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Construction and practice of a human–AI collaborative teaching model in secondary vocational tourism education from the perspective of activity theory

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ABSTRACT

In the context of digital transformation in education, Artificial Intelligence-Generated Content (AIGC) brings new momentum to vocational education reform and promotes changes in traditional teaching methods. This study aims to construct a human–AI collaborative teaching model for study-tour course design in secondary vocational tourism education. It is a design-oriented conceptual study that adopts a theory-driven instructional design development approach. Grounded in activity theory and using DeepSeek, a generative AI platform, as the AI agent and mediating tool, this study constructs a model comprising six elements—subject, object, mediating tools, rules, community, and division of labor. These six elements together form a dynamic activity system. The model emphasizes the interactions and dynamic constraints among these elements and develops a complete teaching process for study-tour course design. To illustrate how the model works, an illustrative teaching case is used to explain how mediating tools support human–AI collaborative teaching. The case shows that AI agent can support precise teaching, identify key teaching difficulties and individual student problems, promote real-time interaction between teachers and students as well as among students, and guide students to learn independently. In this way, the teaching paradigm shifts from a traditional teacher-centered approach to a teacher–student–AI interactive model. Overall, this study explores the construction and practical application of a human–AI collaborative teaching model in secondary vocational tourism education and provides a practical path, case reference, and useful implications for the intelligent transformation of vocational education in practice.

Contribution/Originality: This study is one of the few to integrate activity theory with generative AI to construct a human–AI collaborative teaching model for study-tour course design in secondary vocational tourism education. It moves beyond tool application to reveal how mediating tools support precise teaching, real-time interaction, and a teacher–student–AI interaction model.

1. INTRODUCTION

With the deep integration of new digital technologies, such as big data, the Internet of Things, and cloud computing, into teaching, AIGC is reshaping teaching practice and learning support through mechanisms such as content generation, instant feedback, learning analytics, and intelligent recommendations. It provides new impetus

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for pedagogical reform in vocational education amid digital transformation (Brusilovsky, 2024; Chiu, 2024; Lo, Hew, & Jong, 2024; Prasetya et al., 2025). The quality of teaching in secondary vocational tourism education is crucial for cultivating frontline tourism talent. However, in current teaching practice, problems such as the low level of intelligence in teaching facilities, insufficient teaching competence among teachers, and inadequate support for students' personalized development remain widespread. These problems have created a clear gap between training outcomes and the actual needs of the industry, making it necessary to explore new paths through teaching reform (Busulwa, Pickering, & Pathiranage, 2024; Hazzan-Bishara, Kol, & Levy, 2025; Nakar & Du Plessis, 2023). The rapid development of artificial intelligence offers new possibilities for addressing these challenges. In particular, large language models such as DeepSeek and ChatGPT excel at natural language processing, scenario simulation, and content generation, bringing new vitality to innovation in tourism vocational education (Wang, Zhang, & Mao, 2025). The deep integration of artificial intelligence and education has gradually led to a new teaching paradigm known as educational artificial intelligence. Educational artificial intelligence emphasizes a collaborative approach to education and focuses on interaction between humans and intelligent technologies in educational activities. It explains how human–AI collaboration supports educational development and promotes the co-evolution of human and machine intelligence (Zhu, Han, & Huang, 2021). In this context, the development of new technologies has further promoted human–AI collaborative teaching. Related studies point out that human–AI collaboration is not simply a combination of technical tools; rather, it involves constructing a learning ecosystem in which teachers, students, and AI interact and collaborate (Chiu & Rospigliosi, 2025). This learning ecosystem supports personalized and differentiated learning while preserving the irreplaceable role of human teachers in providing emotional support, value guidance, and creative teaching.

Scholars at home and abroad have explored human–AI collaborative teaching from different perspectives. However, practical research in specific course contexts is still limited. This is especially true in study-tour course design, where systematic application of human–AI collaborative teaching remains underdeveloped, the integration of cognitive theories is insufficient, and related case studies need further work (Kong, Fang, Chen, Xiao, & Zhang, 2025; Zhu, 2025). Based on this situation, this paper introduces activity theory as an analytical framework and builds a teaching activity system model from a human–AI collaboration perspective. Using study-tour course design as the specific context and the DeepSeek platform as the technical tool, this paper examines the framework and practical path of human–AI collaborative teaching in secondary vocational tourism education. The study aims to provide a reference model with theoretical support and practical value for the digital transformation of tourism vocational education, promote deeper integration of artificial intelligence and vocational education, and help train innovative and interdisciplinary tourism talents for the digital era.

2. BASIC CONCEPTS AND THEORETICAL FOUNDATIONS

2.1. Activity Theory

Activity theory is an interdisciplinary framework used to analyze human practical activities and psychological development. It emphasizes that human activity is a complex system that takes place in a specific social and cultural context. In this system, activities are mediated by tools and directed toward an object. In the 1920s and 1930s, the Soviet psychologist Vygotsky proposed sociocultural theory in his pioneering research. This theory highlights the dynamic interaction between individuals and their social and cultural environment (Sirgado, 2000). Based on this foundation, activity theory gradually developed as an important approach to understanding human action. In the 1980s, the Finnish scholar Engeström further expanded activity theory by introducing three additional components: rules, community, and division of labor (Engeström, 1987). Since then, an activity system has been understood as

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consisting of six elements: subject, object, mediating tools, rules, community, and division of labor. The subject refers to the main participant in the activity. The object represents the goal that the subject aims to achieve. Mediating tools include material or psychological tools used in the activity. Rules refer to social or environmental constraints that guide behavior. The community consists of individuals who share the same object. Division of labor describes the distribution of tasks among members of the community. Within an activity system, the interaction among these six elements jointly drives the development of the activity (Engeström, 1987).

