A Study on the Impact of English Teachers' AI Literacy on Classroom Teaching Effectiveness

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Abstract: *With the deep integration of artificial intelligence into foreign language education, English teachers' AI literacy has become a key variable affecting classroom teaching effectiveness. This study systematically elucidates the mechanism through which AI literacy impacts classroom teaching effectiveness: it reconstructs the composite dimensions of AI literacy and the intelligent interactive attributes of classroom teaching effectiveness, revealing the nonlinear coupling relationship between the two; from three pathways, namely intelligent tool operation capability, algorithm understanding level, and data interpretation literacy, it respectively clarifies their influence mechanisms on resource adaptation efficiency, dynamic decision-making adjustment, and learning diagnosis accuracy; and it constructs an effectiveness optimization model that includes a structured adaptation framework, a bidirectional gain logic, and a closed-loop regulation system. This research provides a systematic theoretical framework for understanding the intrinsic relationship between AI literacy and teaching effectiveness.*

Keywords: *English teachers' AI literacy; classroom teaching effectiveness; intelligent tool operation capability; algorithm understanding level; data interpretation literacy; human-machine collaboration.*

Introduction

The widespread application of artificial intelligence technology in areas such as teaching resource generation, learning behavior analysis, and personalized feedback delivery is reshaping the professional competence structure of foreign language teachers. English classroom teaching is gradually shifting from the traditional teacher-learner dyadic interaction to a teacher-AI-learner triadic collaborative model, and this transition poses new requirements for teachers' AI literacy. However, current research on the relationship between AI literacy and teaching effectiveness mostly remains at the level of macro-level description and lacks in-depth analysis of the underlying mechanisms. Specifically, key questions such as how intelligent tool operation capability affects resource adaptation efficiency, how algorithm understanding level moderates classroom decision-making, and how data interpretation literacy mediates the accuracy of learning diagnosis have not yet been systematically answered. Therefore, this study has significant theoretical necessity: on the one hand, it helps to clarify the causal logic and transmission pathways between the various dimensions of AI literacy and classroom teaching effectiveness; on the other hand, it can provide theoretical support for constructing strategies to enhance classroom teaching effectiveness in intelligent educational environments. Through three progressive levels, namely conceptual reconstruction, mechanism analysis, and model construction, this study attempts to establish a systematic explanatory framework for the impact of English teachers' AI literacy on classroom teaching effectiveness.

1. Conceptual Reconstruction of English Teachers' AI Literacy and Classroom Teaching Effectiveness

1.1 Composite Dimensions and Technological Embeddedness Characteristics of English Teachers' AI Literacy

English teachers' AI literacy manifests as a multi-layered and decomposable professional competence structure, encompassing four core dimensions: algorithm understanding, data identification, intelligent tool operation, and adaptive integration in teaching scenarios. The dimension of algorithm understanding refers to teachers' cognitive level regarding the underlying logic of natural language processing, learner profile generation, and the like; the dimension of data identification involves the collection, cleaning, and preliminary interpretation of classroom behavioral data; the dimension of intelligent tool operation focuses on proficiency in using specific applications such as speech synthesis, automated grading, and adaptive learning systems; and adaptive integration in teaching scenarios emphasizes the dynamic reorganization and synergistic operation of the above dimensions in real classroom environments. The technological embeddedness characteristics are manifested in the process in which AI tools gradually shift from assisting resource presentation to participating in instructional decision-making, and this process deeply depends on teachers' matching judgments between technological boundaries and teaching objectives.

1.2 Connotative Extension and Intelligent Interactive Attributes of Classroom Teaching Effectiveness

Classroom teaching effectiveness undergoes connotative extension in the context of foreign language educational technology, extending from traditional efficiency indicators such as time utilization rate and task completion rate to a multidimensional construct that encompasses intelligent interaction quality, personalized feedback timeliness, and the degree of learning path adaptivity. The intelligent interactive attributes are manifested in three key features: first, human-machine collaborative interaction, in which teachers and AI systems jointly participate in classroom discourse flow and response generation; second, data-driven real-time interaction, which relies on real-time learning analytics to achieve fine-tuning and reorganization of teaching strategies; and third, cross-modal interaction, which integrates semantic alignment and information complementation across channels such as speech, text, and images. These attributes mean that teaching effectiveness is no longer dependent solely on the teacher's unilateral output, but rather manifests as the systemic effectiveness of dynamic adaptation among the teacher, AI, and learners[1].

