

# The Role of AI Agents in Enhancing Teachers' TPACK: Mechanisms, Challenges, and Coping Strategies

Jinying Chen

Guangdong Polytechnic of Industry and Commerce, Guangzhou, China  
Email: 1316673287@qq.com

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## Abstract

Against the backdrop of artificial intelligence technology deeply permeating the educational ecosystem, Educational AI Agents, characterized by their high degree of autonomy, interactivity, and adaptability, present new possibilities and paradigms for teacher professional development. The TPACK (Technological Pedagogical Content Knowledge) framework, as a core theoretical construct measuring the capability of teachers to deeply integrate information technology with education, is critical for teachers adapting to the intelligent era. This study aims to systematically explore the specific mechanisms by which AI Agents enhance various dimensions of teachers' TPACK, while deeply analyzing multiple challenges encountered in application, including algorithmic limitations, cognitive and practical barriers of individual teachers, and profound ethical and governance issues. The study posits that AI Agents can serve as "Cognitive Tools", "Reflective Mediators", and "Practical Partners". By simulating complex pedagogical contexts, providing immediate data-driven feedback, and assisting in curriculum design and resource generation, they facilitate the deepening, intersection, and integration of teachers' Technological Knowledge (TK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK). However, the "black box" nature of algorithms, potential entrenchment of bias, teachers' digital literacy barriers, risks of ceding professional autonomy, and data security concerns cannot be overlooked. Accordingly, this study proposes a systematic coping strategy centered on "Human-AI Collaboration, Teacher-Centeredness, and Ethics-First". Core to this strategy is the development of explainable, intervenable, and pedagogy-aware AI Agents, the innovation of reflective practice-based TPACK training models, and the establishment of robust algorithmic ethical review and data governance frameworks. The ultimate goal is to provide a pathway for teacher professional development in the intelligent technology environment that pos-

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sesses both theoretical depth and practical viability.

## Keywords

AI Agents, TPACK, Teacher Professional Development, Human-AI Collaboration, Educational Technology, Ethical Governance

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## 1. Introduction

The iteration of information technology is reshaping social structures and the educational ecology at an unprecedented speed (Fan, 2020). In particular, breakthrough progress in artificial intelligence is driving profound paradigmatic transformations within the educational system. Tian (2021) argues that AI technology enables personalized learning recommendations and precise analysis of learning conditions, posing fundamental challenges and requirements for reshaping the role of teachers. Fan (2020) posits that AI is exerting a revolutionary impact on education, accelerating the transformation of teachers from traditional knowledge transmitters to designers of learning experiences, guides of cognitive development, coordinators of technological environments, and models of lifelong learning. In this historical transition, how teachers harness emerging technologies to support deep student learning—achieving an efficient, appropriate, and creative integration of technology, pedagogy, and content—has become the core benchmark for assessing their professional competence.

The TPACK (Technological Pedagogical Content Knowledge) theoretical framework, expanded by Mishra and Koehler based on Shulman's (1987) classic PCK (Pedagogical Content Knowledge) theory, provides a critical theoretical lens for understanding and evaluating this new integrative capability of teachers. The essence of TPACK theory lies in its emphasis that effective technology integration is not a simple addition of Technological Knowledge (TK), Content Knowledge (CK), and Pedagogical Knowledge (PK), but a complex, dynamic, and situated interaction and regeneration among these three core knowledge domains (Mishra & Koehler, 2006). It further derives intersectional knowledge such as TCK (Technological Content Knowledge), TPK (Technological Pedagogical Knowledge), and PCK, ultimately converging at the apex of integrative knowledge—TPACK. Within the TPACK framework, expert teachers not only master “what to teach” (CK) and “how to teach” (PK) but also possess a profound understanding of “what technology to use” (TK) and “how to utilize specific technologies with optimal pedagogy to achieve specific instructional goals within specific subject contexts”.

