Application Models and Effectiveness Evaluation of Artificial Intelligence Assistants in Information Technology Classes

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Abstract: *With the rapid advancement of artificial intelligence technology, the application potential of intelligent assistants in the educational field has become increasingly prominent. Information technology classes, as an academic environment emphasizing practical skills and innovative thinking, represent a typical scenario for the application of intelligent assistants. This study focuses on the application models and effectiveness evaluation of artificial intelligence assistants in information technology classes. By deconstructing their educational functions and analyzing their alignment with subject-specific characteristics, an application framework centered on contextualization, adaptability, and integration has been developed. This framework delineates key elements of intelligent assistants in terms of role positioning, activity sequences, content ecology, and interaction channels, while also designing a concrete pathway spanning from system customization to classroom implementation and further to data-driven optimization. On this basis, the research further proposes a multidimensional evaluation system encompassing cognitive skills, behavioral engagement, emotional experience, and social interaction, employing a mixed-methods approach to systematically analyze application outcomes. The findings provide theoretical support and practical guidance for the deeper integration of intelligent assistants in information technology education.*

Keywords: *Artificial Intelligence Assistants; Information Technology Classes; Application Models; Effectiveness Evaluation; Deconstruction of Educational Functions*

Introduction

The deepening development of information technology education faces multiple challenges, including significant disparities in student foundations, rapid knowledge updates, and high demands for cultivating practical abilities. Traditional teaching models struggle to achieve an organic integration of scalable education and personalized cultivation. Artificial intelligence assistants, with their technical features such as contextual awareness, natural interaction, and adaptive support, offer new possibilities for addressing these teaching challenges. However, current research predominantly focuses on the introduction of technical functions and descriptions of isolated application cases, lacking systematic deconstruction of the educational functions of intelligent assistants, the construction of application models deeply integrated with subject teaching, and the exploration of a scientific and comprehensive effectiveness evaluation system. This research gap often limits the educational application of intelligent assistants to the tool level, hindering the full realization of their potential to reshape teaching and learning processes. Therefore, systematically studying the application models of artificial intelligence assistants in information technology classes and establishing a corresponding effectiveness evaluation mechanism is not only an inherent requirement for the development of educational technology theory but also an urgent need to enhance the quality of information technology education.

1. Deconstruction of Educational Functions and Adaptability Analysis of Artificial Intelligence Assistants

1.1 Theoretical Foundations of Educational Functions of Artificial Intelligence Assistants

The effectiveness of educational functions of artificial intelligence assistants is rooted in multiple cross-disciplinary theoretical frameworks. Constructivist learning theory provides core support, emphasizing learners as active constructors of knowledge meaning. Artificial intelligence assistants effectively promote students' active exploration and restructuring of cognitive frameworks by providing dynamic, interactive learning environments and immediate scaffolding support. Situated cognition theory further elucidates the value of intelligent assistants in creating authentic learning contexts, as they can simulate complex scenarios in information technology practice, closely connecting learning activities with future application domains.

From the perspective of cognitive load theory, intelligent assistants effectively manage students' extraneous cognitive load when learning complex skills such as programming by encapsulating complicated operations and providing timely guidance, thereby optimizing the allocation efficiency of limited cognitive resources. The socioconstructivist viewpoint enriches the understanding of their interactive nature, highlighting the unique role of intelligent assistants as conversational partners in facilitating the social construction of knowledge[1]. Examined from the human-computer interaction perspective, the Technology Acceptance Model and Media Richness Theory provide analytical tools for understanding user adoption levels and interactive experiences with intelligent assistants. These theories complement and corroborate one another, collectively forming the theoretical foundation for integrating artificial intelligence assistants into the educational ecosystem. They systematically demonstrate the theoretical inevitability and implementation pathways for their transformation from information delivery tools to cognitive collaborative partners.

1.2 Deconstruction of Educational Functions and Adaptability Analysis for Information Technology Classes

A systematic deconstruction of the educational functions of artificial intelligence assistants reveals their multidimensional adaptive characteristics in information technology classes. At the cognitive function level, the code analysis and debugging prompt functions of intelligent assistants precisely address the logical thinking obstacles commonly encountered by students in programming instruction. Their provision of personalized concept explanations and resource recommendations aligns with the characteristics of information technology as a discipline, which features rapid knowledge updates and significant disparities in students' prior knowledge.