1.3 Theoretical Coupling Relationship between AI Literacy and Classroom Teaching Effectiveness

AI literacy and classroom teaching effectiveness form a nonlinear theoretical coupling relationship, the foundation of which lies in the task-tool matching logic mediated by technology. When English teachers' AI literacy is above a certain threshold, intelligent tools can be transformed into facilitating factors for teaching effectiveness, which are specifically manifested as the cognitive offloading effect (reducing repetitive decision-making loads) and the precise intervention effect (improving the quality of individual learning responses). Conversely, insufficient literacy may lead to technological mismatch or functional idleness, resulting in effectiveness loss. The key nodes of the coupling mechanism include teachers' calibration ability regarding AI output results, their sensitivity to identifying algorithmic bias, and their reserve of alternative strategies in the event of technological failure. The synergistic operation of these three factors determines the actual efficiency of the transformation from AI literacy to classroom teaching effectiveness, forming a recursive reinforcing loop of "literacy-application-feedback-re-literacy."

2. Pathway Mechanisms through Which English Teachers' AI Literacy Affects Classroom Teaching Effectiveness

2.1 Transmission Effects of Intelligent Tool Operation Capability on Teaching Resource Adaptation Efficiency

2.1.1 The Compression Mechanism of Operational Fluency on the Time Consumption of Resource Selection

Operational fluency refers to the degree of proficiency with which teachers complete a series of actions such as tool initiation, command input, and parameter adjustment. During the resource preparation stage of English classroom teaching, operational fluency directly determines the time cost of extracting appropriate content from corpora or multimodal platforms. When retrieval is completed quickly through shortcut key combinations or batch processing functions, the proportion of time available for content review and difficulty adaptation within a given teaching unit increases significantly; operational interruptions or repeated trial-and-error, on the other hand, prolong selection time consumption, occupy cognitive resources that should be devoted to core teaching procedures, and weaken the matching accuracy between instructional materials and learners' language proficiency levels.

2.1.2 The Enhancing Effect of Deep Invocation of Tool Functions on the Degree of Resource Personalization

The advanced functions embedded in intelligent tools, such as stratified retrieval, difficulty self-adaptation, and semantic similarity ranking, have their value realization dependent on whether teachers can shift from surface-level operation to deep parameter regulation. Teachers who are able to invoke these advanced functions can set resource filtering thresholds according to the distribution of class language proficiency, for example, by controlling text complexity within the range of i+1 to i+2, or by prioritizing targeted exercises based on the frequency of grammatical errors. Deep invocation behaviors enable the same tool to output differentiated sets of materials across different classes or groups, thereby avoiding the restriction of teaching effectiveness caused by resource homogenization.

2.1.3 The Mitigating Effect of Operational Strategy Repertoire on Tool Function Redundancy

Tool function redundancy manifests as modules that exceed the actual needs of teaching practice, and operational strategy repertoire refers to teachers' ability to select appropriate operational pathways for different tasks, including identifying core and peripheral functions, judging the necessity of function combinations, and maintaining interface orientation. Teachers with sufficient strategic repertoire are able to proactively bypass redundant modules, focus their operations on functions directly related to teaching objectives, reduce cognitive load, and enhance the precision of resource adaptation; insufficient strategic repertoire, on the other hand, tends to lead teachers to be guided by the interface toward unnecessary pathways, resulting in resource acquisition deviating from instructional intentions and a consequent decline in transmission efficiency.

2.2 The Moderating Role of Algorithm Understanding Level on Dynamic Generative Decision-Making in the Classroom

2.2.1 Calibration of Decision Adoption Threshold through Recognition of Algorithm Output Confidence

An important dimension of algorithm understanding level is teachers' ability to judge the confidence of AI output. Most intelligent teaching systems provide confidence scores or probability distributions in an implicit manner. English teachers with a relatively high level of understanding are able to identify low-confidence outputs (such as syntactic analysis results with ambiguous boundaries) and accordingly raise the adoption threshold for decision-making, adopting review or rejection strategies. This calibration mechanism prevents erroneous teaching guidance caused by automatic adoption, and ensures that dynamic generative decision-making in the classroom is based on reliable technical output[2].

