teaching analysis mainly adopts the method of manual annotation. The establishment of scales and the empirical interpretation of coding are the keys to determining the quality of analysis. The Flanders Interaction Analysis System (FIAS) and the S-T analysis method are quite representative in this stage. The advantages of such methods are low cost and relatively easy to learn, but they also have disadvantages such as low - efficiency analysis and being labor - intensive, making it difficult to support large - scale classroom analysis.

In the stage of classroom analysis based on information technology, educators began to use information tools to assist in coding and data processing, or directly generate charts automatically. For example, many educators improved the coding system and developed analysis tools on the basis of the FIAS system, forming analysis systems such as ITIAS, TBAS, and iFIAS for classroom analysis. Although these methods still follow the traditional interaction behavior analysis framework in terms of the perspective of attention, there has been a significant improvement in analysis efficiency and visual presentation.

In the stage of analysis supported by junior artificial intelligence, the introduction of artificial intelligence technology has promoted the intelligence of classroom analysis, and the collection of classroom data has achieved automation and large - scale. Its intelligent transformation presents three significant characteristics: the upgrade of perception from manual coding to machine vision, the evolution of cognition from single - modality analysis to multi - modality fusion, and the transformation of decision - making from empirical judgment to data - driven. The introduction of artificial intelligence in this stage has expanded the breadth and precision of teachers' classroom analysis.

In the stage of analysis supported by generative artificial intelligence, relying on the powerful generative and reasoning abilities of large language models, generative artificial intelligence shows great potential in classroom AI intelligent analysis. Many educational institutions have achieved quantitative and qualitative analysis of teachers' teaching abilities by constructing large multi - modality data analysis models and vertical large models for expert teaching evaluation. Some educational institutions have designed teaching and research AI agents based on the chain - of - thought prompting logic to assist in the interpretation and transformation of classroom teaching analysis reports, so as to solve the dilemma of "teachers having difficulty in understanding classroom AI intelligent analysis reports". Although the development of this stage is still in the exploration period, generative artificial intelligence has shown important value in opening the "black box" of classroom intelligent analysis and providing actionable teaching improvement suggestions.

Overall, early classroom analysis only focused on the surface phenomena of classroom behaviors and mainly relied on outcome - based evaluation. After the emergence of artificial intelligence technology, classroom analysis has developed to rely on artificial intelligence technology and can conduct interpretable analysis of the teaching process. The development of generative artificial intelligence technology has broken through the limitation of teachers' lack of direct participation in the process of generating classroom diagnostic reports, enabling teachers to carry out human - machine collaborative teaching with AI, thus realizing the dynamic improvement and continuous optimization of teaching.

3. PRACTICAL PATHS FOR AI INTELLIGENT ANALYSIS IN CLASSROOM TEACHING

The core of AI intelligent analysis in classroom teaching lies in the realization of intelligent diagnosis and dynamic feedback of the classroom teaching process through the three-dimensional coordination mechanism of “objectives/features/algorithms”. From the perspective of evaluation objects, the empowerment of teaching by AI intelligent analysis in classroom teaching mainly involves three dimensions: teachers, students and teaching evaluation. Each dimension is not only the object of analysis, but also an important entry point for teaching improvement.

3.1 The practical of teachers’ dimension

AI intelligent analysis can accurately capture and scientifically analyze teachers' classroom teaching behavior through multi-source data and intelligent algorithms, so as to realize the objective diagnosis and dynamic optimization of the level of teaching ability. Its main applications are concentrated in the analysis of teachers' teaching behavior, attention distribution analysis, classroom question and answer behavior analysis, and ability assessment based on teaching behavior, promoting the transformation of teachers from experience-driven to data-driven precision teaching.

For example, AI can identify whether the teacher's speech speed and tone are suitable for students to understand when explaining a certain knowledge point, or whether the teacher's interaction frequency in classroom management is reasonable; According to students' learning feedback data, AI can detect when students generally have difficulties understanding certain areas of content. In such cases, it can suggest that teachers adjust their teaching methods or provide additional supporting examples. In addition, AI can also help teachers with teaching reflection, by generating detailed classroom reports, analyzing the highlights and shortcomings of teaching, so as to provide directions for continuous improvement. This kind of teaching optimization based on data not only improves teachers' teaching efficiency, but also promotes the innovation of teaching mode, so that teachers can better adapt to the personalized needs of students.

3.2 The practical of students’ dimension

In students’ dimension, the core of AI intelligent analysis lies in the realization of accurate diagnosis and dynamic feedback of students' learning status through multi-modal data collection and algorithm analysis. Based on the accurate perception and analysis of students' learning behavior, learning style and learning interest by the AI intelligent analysis in classroom teaching system, it helps to promote the implementation of "student-centered" personalized teaching and provides scientific support for differentiated teaching and precise intervention.