Domestic and international scholars have introduced activity theory into research on the teaching of study-tour course design, focusing on key factors that influence learning in study-tour course design. Wang (2025) adopted an event studies perspective and elevated the "activity view" to the level of worldview, identifying seven core dimensions such as experientiality and ritualization. He emphasized the role of activities in shaping individual worldviews and their value in building a better life, thereby providing a theoretical reference for teaching concepts in tourism and event-related disciplines. Xu and Liu (2025) positioned study travel as "a form of learning practice involving authentic interaction in an uncertain field" and proposed systematic study-tour experience events, sequenced study-tour activity tasks, three-dimensional study-tour interaction networks, and dynamic study-tour expansion fields to realize authentic integrated learning. Li (2024) started from core competencies and emphasized that study-tour activity courses should be designed as interrelated modules to form a complete curriculum system, focusing on the systematic nature of the curriculum and the cultivation of students' comprehensive competencies, which is intrinsically consistent with the interactive logic of activity system elements emphasized by activity theory. Ramey et al. (2024) used cultural-historical activity theory to analyze the systemic contradictions faced by K-12 teachers when designing outdoor learning experiences, revealing how tensions between classroom learning activity systems and outdoor learning activity systems influence instructional design decisions, thus providing methodological insights for understanding the dynamic relationships among elements in study-tour course design. Overall, these studies emphasize the role of mediation and feedback in tourism teaching from the perspective of activity theory and demonstrate the strong theoretical value and practical significance of this theory in understanding learning activities in tourism education and in guiding study-tour course design.

This study adopts activity theory as its theoretical framework and applies the activity theory triangle model to the teaching of study-tour course design in secondary vocational tourism education, as shown in Figure 1. Using the AI agent DeepSeek as a mediating tool, this study applies activity theory by defining six elements: subject, object, mediating tools, rules, community, and division of labor. The subject refers to the students; the object refers to the learning goals; the mediating tool refers to the AI agent, operationalized as DeepSeek; the rules refer to institutional and procedural constraints; the community comprises teachers and peers; and the division of labor refers to the roles of teachers, students, and the AI agent. In the teaching context, the community and division of labor encompass teachers, students, class groups, and AI agents, whose roles are distributed and coordinated in the teaching process. These six activity elements are connected and interact with one another in teaching practice. Together, they form a dynamic activity system that provides important theoretical support for human–AI collaborative teaching in study-tour course design in secondary vocational tourism education.

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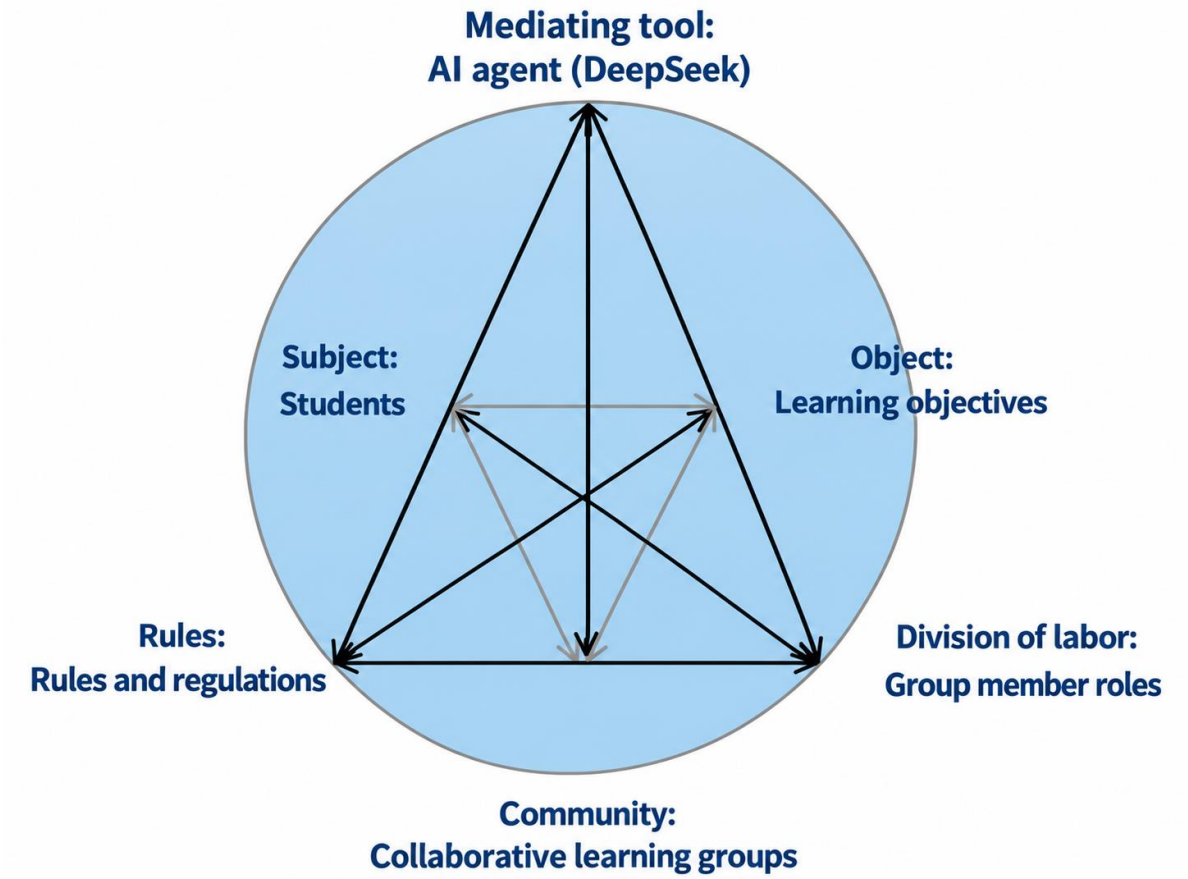


Figure 1. The triangle model based on activity theory.