However, promoting the development of teachers' TPACK has long been a practical dilemma in the field of teacher education. Traditionally, one-off technology training (the “Workshop” model) often prioritizes “technique” over “pedagogy”, focusing on the transmission of TK while neglecting the deep integration of technology with PK and CK. This leads to a prevalent “knowing-doing gap” in

teachers' TPACK development.

The emergence of AI Agents offers a new opportunity to resolve this dilemma. Unlike previous educational technology tools (such as courseware, LMS, or early Intelligent Tutoring Systems, which relied on pre-defined rules and decision trees), modern AI Agents, particularly those based on Large Language Models (LLMs), are defined in this study as intelligent systems possessing "Agency". They are characterized by perception, autonomous planning, decision-making, and execution capabilities driven by goal-directed behaviors. They demonstrate unprecedented autonomy, generativity, interactivity, and environmental adaptability. They can comprehend complex natural language instructions, invoke external tools, perform autonomous planning and decision-making, and actively participate in complex cognitive activities as "partners" or "assistants". In the educational domain, AI Agents are no longer "toolboxes" passively waiting to be invoked by teachers; instead, they can assume diverse roles such as "virtual teaching assistants", "instructional designers", "reflection coaches", and even "intelligent learning companions". Yu (2019) classifies them into four levels: AI as an "agent" for repetitive tasks, an "assistant" for information processing, a "teacher" for transmitting knowledge and providing exercises, and even a "partner" for collaborative exploration and innovation.

The academic community has keenly captured the potential disruptive impact of AI Agents on education. Zhu et al. (2025) suggests that educational intelligent agents can profoundly intervene in the entire process of how teachers understand, reconstruct, and impart specific subject content. Li (2025) believes that the development of AI technology brings multiple challenges and impacts to teaching philosophies, content, resources, and models. However, "research on intelligent agents in the field of education, both domestically and internationally, is still in its nascent stage" (Lu et al., 2024). Current research predominantly focuses on applications in student personalized learning, intelligent assessment, and learning analytics. Studies conducted from the perspective of integrating AI technology, subject content, and teaching activities are relatively scarce (Yan et al., 2020). Theoretical and empirical research on how AI Agents, as a form of "Meta-Technology", can systematically support teacher professional development—specifically, how they can precisely empower the core construct of Teacher TPACK—remains in the early exploration phase and urgently requires deepening.

Based on this, the present study grounds itself in the TPACK theoretical framework, focusing on the specific, highly agentic technological form of AI Agents. It aims to address a series of interrelated core issues: First, through what specific mechanisms do AI Agents promote the deepening and integration of the seven dimensions of Teacher TPACK? Second, what profound challenges arising from technological, individual, organizational, and ethical levels will be encountered in the process of embedding AI Agents into teacher professional development? Third, facing these challenges, how can we construct a sustainable, responsible, and "teacher-centered" coping strategy framework from the dimensions of tech-

nological design, training system restructuring, and policy governance innovation? A systematic response to these questions will not only deepen the theoretical understanding of the laws of teacher professional development in the intelligent era but also provide critical practical guidance for the prudent, effective, and humanistic application of AI Agents in education.

## 2. Core Mechanisms and Pathways of AI Agents Empowering Teacher TPACK Development

The uniqueness of AI Agents in empowering teacher TPACK lies in their transcendence of the traditional “auxiliary” role of tools, evolving into “Cognitive Partners” and “Practical Catalysts” in the process of teacher professional development (Wang, 2021). By providing situated support, data-driven feedback, and intelligent resource generation, they deeply permeate various knowledge dimensions of TPACK, facilitating a shift from separation to integration. This deep integration fosters the emergence of a new dimension of knowledge: “Technological-Human Collaborative Knowledge” (T-HCK). Unlike traditional TPACK which focuses on the teacher’s internal cognition, T-HCK emphasizes the distributed cognition between the teacher and the AI Agent.