At the practical skills cultivation level, intelligent assistants can simulate software operation processes and automatically evaluate project outcomes. This immediate feedback mechanism highly corresponds with the emphasis on hands-on practice and problem-solving in information technology courses. Regarding collaboration and metacognition, intelligent assistants serve as conversational agents that can guide groups in project planning and task decomposition, while also promoting students' monitoring and reflection on their own learning processes through questioning. This profound functional adaptation demonstrates that artificial intelligence assistants are not mere applications of generic tools but require functional activation and targeted enhancement based on the inherent logic of the information technology discipline.

1.3 Construction of Adaptation Strategies and Optimization Pathways

The development of effective adaptation strategies requires adherence to systematic principles ranging from macro-level design to micro-level interventions. The primary strategy involves achieving precise alignment between the intelligent assistant and curriculum objectives, where corresponding knowledge graphs and dialogue scripts are pre-configured based on the core content of different teaching units, ensuring its supportive behaviors consistently revolve around instructional goals.

Secondly, implementing a layered intervention strategy is crucial. This approach dynamically adjusts the granularity and content of support provided by the intelligent assistant according to individual students' cognitive levels and task difficulty, establishing a graded support pathway ranging from simple syntax error prompts to complex algorithm optimization suggestions. Another key strategy lies in reshaping the human-machine collaborative teaching process, which involves clearly defining the role division between teachers and intelligent assistants in the classroom: teachers lead higher-order thinking guidance and emotional interaction, while intelligent assistants handle repetitive Q&A and personalized exercise generation, forming functional complementarity.

The optimization pathway relies on continuous data-driven iteration. By analyzing interaction logs between teachers, students, and intelligent assistants, effective interventions can be distinguished from ineffective interruptions, subsequently enabling cyclic improvements to its knowledge base, feedback mechanisms, and interaction interface. This process facilitates dynamic evolution and spiral advancement of adaptability[2].

2. Construction of Application Models for Intelligent Assistants in Information Technology Classes

2.1 Theoretical Basis and Design Principles for Application Model Construction

The development of application models for intelligent assistants is grounded in the dual foundations of cognitive load theory and distributed cognition theory. Cognitive load theory posits that working memory capacity is limited, while information technology learning often involves complex and abstract programming concepts and system operation procedures that can easily induce cognitive overload. Intelligent assistants effectively manage students' extraneous cognitive load by providing timely scaffolding support and encapsulating underlying complex operations, thereby facilitating schema construction and automated processing. Distributed cognition theory views cognitive activities as systems distributed among individuals, tools, and environments. As cognitive artifacts, intelligent assistants can undertake partial memory, computation, and logical reasoning tasks, enabling students to concentrate cognitive resources on higher-level problem-solving and innovative design, thus reshaping the overall efficacy of the classroom cognitive system.

Based on these theoretical frameworks, model construction follows three core design principles: contextualization, adaptability, and integration. The principle of contextualization requires that the interactive design of intelligent assistants must be deeply embedded within the specific context of the information technology discipline. For instance, in Python programming instruction, they should be capable of understanding and addressing typical issues like indentation errors and undefined variables, rather than providing generic responses. The adaptability principle emphasizes the system's capacity for dynamic diagnosis and feedback, enabling it to assess students' knowledge mastery levels and cognitive obstacles based on real-time code operations or question types, while providing gradated support ranging from syntax prompts and algorithm optimization to project structure suggestions. The integration principle focuses on seamless connectivity between intelligent assistants and existing teaching workflows. Their intervention should not fragment or replace original teacher-student and peer interactions, but rather serve as an organic link connecting individual learning with collective intelligence, classroom exercises with project practice through data sharing and activity design.

2.2 Key Elements and Structure of the Intelligent Assistant Application Model

The structural framework of this application model is synergistically composed of four core elements: goal-oriented role definition, multi-dimensional activity sequences, dynamically generated content ecology, and bidirectional closed-loop interaction channels. The role definition element transcends instrumental perception by positioning intelligent assistants as entities possessing dual identities as both expert models and cognitive partners. As expert models, they internalize the core knowledge structures and problem-solving strategies of the information technology field; as cognitive partners, they guide students in reflecting on their own learning paths and problem-solving processes through heuristic questioning and metacognitive prompts.The activity sequence element constructs a cyclical teaching process of "preset-generate-reflect," which not only includes preset task-driven learning phases but also encompasses dynamic adjustments to learning paths based on real-time interaction data from intelligent assistants, along with structured reflection guidance after task completion, thereby forming a complete cognitive cycle[3].