2.2. Human-AI Collaboration and Study-Tour Course Design and Teaching

Artificial intelligence is shifting from an auxiliary tool to a teaching partner, and this change is driving fundamental transformation in tourism teaching. In the field of educational artificial intelligence, human–AI collaboration refers to an educational model that combines teachers' teaching and students' learning with the support of intelligent technologies to improve teaching quality and efficiency (Yang, Guo, Huang, & Zhao, 2020). With the support of the AI agent as a mediating tool, the traditional dual teaching community composed of teachers and students is transforming into a triadic collaborative teaching community consisting of teachers, students, and the AI agent. Wang et al. (2025) scholars pointed out that artificial intelligence is accelerating the implementation of "AI + education" practices and promoting deep changes in teaching content, teaching methods, and evaluation systems (Wang, 2025). Yu (2025) further explained the reconstruction of the relationship between tourism talents and AI, which is pushing the tourism industry into a new era characterized by "human–AI co-intelligence" (Yu, 2025). In international studies, Chiu and Rospigliosi (2025) emphasized the reconstruction of the "teaching partner" role. They argued that artificial intelligence is not only an auxiliary tool, but a real collaborative partner that participates in learning and teaching processes, with teachers, students, and AI working together to improve learning engagement and teaching effectiveness (Chiu & Rospigliosi, 2025). From the perspective of learner control and human–AI collaboration, Brusilovsky (2024) pointed out that human–AI collaboration in educational applications requires systematic design between personalized recommendation and controllability and explainability, in order to form a healthier collaborative learning ecosystem (Brusilovsky, 2024). In tourism and hospitality education contexts, related studies have also begun to focus on the impact of generative AI on learning outcomes and personalized learning. For example, the relationship between ChatGPT and learning outcomes in tourism education has been examined within the framework of digital literacy and individualized learning pathways (Dalgıç, Yaşar, & Demir, 2024). Other studies have discussed the opportunities and challenges brought by ChatGPT from the perspectives of tourism education

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practice and academic integrity (Skavronskaya, Hadinejad, & Cotterell, 2023). Overall, these studies systematically propose frameworks for AI-driven restructuring of tourism disciplinary systems and provide a theoretical basis for understanding the value of human–AI collaboration in tourism education.

In terms of teaching model practice, scholars at home and abroad have explored various tourism teaching models driven by human–AI collaboration. First, at the macro level, from the perspectives of industry and policy, the National Tourism Vocational Education Teaching Steering Committee summarized innovation in tourism vocational education under the background of artificial intelligence into the "Five New" aspects. It also plans to promote deep integration of AI and tourism vocational education through thematic reports and case-sharing activities. At the meso level, focusing on the reconstruction of teaching models at the institutional and professional levels, Wang (2025) took tourism vocational colleges as the research context and constructed a teaching reform framework based on artificial intelligence applications. He proposed that student learning data should be analyzed to provide personalized courses and resource recommendations (Wang, 2025). At the micro level, regarding the effects of artificial intelligence on teachers' instructional behaviors and students' learning processes, Yeh (2025) pointed out that generative AI can empower students to engage in inquiry-based learning, enhance their deep engagement, and ultimately provide personalized and practice-oriented learning experiences. At the same time, Yu, Yang, Sun, Zhao, and Fu (2025) found through meta-analysis that the degree of AI anthropomorphism can significantly improve users' cognitive, emotional, and behavioral intentions. This finding provides empirical support for integrating anthropomorphic elements into AI design for tourism teaching (Yu, 2025). In addition, Onilude, Aderoju, and Dubay (2026) integrated a customized AI chatbot, NEX, into an undergraduate hospitality management course, adopting a problem-based learning (PBL) approach that engaged undergraduates in a four-week learning project: interacting with AI around open-ended industry scenarios. In this process, NEX was designed as a "reflective learning partner," guiding students by asking questions rather than directly providing answers. The study indicated that the combination of PBL and AI helped promote students' deep engagement in learning and critical evaluation of AI-generated content. Overall, these studies on human–AI collaborative teaching explore ways to construct collaborative teaching models at the theoretical level and verify, in practice, the positive effects of such models on improving teaching outcomes.

Through a systematic review of the relevant literature, this study finds that many pressing problems remain to be addressed in current teaching practices for study-tour course design. First, teaching methods are overly uniform. Teaching tends to be traditional, and classrooms are still dominated by the pattern in which "teachers talk and students listen." Teaching content often remains at the theoretical level of writing plans, with few opportunities for simulation design in real-world contexts or project-based practical training. There is limited inquiry-based learning and interaction between teachers and students, resulting in low levels of student initiative and participation (Liu, Guang, & Hou, 2024). Second, the teaching content is limited and disconnected from industry practice. Instruction is mostly confined to classroom-based theoretical explanations, such as defining study tours and explaining policy backgrounds. Students are exposed mainly to abstract concepts and lack support from vivid, well-grounded cases, making it difficult for them to develop an in-depth understanding of the realities of the industry. Shahedul Alam, Tasnim, and Mizan (2026), through a survey of 84 industry practitioners and scholars, found that graduates in tourism and hospitality management fail to meet industry requirements in communication, interpersonal, technical, and operational skills, revealing a significant gap between the skills cultivated by curricula and the actual needs of the industry. Third, students' learning experiences and emotional engagement are insufficient. In course teaching, the learning environment and contextual design are relatively inadequate. Teachers rarely use digital technology, music, multimedia, or physical teaching aids to construct authentic and vivid study-tour scenarios, making it difficult to create an immersive learning experience. Traditional study-tour practice-education models mainly rely on