2.2.2 The Corrective Role of Algorithm Bias Sensitivity on the Direction of Teaching Intervention

Algorithm bias manifests as the system's tendency to produce skewed outputs toward specific linguistic structures or stylistic registers due to imbalanced training data. English teachers' bias sensitivity is reflected in their ability to detect that the system repeatedly marks certain non-standard expressions or exhibits low recognition rates for particular spoken variants. In dynamic classroom decision-making, this sensitivity prompts teachers to critically examine AI output and, when systematic bias is identified, to actively adjust the direction of intervention, such as by supplementing explanations of algorithmic limitations or temporarily switching to non-automated strategies. The higher the bias sensitivity, the more effectively it prevents algorithmic deficiencies from being transferred to classroom decision-making, thereby maintaining the pragmatic rationality of teaching interventions.

2.2.3 The Support of Algorithmic Logic Mapping for Decision Flexibility in Uncertainty Contexts

Dynamic generative decision-making in the classroom often occurs in highly uncertain contexts, such as unexpected pragmatic issues or cross-linguistic transfer errors. Algorithmic logic mapping refers to teachers' ability to inversely map abstract outputs back to the system's processing rules and to understand the generative logic behind the conclusions. Teachers equipped with such mapping ability can quickly assess the applicable boundaries of AI output in uncertain situations, and decide whether to fine-tune parameters within the original framework or to completely detach from AI and shift to autonomous decision-making. This decision flexibility allows the teacher's leading role in human-machine collaboration to be maintained, and prevents the classroom from becoming rigid due to technological mismatch.

2.3 The Mediating Mechanism of Data Interpretation Literacy on the Diagnostic Accuracy of Learning Behaviors

2.3.1 The Hierarchical Impact of Data Granularity Selection on Diagnostic Resolution

Learning behavior data can be collected at different granularities, such as the task level (completion degree of a whole composition), the sentence level (number of modifications per sentence), and the word level (dwelling time on specific vocabulary retrieval). Data interpretation literacy is first manifested in teachers' ability to select the appropriate granularity according to the diagnostic objective: macro-level diagnosis calls for aggregated data at the task level, whereas the localization of individual difficulties requires descending to the sentence or word level. Adhering to a single granularity leads to resolution mismatch—excessively coarse granularity obscures local problems, while excessively fine granularity increases information noise. Accurate diagnosis depends on teachers' flexibility in switching among different granularities and their integrative ability to correlate and interpret multi-granularity data.

2.3.2 The Decisive Role of Attribution Judgment of Outliers in Diagnostic Reliability

Outliers in learning behavior data, such as excessively long time spent on simple items or unusually rapid responses to complex tasks, require attribution judgment to distinguish whether they originate from technical recording errors, contextual factors, or genuine cognitive difficulties. Incorrect attribution directly undermines diagnostic reliability: misjudging cognitive difficulties as technical errors leads to the absence of intervention, while attributing technical errors to cognitive difficulties triggers unnecessary adjustments. Teachers with relatively high interpretation literacy tend to establish multi-source verification strategies, such as cross-checking abnormal response times with performance on other tasks, or confirming the true causes of outliers through immediate follow-up questioning.

2.3.3 The Pathway through Which Multi-source Data Fusion Enhances the Actionability of Diagnostic Conclusions

The diagnostic information provided by a single data source is limited and prone to interference from superficial factors. The ability of multi-source data fusion is manifested in teachers' joint interpretation of data from different dimensions, such as correct rate, response timing, revision trajectory, and speech fluency, so as to form actionable diagnostic conclusions. Integrative interpretation can reveal the cognitive strategy differences hidden behind the correct rate: two students with the same correct rate may respectively exhibit "quick response without revision" and "correct after multiple revisions"; the former suggests a higher degree of automation in procedural knowledge, while the latter suggests active metacognitive monitoring but inefficient knowledge retrieval. Teaching instructions derived from integrative diagnosis are more targeted than those from single-source diagnosis, thereby improving the efficiency of transformation from data to pedagogical action[3].