For example, AI can real-time monitor students' emotional changes and attention distribution in the classroom through facial expression recognition, eye movement tracking and other technologies, so as to judge their learning engagement. If AI finds that a student is frequently distracted in class, it can timely remind the teacher or the student himself, or even automatically push relevant learning resources to help the student refocus. AI can identify the weak links in learning by analyzing students' classroom interaction, homework completion and test scores, and recommend personalized learning paths for them. In addition, AI can also generate learning files by long-term tracking of students' learning data, helping teachers and parents better understand students' learning

habits and growth trajectory. This kind of personalized learning support based on AI not only improves students' learning efficiency, but also enhances their learning initiative and confidence.

3.3 The practical of teaching evaluation's dimension

Teaching evaluation is an important link to analyze the effectiveness of classroom teaching from a macro perspective, and it is also a concentrated demonstration of how AI intelligent analysis in classroom teaching enhances classroom management and evidence-based teaching research. In the dimension of teaching evaluation, AI intelligent analysis provides a more scientific and comprehensive solution for classroom teaching evaluation through the integration of multi-dimensional data and the construction of algorithm models.

First of all, AI can collect data from multiple dimensions such as teachers, students and classroom environment, including teachers' teaching behavior, students' learning status, classroom interaction frequency, etc., and generate objective and quantitative classroom evaluation reports through the comprehensive analysis of these data by algorithm models. AI can evaluate the teaching efficiency of teachers in the classroom, the learning outcome of students, and the overall quality of the classroom atmosphere, so as to provide a basis for teaching improvement. Secondly, AI can identify the rules and trends in teaching by long-term tracking of classroom teaching data, and provide decision-making support for curriculum optimization and resource allocation for education managers. In addition, AI can also dig excellent teaching cases for teacher training by comparing the teaching data of different teachers or classes. This kind of teaching evaluation system based on AI not only improves the scientificity and objectivity of evaluation, but also provides a strong guarantee for the continuous improvement of teaching quality.

4. REALISTIC DILEMMAS OF AI INTELLIGENT ANALYSIS IN CLASSROOM TEACHING

4.1 The lack of standardization in multimodal data integration,

Classroom AI intelligent analysis relies on multi-modal data from different devices, different formats, and different time stamps, such as classroom videos, voice conversations, handwriting trajectory and interaction records of learning platforms. How to efficiently and accurately integrate these heterogeneous data is a core issue affecting the quality of analysis.

First, there is a lack of unified classroom data collection and annotation standards. At present, classroom collection devices and analysis platforms in different regions and manufacturers often adopt their own data formats and annotation systems, making it difficult to share data across platforms and joint modeling. This "data island" phenomenon not only reduces the comparability of analysis, but also increases the cost of algorithm adaptation and maintenance.

Second, the technical threshold for multi-modal data synchronization and fusion is high. Classroom behavior occurs in a highly dynamic and multi-interference environment, and there are problems such as inconsistent acquisition frequency, time delay, and signal-to-noise ratio differences in different modal data, which directly affect the accuracy of feature extraction and fusion modeling. Although cross-modal alignment and feature mapping algorithms currently exist, their real-time performance and stability still need improvement in high-complexity scenarios such as classrooms.

4.2 The limited interpretability of analysis results

Although techniques such as deep learning perform well in classroom behavior recognition and prediction, their "black box" characteristic makes it difficult for teachers to understand the analysis results intuitively, thus affecting their adoption and application in teaching practice.

First, there is a lack of an interpretation framework for instructional decision-making. The results of AI intelligent analysis in classroom teaching are mostly presented in the form of statistical indicators or heat maps, which are accurate but rarely explain how these indicators map to executable teaching strategies. For example, the system prompts "low teacher interaction frequency", but does not further indicate which links should be adjusted and what kind of interaction method should be adopted, making it difficult for teachers to translate the analysis results into operational classroom adjustments. At the same time, although the introduction of large models and intelligent agents provides technical feasibility for addressing the interpretability issues in AI intelligent analysis in classroom teaching, their practical implementation in educational scenarios still requires coordination with educational knowledge graph construction, subject-specific prompt design, and localized deployment to ensure the scientificity and situational adaptability of strategy generation.

Second, it neglects the integration of educational theory and contextual factors. Many analysis models only optimize recognition and prediction accuracy from a technical perspective, while ignoring the differences in behavior patterns under different subjects, different age groups, and different teaching objectives. This "decontextualized" analysis often lacks specificity and is difficult to complement teachers' empirical judgments, weakening the practical value of intelligent analysis.

4.3 The ambiguity in the compliance of data collection

AI intelligent analysis in classroom teaching heavily relies on the continuous collection of multi-modal data, including video, audio, sensor records, and learning behavior logs. However, this "panoramic" data acquisition, while promoting teaching diagnosis and optimization, also inevitably touching upon the sensitive areas of data security and personal privacy protection.

First, there is a grey area in the legality and compliance of classroom data collection. When schools use cameras, wearable devices, or online learning platforms to collect classroom behavior data, there is often a lack of unified norms and institutional guarantees. Especially when it comes to biometric information such as facial expressions, voice characteristics, and physiological signals, issues such as whether informed consent has been obtained and whether data storage and transmission are encrypted may trigger legal and ethical disputes.