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sightseeing visits and simple mechanical imitation, resulting in a limited range of course formats, insufficient depth of student experience, and low participation (Liu, 2025). Teaching often focuses too heavily on knowledge delivery and skills training, which weakens the emotional experience and value formation emphasized in study tours. It also neglects the processes of emotional resonance and value identification, thereby reducing the overall educational effectiveness of the course (Li, Zhang, Xu, & Wang, 2024). It can be seen that current teaching in study-tour course design has obvious shortcomings in content relevance, practical alignment, and learning experience, and these shortcomings urgently need to be addressed through innovation in teaching models.

3. METHODOLOGY

3.1. Research Design and Context

This study is a design-oriented conceptual study that adopts a theory-driven instructional design approach. It seeks to construct a human–AI collaborative teaching model grounded in activity theory and to illustrate its operational logic through a designed teaching case. This study is positioned as the design phase of design-based research (DBR), rather than a complete DBR cycle, because it does not involve a real classroom or data collection.

The research context is secondary vocational tourism education in China, specifically the course Study-Tour Course Design and Implementation, which is a national planning textbook for vocational education. The DeepSeek platform serves as the technical and mediational tool in this study. Its functions, including personalized resource recommendation, case simulation, and assessment report generation, are integrated into the designed human–AI collaborative teaching model. Therefore, the research context is a designed instructional context rather than a naturally occurring classroom setting.

3.2. Model Construction and Case Design

3.2.1. Theoretical Framework and Model Construction

Activity theory serves as the theoretical framework for this study. The six elements of activity theory—subject, object, mediating tools, rules, community, and division of labor—are mapped onto the human–AI collaborative teaching context: students as the subject, learning goals as the object, the AI agent (DeepSeek) as the mediating tool, teachers and peers as the community, institutional and procedural constraints as the rules, and the roles of teachers, students, and the AI agent as the division of labor. The interactions among these six elements jointly constitute the human–AI collaborative teaching model.

3.2.2. Illustrative Teaching Case Design

This study presents an illustrative teaching case to demonstrate how the model operates in a specific teaching scenario. The case is selected from Task Ten in Module Three of the textbook Study-Tour Course Design and Implementation. Its implementation process is situated within the human–AI collaborative teaching model, in which DeepSeek is used to provide intelligent assistance to students as they write study-tour course plans. The teaching process is divided into three stages and seven phases. The three stages are the pre-class intelligent learning diagnosis stage, the in-class human–AI-assisted learning stage, and the post-class precise learning evaluation stage. The seven phases are analysis, resource delivery, instruction, collaboration, peer assessment, final evaluation, and intervention. Together, they constitute a closed-loop instructional pathway spanning pre-class, in-class, and post-class activities.

3.2.3. Research Materials

The materials used for constructing the model and the illustrative case include: (1) theoretical literature on activity theory, human–AI collaborative teaching, generative AI in education, and study-tour course design; (2) the national vocational education textbook Study-Tour Course Design and Implementation, with particular reference to

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Task Ten in Module Three; (3) functional descriptions and simulated interactions of the DeepSeek platform, used to illustrate how an AI agent can serve as a mediating tool; and (4) the researcher-designed teaching process, including a three-stage, seven-phase workflow.

3.3. Analysis and Evaluation Process

The evaluation involves three forms: (1) theoretical alignment, examining whether the six elements of activity theory can be fully mapped onto the human–AI collaborative teaching system; (2) logical consistency, checking whether the three-stage, seven-phase procedure constitutes a coherent, closed-loop teaching process; and (3) an illustrative walkthrough, using the designed teaching case to demonstrate how the model would operate in a specific study-tour course design task. Since this study did not conduct any form of empirical effect testing, the evaluation in this study demonstrates only the theoretical feasibility and operational clarity of the model.

3.4. Ethical Considerations

Ethical review was not required for this study because it involved no human or animal subjects. No students, teachers, or administrators were recruited, interviewed, observed, or surveyed. The teaching case involved designed roles—namely, the teacher, the students, and the AI agent—which are analytical and pedagogical constructs used to illustrate the model. These roles are not based on real individuals, and no personal data were collected.

4. HUMAN–AI COLLABORATIVE TEACHING MODEL FROM THE PERSPECTIVE OF ACTIVITY THEORY

In response to the problems identified in the teaching of study-tour course design, this study adopts activity theory as the analytical framework and uses the DeepSeek platform as a technical tool to construct a human–AI collaborative teaching framework. On this basis, a specific teaching model for study-tour course design is further developed. By introducing an AI agent as a mediating tool, the model supports human–AI collaborative teaching and promotes a shift in the teaching paradigm from a traditional teacher-centered approach to a teacher–student–AI interactive model. On the one hand, it enriches teaching content and methods and enables precise support and personalized instruction based on learning process data. On the other hand, it strengthens real-time interaction between teachers and students, as well as among students, and guides students in designing immersive study-tour experiences. In this way, the model is intended to improve the learning experience, support learner engagement, and stimulate students' active participation in learning.