The content ecology element manifests as a highly contextualized and personalized resource network driven by intelligent assistants. This ecology not only contains static knowledge bases but, more crucially, can dynamically assemble and generate explanatory texts, executable code examples, visualized execution processes, and relevant conceptual maps based on the current task context, student operation history, and common error patterns.The interaction channel element is designed to achieve natural, efficient, and pedagogically intentional human-machine dialogue. This requires meticulously designed dialogue management strategies to ensure intelligent assistants can accurately understand students' natural language queries and code contexts, respond in structured and multimodal ways, while maintaining dialogue coherence and focus on instructional objectives, thereby forming a closed-loop learning circuit from student questioning to assistant feedback, and further to student operational verification.

2.3 Specific Pathways and Operational Procedures for Model Implementation

The initial phase of the model implementation pathway focuses on in-depth system customization and capability preparation, with the quality of this stage directly determining the effectiveness of subsequent applications. Beyond fundamental domain knowledge integration, particular attention must be paid to the rule-based configuration of teaching strategies — presetting multiple intervention strategies and feedback modes according to different instructional objectives and students' cognitive characteristics. Specifically, this phase involves constructing a subject ontology library covering core course concepts, defining diagnostic rules for typical error types and corresponding remediation strategies, compiling feedback corpora for students at different cognitive levels, and conducting systematic capacity building for both teachers and students. Teacher training should extend beyond tool operation to help educators understand the intelligent assistant's operational mechanisms and capability boundaries, mastering methods for designing teaching activities compatible with intelligent assistants. Student guidance should cultivate their literacy for collaborating with AI, including how to formulate precise questions, interpret assistant feedback, and maintain critical thinking. The refinement level of this stage directly determines the response quality and pedagogical appropriateness of the intelligent assistant in teaching scenarios.

During the classroom normalization phase, the implementation process manifests as an iterative inquiry-based learning approach supported by intelligent assistants, restructuring the traditional teaching sequence. The complete learning cycle begins with a carefully designed, appropriately challenging authentic learning task, where students proactively seek help from the intelligent assistant when encountering cognitive bottlenecks or technical obstacles during independent attempts and collaborative discussions. The intelligent assistant does not provide direct answers but offers tiered support — from error localization and concept clarification to strategy suggestions and exemplary demonstrations — based on predefined pedagogical logic, with the support intensity dynamically adjusted according to students' attempt frequency[4].

Supported by this framework, students continuously refine their understanding and iterate their work products, submitting both their interaction processes with the assistant and final solutions as learning artifacts for group sharing. In the post-class phase, the system automatically generates multidimensional analytical reports based on complete process interaction data, not only visualizing the class's overall knowledge mastery distribution and common difficulty points but also tracking individual students' learning paths and cognitive development trajectories. These analytical results provide empirical evidence for teachers to optimize subsequent instructional designs while driving the intelligent assistant to deliver highly differentiated extension exercises or remedial materials to different students, thereby achieving organic integration of scalable education and personalized cultivation, and forming a continuously improving closed-loop teaching quality system.

3. Multidimensional Evaluation System for Intelligent Assistant Application Effectiveness

3.1 Theoretical Framework and Foundation for Constructing the Multidimensional Evaluation System

The construction of a multidimensional evaluation system for intelligent assistant application effectiveness requires a theoretical foundation that transcends singular learning outcome measurement, shifting toward comprehensive examination of interventions within complex instructional systems. This framework integrates the theoretical core of Kirkpatrick's Four-Level Evaluation Model and educational data mining. The Kirkpatrick model provides a logical progression from immediate reactions to long-term impacts for effectiveness evaluation, encompassing reaction, learning, behavior, and results levels. In the educational context, this corresponds to students' usage experience with intelligent assistants, their acquisition levels of specific knowledge and skills, cognitive strategy changes manifested in learning behaviors, and ultimately the enhancement of comprehensive competencies. Educational data mining technology offers methodological support for capturing and analyzing performance data across these levels, enabling the explicit representation and quantitative analysis of implicit, process-oriented learning states.

The foundation of the evaluation system emphasizes evidence-centered design and systemic principles. Evidence-centered design requires that each component of the evaluation process focuses on collecting specific evidence of utility, ensuring the gathered data can form valid evidentiary chains that either support or refute the effectiveness of instructional interventions. The systemic principle advocates treating the intelligent assistant as an organic component within the instructional system, where effectiveness evaluation must consider its interactions with other elements including teachers, students, curriculum content, and technological environments[5]. Consequently, the evaluation framework must not only observe students' final outputs but also analyze how intelligent assistants mediate teacher-student interactions, influence task engagement, and alter knowledge construction pathways within specific instructional contexts, thereby objectively revealing their true utility and operational boundaries within systemic dynamics.