Second, the risk of data abuse and secondary use is increasing. In the context of large-scale data collection, classroom data is not only used for teaching analysis, but may also be used for commercial development, algorithm training, and other activities beyond the original authorization scope. Once there is a lack of strict data access permission control and tracking mechanisms, data leakage or improper use will seriously harm the rights and interests of teachers and students, and weaken the trust of education entities in the intelligent analysis system.

5. CONCLUSION AND RECOMMENDATIONS

AI intelligent analysis in classroom teaching has become an important way to promote the transformation of classroom teaching from "experience-driven" to "digital intelligence-driven", and from "common adaptation" to "precise empowerment". It has shown significant practical paths in the three dimensions of teachers, students and teaching evaluation: in the teacher dimension, it can accurately depict teaching behavior through multi-modal data and intelligent algorithms, supporting evidence-based self-diagnosis and improvement; in the student dimension, it can realize real-time perception of learning behavior and cognitive state, promoting personalized teaching and precise intervention; in the teaching evaluation dimension, it can provide comprehensive analysis support for classroom processes and results, promoting evidence-based improvement and quality assurance. Therefore, classroom AI intelligent analysis not only expands the depth and breadth of classroom teaching analysis, but also provides a new fulcrum for teaching research and the refinement of teacher professional development.

The three core dilemmas that restrict the deep application of classroom AI intelligent analysis include: first, insufficient integration and standardization of multi-modal data, which weakens the accuracy and comparison of cross-platform and cross-scene analysis; second, limited interpretability of analysis results, making it difficult to effectively transform technical output into executable teaching strategies; third, insufficient systems and risk accumulation of data collection and privacy protection, affecting the trust and acceptance of education entities in intelligent analysis systems. These dilemmas indicate that there is still a "gap" between the technical potential and educational value of AI intelligent analysis in classroom teaching.

To address the problem of multi-modal data fusion and standardization in AI intelligent analysis in classroom teaching, it is first necessary to establish unified classroom data collection and annotation standards, and promote data sharing and joint modeling within the industry. The education department should take the lead in formulating relevant norms, clarifying data formats, collection frequencies, and annotation systems, to ensure that data from different devices and platforms can be seamlessly connected. At the same time, it should increase investment in research and development of multi-modal data synchronization and fusion technologies, develop real-time algorithms adaptable to high dynamic classroom environments, and improve the accuracy and stability of data alignment. For example, the impact of data delays and signal-to-noise ratio differences on analysis results can be reduced by optimizing the time stamp synchronization mechanism and introducing multi-modal feature mapping technology. In addition, cross-disciplinary collaboration should be encouraged to combine knowledge from education, psychology and computer science to design data fusion models that better suits classroom scenarios, providing technical support for improving analysis accuracy.

To address the issue of insufficient interpretability of analytical results, it is necessary to construct an explanatory framework oriented towards instructional decision-making, tightly integrating technical analysis with educational practice. First of all, the intelligent analysis system should not only provide statistical indicators or heat maps, but also further generate specific teaching improvement suggestions. For example, when the system prompts "low teacher interaction frequency", it should clearly suggest specific strategies such as increasing questions, group discussions, or individual counseling based on the classroom situation. Secondly, the introduction of education knowledge graphs and subject-specific prompts design enhances the contextual adaptability of analysis results. By combining educational theory with technical models, it is ensured that the analysis results can complement teachers' empirical judgments and improve their operability in actual teaching. Furthermore, teacher training should be strengthened to help them understand and effectively utilize intelligent analysis results, thereby promoting the practical application of technology.

In response to the ambiguity regarding classroom data collection compliance and privacy and ethical disputes, it is urgent to improve relevant laws and regulations , as well as institutional construction, and clarify the boundaries of data collection, storage and use. First of all, the education department should formulate a compliance guide for classroom data collection to ensure that when collecting sensitive information such as facial expressions and voice characteristics, full informed consent is obtained from teachers, students and parents, and encryption technology is used to protect data security. Secondly, establish strict data access permission control and tracking mechanisms to prevent data abuse and secondary use. For example, the traceability of data can be achieved through blockchain technology to ensure that data use complies with the authorized scope. At the same time, strengthen data ethics education to enhance teachers' and students' awareness of data privacy protection, and promote the healthy development of intelligent analysis systems within a legal and compliant framework.

In the future, to address the challenges of AI intelligent analysis in classroom teaching requires coordinated advancement from multiple dimensions, including technology, policy, and educational practice. At the technical level, continue to optimize algorithm models to improve the efficiency and accuracy of data fusion and analysis; at the policy level, improve laws and regulations to provide institutional guarantees for data collection and use; at the education practice level, strengthen teacher training and cross-disciplinary collaboration to promote the deep integration of intelligent analysis technology and teaching needs. Through multi-party collaboration, AI intelligent analysis in classroom teaching will better serve educational modernization and provide strong support for improving teaching quality and learning outcomes.

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