4.1. Human–AI Collaborative Teaching Model Framework

Based on the activity theory system triangle model, this study integrates four elements from human–AI collaborative teaching, namely teacher intelligence, machine intelligence, collaborative teaching, and student intelligence, to construct a human–AI collaborative teaching framework (Gao, Lu, Wang, Shang, & Zhou, 2021). In this framework, the AI agent functions as the mediating tool in the triangle model and serves as a bridge between students and teachers. It supports teachers in carrying out teaching tasks and assists students in personalized learning. Teachers are key members of the teaching activity system and belong to the community element. In human–AI collaborative teaching, teachers act as learning guides who coordinate the interaction between students and the AI agent and ensure the orderly progress of learning activities. Students serve as the subject of the triangle model. With guidance from teachers and collaborative support from the AI agent, students complete learning tasks and achieve expected learning goals. The human–AI collaborative teaching framework is shown in Figure 2.

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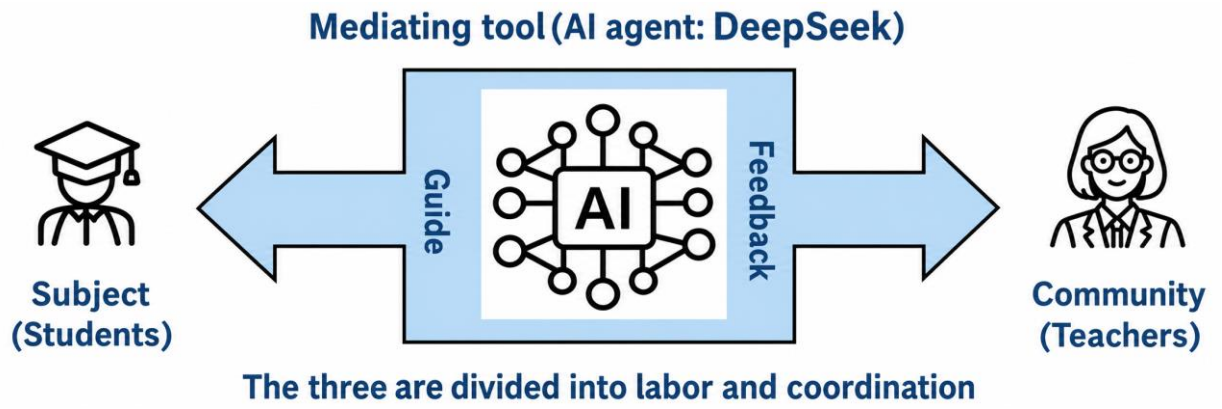


Figure 2. Human–AI collaborative teaching framework.

4.2. The Construction of Human–AI Collaborative Teaching Model

Grounded in activity theory, this study uses an AI agent as a mediating tool for assisted teaching and, taking study-tour course design as an example, constructs a human–AI collaborative teaching model, as shown in Figure 3. The model comprises six elements and systematically presents the activity structure and operating mechanism of the learning process. In teaching practice, these six elements influence and interact with one another, and their tensions and contradictions drive the learning process. Together, they form a dynamic activity system, providing theoretical support for the design and implementation of human–AI collaborative teaching.

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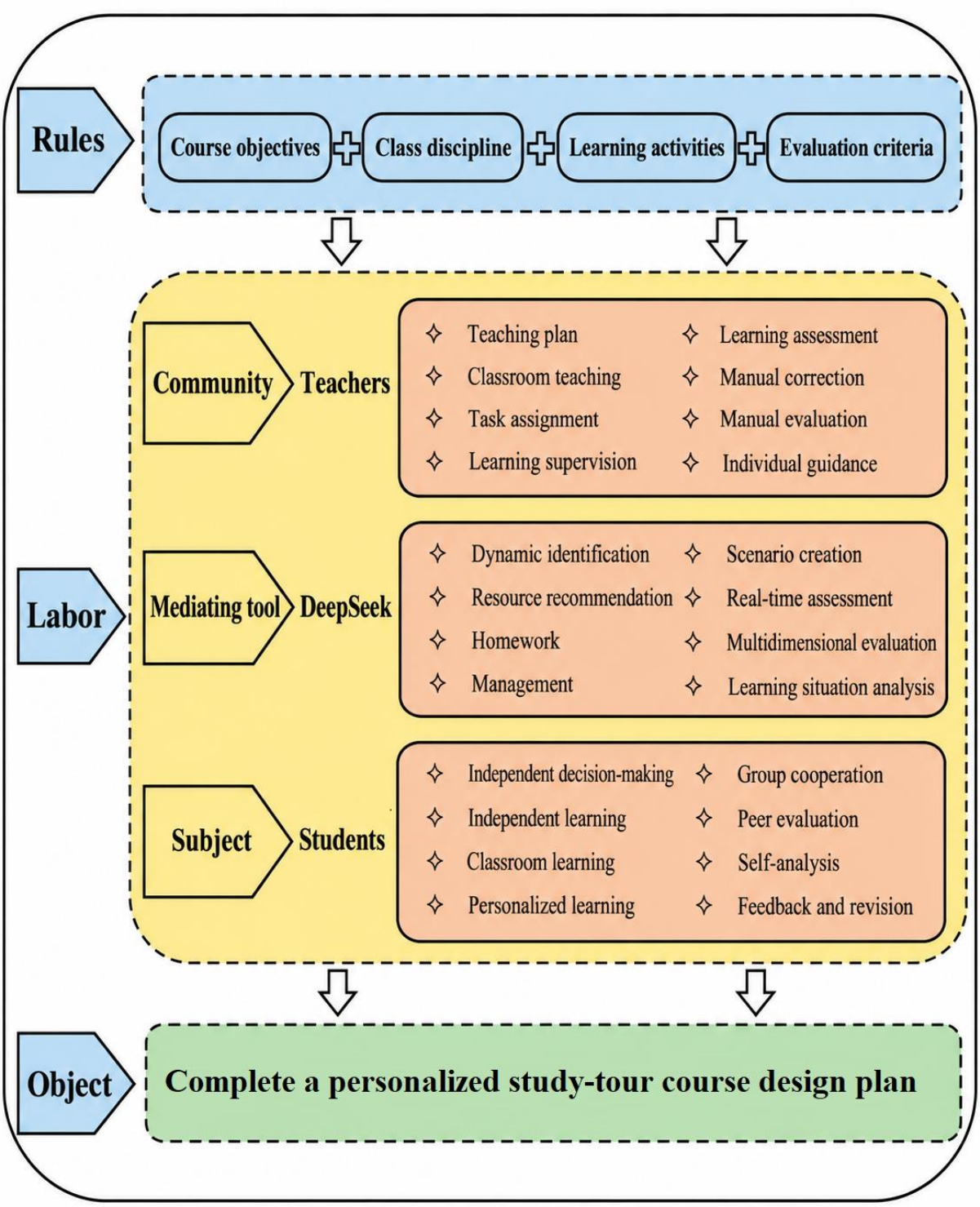