3.2 Systematic Design and Dimensional Integration of Evaluation Indicators

The systematic design of evaluation indicators follows a multidimensional integration pathway ranging from internal cognition to external behavior, and from individual development to group interaction. Within the cognitive and skills dimension, evaluation indicators focus on the solidity of knowledge acquisition and the flexibility of skill transfer, specifically including the accurate understanding rate of core concepts, independent completion rate of programming tasks, the quantity of innovative solutions for unconventional problems, and improvements in debugging efficiency.In the behavior and engagement dimension, indicators examine changes in learning behavior patterns following the introduction of intelligent assistants, characterized through the frequency and depth of student interactions with intelligent assistants, sustained focus duration on complex tasks, the proportion of self-initiated inquiry questions, and the frequency of referencing assistant suggestions in collaborative discussions.

Regarding the affective and experiential dimension, evaluation emphasizes students' psychological perceptions and acceptance within the human-machine collaborative learning environment, typically measured through scales derived from the Technology Acceptance Model assessing their usage intention and perceived ease of use, combined with monitoring changes in cognitive load levels and self-efficacy within learning contexts.For the social and interaction dimension, indicator design focuses on the intelligent assistant's impact on classroom social networks and interaction structures, involving the overall quality of group collaborative outcomes, communication density among team members, and proportional changes in higher-order thinking dialogues within teacher-student interactions. These four dimensions of indicators do not exist in isolation but are interconnected and mutually validating, collectively forming a comprehensive indicator network that reflects the complete picture of intelligent assistant application effectiveness. Their integrated analysis facilitates the revelation of internal mechanisms and conditions underlying effect generation.

3.3 Implementation of Evaluation Methods and Analysis of Results

The implementation of evaluation methods employs a mixed-methods approach that integrates quantitative data and qualitative evidence to achieve triangulation. Quantitative methods rely on analyzing process data recorded in the Learning Management System, including automated scoring of student portfolios, pattern recognition in code submission sequences, semantic analysis of dialogue logs with intelligent assistants, and statistical analysis of pre- and post-test academic achievements. Qualitative methods, implemented through structured classroom observations, retrospective interviews with selected students, and content analysis of learning reflection reports, deeply capture the specific impacts of intelligent assistants on students' problem-solving strategies, metacognitive development, and learning motivation. This data integration strategy compensates for the limitations of individual methods, forming a more comprehensive and profound interpretation of application outcomes[6].

The analysis of evaluation results aims to transcend descriptive statistics by delving into causal relationships and interaction pathways among variables. The analytical process utilizes statistical testing to compare the significance of differences in key indicators across various application models or student groups, while employing process mining techniques to visualize typical learning pathways supported by intelligent assistants. For qualitative materials, coding and theme extraction techniques are applied to identify key contextual characteristics where intelligent assistants either provide effective support or encounter interaction obstacles. The final analytical report not only presents "what" the outcomes are but also endeavors to explain "why" they occur—analyzing the causes and conditions underlying these effects by examining specific teaching contexts and intelligent assistant intervention methods. This approach provides actionable basis and direction for precise optimization of application models, thereby establishing a closed-loop feedback system extending from evaluation to improvement.

Conclusion

This study systematically constructs application models and a multidimensional evaluation framework for artificial intelligence assistants in information technology classes, clarifying their theoretical foundations and adaptation pathways in educational functions. It designs an application model structure centered on role positioning, activity sequences, content ecology, and interaction channels, while proposing an evaluation framework that integrates quantitative analysis and qualitative research. The findings demonstrate that the effective application of intelligent assistants relies on their deep alignment with disciplinary logic, organic integration with teaching processes, and continuous data-driven optimization.

Future research may advance in the following directions: exploring intelligent assistants' support strategies in cross-disciplinary project-based learning, investigating their long-term effects on the development of students' higher-order thinking such as computational thinking, and developing real-time evaluation and adaptive feedback technologies based on multimodal data fusion. These explorations will further promote the deep integration of artificial intelligence technology with educational practice, providing support for constructing a new intelligent educational ecosystem.

Fund Projects

Research on the Construction of the "Chinese Youth" Image in the New Era and Its Cultivation Pathways through Curriculum Integration

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