3. Optimization Model of Classroom Teaching Effectiveness Based on AI Literacy Enhancement

3.1 A Structured Adaptation Framework of AI Literacy for Teaching Scenarios

3.1.1 Classification of Teaching Scenarios and Mapping of AI Literacy Demands

English classroom teaching scenarios can be classified into categories such as explicit knowledge instruction, skill training, pragmatic generation, and classroom management, based on task type and the degree of technological involvement. Different scenarios entail varying weight distributions across the dimensions of teachers' AI literacy: explicit knowledge instruction emphasizes the credibility judgment of algorithm-recommended content; skill training stresses proficiency in tool operation; pragmatic generation relies on data interpretation literacy to locate error types in language use; and classroom management focuses on the ability to handle anomalies in automated processes. The establishment of such demand-mapping relationships provides a classification basis for the organization of competency units.

3.1.2 The Structured Organization of Scenario-Sensitive Competency Units

The structured adaptation framework decomposes AI literacy into competency units that can be independently invoked or compositely integrated, with each unit corresponding to the functional requirements of a specific scenario. The organization of competency units follows the principles of horizontal independence and vertical nesting: horizontal independence means that the competency units for different scenarios are logically separable, thereby avoiding redundant competency burdens; vertical nesting means that higher-order scenario units include lower-order units as prerequisites. This organizational structure enables teachers to quickly activate relevant competency units according to the current teaching scenario, thereby enhancing the goal-directedness of technology application.

3.1.3 The Dynamic Calibration Mechanism of the Adaptation Framework

Teaching scenarios undergo continuous evolution in the course of classroom instruction, in response to student reactions and task phases, and the adaptation framework incorporates a built-in dynamic calibration mechanism to adjust the activation weights of competency units. This calibration mechanism relies on both explicit signals (teachers' active mode switching) and implicit signals (system monitoring of interaction frequency or error rate fluctuations). When implicit signals indicate a drift in scenario type, the framework automatically triggers a redistribution of competency unit weights, for example, shifting from an emphasis on operational proficiency to an emphasis on the depth of data interpretation, thereby preventing the literacy framework from degenerating into a static classification table[4].

3.2 The Bidirectional Gain Logic of Classroom Effectiveness from the Perspective of Human-Machine Collaboration

3.2.1 The Positive Support Pathway of AI Systems for Teachers' Decision-Making Efficiency

The positive support pathway begins with the preprocessing and structured presentation of classroom information flow by AI systems. The AI system completes in real time the speech transcription, grammatical error annotation, and fluency calculation of students' oral output, and transforms the raw data into diagnostic summaries, thereby achieving cognitive offloading. Teachers no longer need to simultaneously undertake the threefold tasks of information collection, feature extraction, and instructional decision-making, and the decision-making cycle is significantly shortened. Teachers without such support need to go through four steps of observation, recording, analysis, and judgment to complete instructional adjustments, whereas under AI support, the steps of observation and recording are replaced, and decision-making efficiency is theoretically improved.

3.2.2 The Reverse Calibration Effect of Teacher Feedback on AI Model Output

The reverse calibration effect originates from the modification of AI model output rules by teachers' pedagogical judgments. When teachers detect a systematic deviation between the suggestions provided by the AI and the actual learning state of the class, they input signals to the system through explicit feedback (such as scoring, marking, and replacement) or implicit feedback (such as the frequency distribution of ignoring certain types of suggestions). Upon receiving the feedback, the system adjusts its parameters, for example, by recalibrating the threshold for grammatical error annotation or updating the recommendation weights of corpora. This reverse calibration enables the AI model to gradually adapt to the current teacher's teaching style and the linguistic characteristics of the class, thereby preventing the under-adaptation of generic models in specific classroom environments.