Figure 3. Human–AI collaborative teaching model based on activity theory.

First, in human–AI collaborative teaching activities, rules constrain the overall functioning of teaching. In activity theory, rules not only constrain the external teaching environment but also mediate the relationship between the subject and the object. These rules include classroom discipline, teaching task arrangements, norms for learning activities supported by the AI agent, and evaluation criteria for teachers, peers, and AI. By defining acceptable learning behaviors and assessment standards, rules create stable yet flexible boundaries for human–AI collaboration. At the same time, the contradiction between students' need for autonomy and rule constraints can stimulate students'

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self-regulation and responsible use of AI. This contradiction enables students to learn more freely and in an orderly manner under the constraints of rules.

Second, teachers are the guides and organizers of the entire teaching activity. From the perspective of activity theory, teachers are not the sole center of teaching activity but an important link between the community and the division of labor. They guide students and the AI agent to collaboratively support student learning, and they guide the AI agent to function as a teaching tool throughout the teaching process. During teaching, teachers formulate teaching plans for the study-tour course, conduct classroom teaching, assign study-tour course design tasks, supervise human–AI collaborative learning, assess student learning performance, and ultimately complete grading, evaluation, and guidance tasks. The interaction between teacher guidance and student self-directed learning creates a contradiction: while receiving external support, students also need to assume responsibility for their own learning and be accountable for it. This contradiction helps promote the shift from a teacher-centered model to a teacher–student–AI interactive model.

Third, DeepSeek, as the AI agent and mediating tool, dynamically identifies students' learning needs and interests during the learning process. It provides precise learning resource recommendations, generates and simulates authentic study-tour case scenarios, and assists students with assignment management and personalized learning, ultimately conducting a multidimensional evaluation and analysis of their learning outcomes. In this way, DeepSeek provides technical support for efficient teaching, learning path optimization, and closed-loop interaction and feedback between teachers and students. However, as a mediating tool, DeepSeek also creates a potential contradiction between efficient support and overdependence. This contradiction requires students to critically evaluate AI-generated content and treat it as a resource rather than a substitute for thinking, thereby promoting higher-order learning.

Finally, students are the subjects of the human–AI collaborative teaching model. During learning, they integrate multiple learning resources, independently formulate and carry out learning plans, creatively design and implement study-tour plans, and continuously improve their study-tour course design based on feedback from teachers, peers, and the AI agent. In this process, students gradually transform from passive recipients of knowledge into explorers, decision-makers, and creators of knowledge. These contradictions—between their current abilities and the demands of the activity's object, and between individual autonomy and community expectations—drive them to adjust their learning strategies, engage in learning actions, and ultimately achieve their learning goals.

In summary, the human–AI collaborative teaching model is a dynamic activity system constrained by procedural rules. Under the organization and guidance provided by teachers, students, as the subjects of learning, engage in personalized and autonomous learning with the help of DeepSeek as an intelligent mediating tool. Teachers and peers, as members of the community, advance learning activities through collaborative guidance and interactive support, while a clear division of labor forms a multilevel support mechanism. Through this system, students complete the study-tour course-design task and achieve the expected learning goals. More importantly, as a dynamic system, the model involves interactions and contradictions among its six elements, including those between autonomy and rules, teacher guidance and student independence, AI efficiency and critical thinking, and multiple evaluation standards. These contradictions drive learners' reflection, negotiation, and decision-making, ultimately helping them complete the activity task.

4.3. Implementation Process of Human–AI Collaborative Teaching

The teaching implementation process involves three roles (teachers, DeepSeek, and students) and comprises three stages and seven phases, as shown in Figure 4. The three stages are pre-class intelligent learning diagnosis, in-class human–AI-assisted learning, and post-class precise learning evaluation. The seven phases are analysis, resource delivery, instruction, collaboration, peer assessment, final evaluation, and intervention. The following teaching scenario case illustrates how these phases operate within a specific textbook task.