3.2.3 The Identification and Repair Mechanisms for Interruption Nodes in Bidirectional Gain

Interruption nodes in bidirectional gain may occur, manifesting as persistent conflicts between AI output and teacher judgment, system information exceeding teachers' interpretive capacity, or ineffective transmission of feedback signals. The identification mechanism detects states in which suggestions are frequently overridden without system adjustment, through comparative analysis of teachers' operation logs and system response logs. The repair mechanism provides three types of operations, namely path resetting (clearing accumulated biases), hierarchical reduction (disabling some AI functions), and manual takeover (switching to teacher-led mode), and resumes collaboration after the system converges[5].

3.3 Closed-loop regulation system of teaching effectiveness driven by dynamic feedback.

3.3.1 The real-time perception of teaching state and data collection granularity

The first link of the closed-loop regulation system is the real-time perception of teaching state, and its core lies in the setting of data collection granularity. Excessively coarse granularity leads to the loss of critical transient information, while excessively fine granularity generates redundant noise. English classrooms adopt a hierarchical granularity strategy: at task switching points, the transition time is recorded at the second-level granularity; during stable execution phases, the completion quality is recorded at the task-level granularity; and during interaction-intensive phases, the response sequences are recorded at the turn-level granularity. The data collection granularity is dynamically adjusted by the system according to the classroom rhythm, and teachers can set thresholds for intervention.

3.3.2 Diagnosis of Effectiveness Deviation and Generation of Intervention Strategies

The perceived data need to be compared with the effectiveness baseline to identify the direction and magnitude of deviation. The diagnosis of effectiveness deviation includes deviation localization (determining whether the decline in effectiveness occurs in the dimension of knowledge transmission, skill training, or management) and deviation attribution (distinguishing among teacher-related, student-related, or technological factors). After the diagnosis is completed, the process moves to the generation of intervention strategies, and the strategy library is organized by deviation type: deviation in the knowledge transmission dimension corresponds to adjusting the density of examples or switching the difficulty level of corpora; deviation in the skill training dimension corresponds to shortening the duration of practice units or lowering the threshold for speech recognition. The strategy generation follows the principle of minimal intervention, giving priority to the available strategy that entails the smallest adjustment magnitude.

3.3.3 Feedback Delay Control and Adaptive Adjustment of Step Size

The effectiveness of the closed-loop regulation system depends on the matching between feedback delay and adjustment step size. Feedback delay refers to the time interval from perception to intervention execution, and an excessively long delay may lead to phase lag. The control strategies include deploying the diagnostic module on edge computing nodes and pre-generating intervention plans for common deviations. The adjustment step size refers to the magnitude of parameter change in a single intervention; an overly large step size may trigger system oscillation, while an overly small step size results in slow convergence. The adaptive adjustment algorithm dynamically modifies the step size based on historical intervention effects: when two consecutive interventions in the same direction yield improvement, the step size is gradually increased to accelerate convergence; when overshoot occurs, the step size is immediately halved and the adjustment frequency is reduced, so that the regulation system maintains stable convergence characteristics across different teaching rhythms.

Conclusion

This study systematically investigates the impact of English teachers' AI literacy on classroom teaching effectiveness from three levels, namely conceptual reconstruction, pathway mechanisms, and optimization modeling. The study clarifies the multidimensional structure of AI literacy and the intelligent interactive attributes of classroom teaching effectiveness, reveals three differentiated influence pathways of operational capability, algorithm understanding, and data interpretation, and constructs an effectiveness optimization model that integrates an adaptation framework, a bidirectional gain logic, and a closed-loop regulation system. The above theoretical work provides an extensible analytical framework for foreign language teaching research in intelligent educational environments.

Future research can be pursued in the following directions: first, future research can explore the differential characteristics of English teachers' AI literacy structure across different educational stages, such as basic education and higher education; second, it can examine the matching issue between the iteration speed of AI systems and the development cycle of teachers' literacy; third, it can investigate the degree of dependence of tacit knowledge transfer in the classroom on AI literacy and its boundary conditions; fourth, it can develop literacy support tools based on natural interaction interfaces to reduce teachers' technological cognitive load. The advancement of the above directions will further improve the theoretical landscape of the relationship between English teachers' AI literacy and classroom teaching effectiveness.

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