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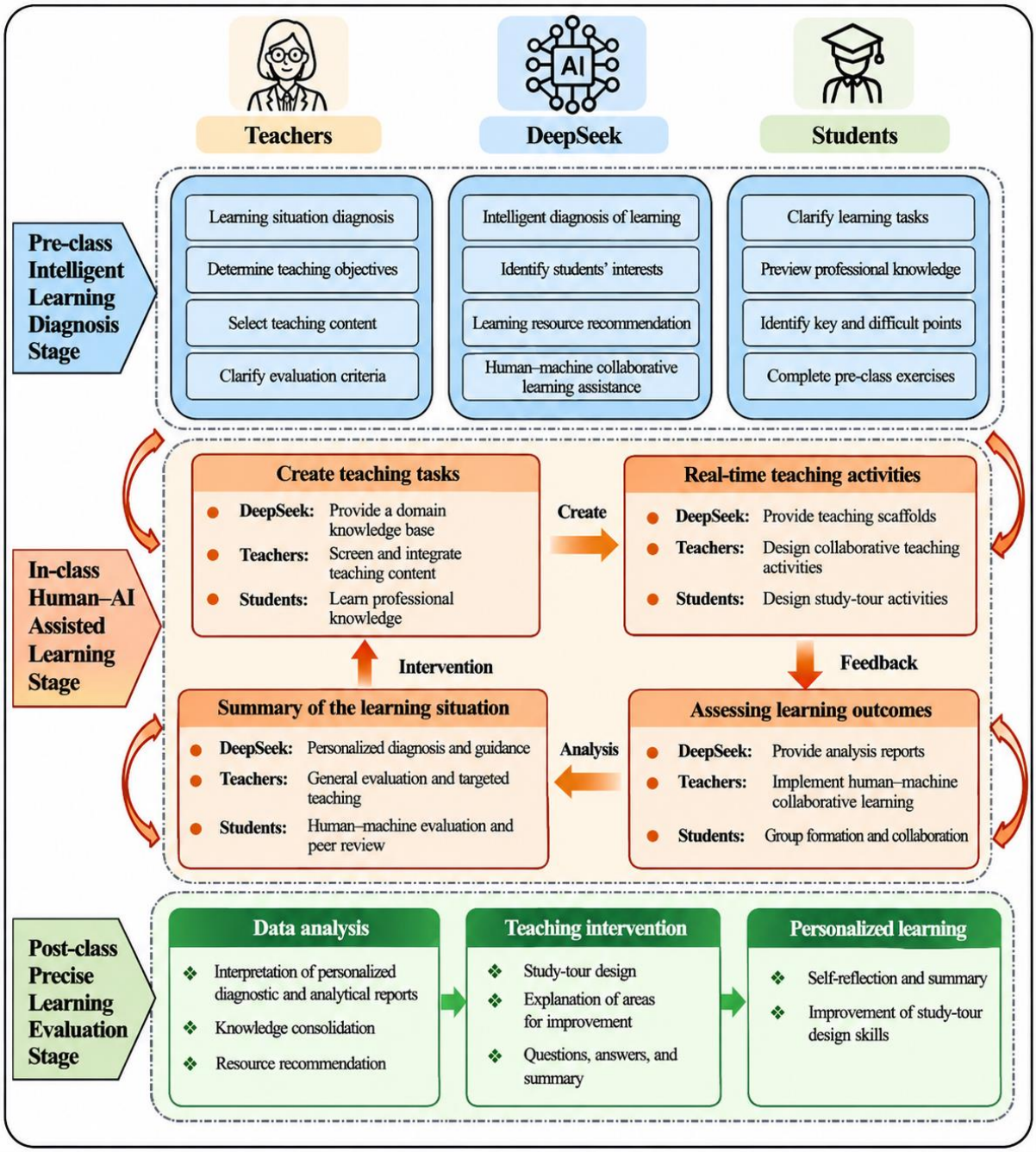


Figure 4. The teaching implementation process of the human–AI collaborative study-tour teaching model.

4.4. Responsible AI Use and Safeguard Measures

The human–AI collaborative teaching model assigns the AI agent multiple responsibilities: analyzing learning data, identifying difficulties, recommending resources, assessing assignments, and generating diagnostic reports. However, it also brings risks such as model hallucinations, inaccurate outputs, algorithmic bias, privacy breaches, insufficient assessment transparency, and the need to verify feedback. To address these risks, safeguard measures are proposed. First, human oversight is essential. Teachers must review and verify all AI-generated assessments, reports, and recommendations before using them for decision-making or providing student feedback. The final teacher evaluation and teaching intervention phases are designed for this purpose. Teachers remain irreplaceable in innovation, humanistic care, and value guidance. Second, students must critically evaluate AI-generated content, cultivate an awareness of questioning, revise it based on teacher feedback, peer assessment, and self-reflection, and independently design study tour plans to prevent overreliance on the AI agent. Third, the AI agent's collection and

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processing of student data must comply with data protection regulations. Data should be anonymized, securely stored, and used only for legitimate teaching purposes, with access limited to authorized personnel. The AI agent's assessments should also be transparent, explaining the criteria, evidence, and uncertainties. In summary, these measures regulate the AI agent's application and safeguard human agency, student rights, and educational values, ensuring responsible application while upholding the ethical foundations of education.

5. HUMAN–AI COLLABORATIVE TEACHING IMPLEMENTATION BASED ON ACTIVITY THEORY

In response to the problems previously identified in the teaching of study-tour course design, this study constructs a human–AI collaborative teaching model and selects Task Ten in Module Three of the Chinese national vocational education textbook Study-Tour Course Design and Implementation (The 14th Five-Year Plan national planning textbook) as a case for teaching implementation. The study examines the case through its specific implementation process. In this model, DeepSeek assists students in writing study-tour course plans, and the teaching process is organized into "three stages and seven phases." The three stages are the pre-class intelligent learning diagnosis stage, the in-class human–AI-assisted learning stage, and the post-class precise learning evaluation stage. The seven phases are analysis, resource delivery, instruction, collaboration, peer assessment, final teacher evaluation, and teaching intervention. Together, they form a closed-loop teaching implementation pathway that covers pre-class, in-class, and post-class activities.

5.1. Pre-Class Intelligent Learning Diagnosis Stage

a. Data analysis phase: Teachers use DeepSeek to analyze learning data from students' previous study-tour course plans or ask students to submit a short written response to "My understanding of study tours." DeepSeek can quickly identify common areas of unclear understanding, knowledge gaps, or skill weaknesses among students. Finally, based on the given instructions, DeepSeek analyzes the data and generates an overall class learning diagnosis report. This report helps teachers clearly understand students' learning conditions and identify key teaching difficulties and focal points.

b. Resource delivery phase: Based on the learning diagnosis results, DeepSeek provides differentiated pre-class learning resources to students with different levels of prior knowledge and varying needs. For students with relatively weak foundations, it provides introductory materials, such as interpretations of study-tour policies and explanations of core concepts. For students with a certain level of prior understanding, it delivers high-quality study-tour course design cases (in text or video), analyses of typical plan structures, and comparative materials illustrating positive and negative cases. This approach guides students in completing targeted pre-class preparation and formulating questions, thereby laying the foundation for subsequent human–AI collaborative learning in the classroom.

5.2. In-Class Human–AI Assisted Learning Stage

c. Precise instruction phase: After students complete their pre-class preparation, teachers review prerequisite knowledge. They explain common gaps in knowledge identified by DeepSeek. Next, teachers introduce the new course content. This includes defining the key elements of a study-tour course plan, such as the course overview, course unit content, service support, and course evaluation, and building the overall structure of the course plan. During this process, teachers can instruct DeepSeek to generate three study-tour course plans with different structures in real time, guiding students to compare and analyze the strengths and weaknesses of each structure. Finally, through a comparison of high-quality positive and negative cases, students understand the key elements of effective study-tour course-plan design.

d. Human–AI collaboration phase: After learning common study-tour course structures under human–AI guidance, students can choose an approach to design a course plan and interact dynamically with DeepSeek. First,

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using its personalized content-generation capabilities, DeepSeek provides resources such as explanations of local culture and examples of local study-tour activities. Students can independently select activities from these resources to design their plans. Second, DeepSeek can simulate role-play involving a specific student group and engage in dialogue with students, allowing them to design plans in an immersive environment. Finally, training scenarios involving reception services, itinerary planning, and emergency response can be created to support students' end-to-end practice and simulation.

e. Peer assessment phase: After students complete their study-tour plans, they enter the group-based peer-assessment stage. Students discuss, exchange ideas, and present their study-tour plans within their groups. They not only provide feedback to one another but also use DeepSeek to conduct multidimensional and objective analyses of their peers' plans and generate diagnostic reports. Through continuous interaction with their peers and DeepSeek, students repeatedly revise and improve their group-designed outcomes.

f. Final teacher evaluation phase: As a guide to human–AI collaborative teaching, the teacher conducts the final review of study-tour plans that have been refined through human–AI collaboration. At this stage, the study-tour plans are expected to be of higher quality than those produced through traditional assignments, although this potential benefit requires empirical verification in future classroom implementation. Teachers can provide higher-level guidance in areas that are difficult for AI to evaluate, such as innovation, humanistic care, educational values, and guidance on values. Finally, based on feedback from teachers, peers, and AI, students are expected to produce higher-quality and more personalized final versions of their study-tour course plans.

5.3. Post-Class Precise Learning Evaluation Stage

g. Teaching intervention phase: After the course ends, DeepSeek analyzes all students' study-tour plans, peer-assessment records, and interaction data across the class using AI. It automatically generates multidimensional and personalized learning analysis reports. These reports can show, for example, that the class is generally weak in "safety design," that Student A has difficulties with "evaluation rubric design," or that Student B demonstrates strong innovative thinking. Based on these multidimensional learning analysis reports, teachers carry out precise teaching interventions and provide personalized guidance. The results are also used to optimize the teaching design of the next round of pre-class learning diagnosis.

6. CONCLUSIONS AND PROSPECTS

The human–AI collaborative teaching model constructed in this study, grounded in activity theory and supported by DeepSeek as both the AI agent and the mediating tool, is intended to stimulate the learning agency of secondary vocational students. In this model, students are expected to gradually shift from passive recipients of knowledge to active designers of their course plans, thereby improving their learning experiences and participation. As an intelligent mediating tool for assisted teaching, DeepSeek can influence five elements of the activity system—namely, the subject, object, community, rules, and division of labor—and promote a shift in the teaching paradigm from a teacher-centered approach to a teacher–student–AI interactive model. Through learning by doing, students continuously adjust their learning strategies and ways of thinking. They are expected to move from relying on teacher guidance to independently designing study-tour course plans, potentially improving their learning abilities. As a result, this model is intended to provide a systematic approach to addressing long-standing problems in study-tour teaching in secondary vocational tourism education, such as weak teaching content, limited teaching methods, and low student participation. However, these potential benefits require empirical verification through future classroom implementation.

For future research, broader human–AI collaborative teaching models can be further explored and applied to other core courses in secondary vocational tourism education. Through continuous cross-course practice and iterative optimization, an intelligent teaching system covering a range of professional courses can gradually be developed. On

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the other hand, as artificial intelligence technologies continue to advance, the functionality and intelligence of human–AI collaborative tools will continue to improve. Therefore, ethical risks and governance issues in human–AI collaborative teaching need to be addressed proactively. This requires not only technical safeguards but also institutional norms, teacher training, and clear accountability mechanisms to ensure that AI serves educational goals without compromising human agency and educational values. Future teaching practice should consciously cultivate students' critical thinking and guide them in developing the ability to judge and evaluate technological outputs, thereby avoiding overreliance on artificial intelligence. The goal of education is not to train blind followers of technology but to cultivate learners who can use technology rationally, think independently, and maintain their creativity. Only by upholding educational subjectivity and humanistic concern in human–AI collaboration can the risks of technological dependence be effectively avoided and the original purpose of technology-enabled education be truly realized.

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