At the level of Technological Knowledge (TK), AI Agents are triggering a profound “de-instrumentalization” revolution. Traditional TK training focuses on operational skills for specific software, whereas AI Agents, with their powerful natural language interaction capabilities, enable teachers to “operate with the language of thought”. Teachers no longer need to memorize complex menus and commands; they simply describe their pedagogical intent to the agent (e.g., “Please design an interactive simulation experiment on ‘cell division’ suitable for eighth-grade students”), and the agent can autonomously invoke tools or generate content. This drastically lowers the threshold for technology application, releasing teachers’ cognitive resources from “how to operate” to higher levels of “why to use” and “how to use well”. More importantly, advanced AI Agents are designed to explain the “Pedagogical Rationale” behind their technological choices. They can explain to the teacher: “I recommend using a ‘simulation experiment’ rather than a ‘video’ because the former better supports ‘Inquiry-Based Learning’ (TPK) advocated by constructivist learning theory”. This interaction propels teachers’ TK from “operational knowledge” to “Critical Technological Literacy”, which encompasses technological ethics, philosophy of technology, and technological pedagogy (TPK).

At the level of Technological Content Knowledge (TCK), AI Agents play the roles of “Subject Expert Assistant” and “Representation Reconstructor”. The core of TCK lies in the teacher’s understanding of how to use technology to represent and transform specific subject content most appropriately, making it comprehensible to students. Leveraging powerful information processing and content generation capabilities, AI Agents can provide teachers with massive, diverse schemes for subject content representation. For instance, in history teaching, an agent can help teachers rapidly generate dynamic trade maps of the “Silk Road” across dif-

ferent periods, visualizing abstract economic and cultural exchanges (CK + TK); in physics teaching, it can generate interactive models simulating “relativistic effects”, allowing students to “see” the time-space distortion caused by the invariance of the speed of light (CK + TK). Agents can also assist teachers in the “conceptual analysis” of subject knowledge, mining deep connections between knowledge points, and recommending technological tools best suited to exhibit these connections (such as knowledge graphs or concept map software), thereby greatly enriching and deepening teachers’ TCK.

At the level of Technological Pedagogical Knowledge (TPK), the role of AI Agents is particularly prominent, offering a “low-risk, high-frequency, data-driven” environment for practice and reflection that traditional teacher education struggles to match. Agents can construct “Pedagogical Rehearsal Spaces”. In a virtual environment, teachers can repeatedly practice various teaching strategies (such as facilitating “Project-Based Learning”, organizing “Cooperative Learning”, or using “Socratic Questioning” techniques) facing a group of “virtual students” played by AI with different learning styles and cognitive levels. Compared to traditional “Micro-teaching”, this possesses high controllability, immediacy, and privacy. The agent can capture data on teachers’ instructional behaviors in real-time (such as question types, wait time, feedback patterns) and provide immediate data reports and improvement suggestions (TK) based on pedagogical and psychological theories (PK) after the rehearsal. This immediate, non-judgmental formative feedback proves critical for promoting the development of teachers’ Practical Knowledge. It enables the “Reflection-in-action” and “Reflection-on-action” advocated by Donald Schön to become normalized and precise under technological support.

Ultimately, the core value of AI Agents lies in promoting the holistic integration and situated generation of TPACK. The highest realm of TPACK is when teachers can “intuitively” invoke and integrate all knowledge elements in rapidly changing real classroom situations to make optimal instructional decisions. AI Agents act as “Cognitive Scaffolds” and “Wisdom Coaches” in this process. During the instructional design phase, teachers can engage in “Paired Design” with AI Agents. The agent is no longer a passive command executor but an equal conversational partner, proactively asking the teacher: “What core competencies do you hope students will achieve (CK)?” “Is ‘Flipped Classroom’ (PK) superior to ‘Direct Instruction’ for this goal?” “Will the online collaboration tool (TK) you chose create technical barriers for some students?” This continuous, context-based “cognitive probing” forces teachers to constantly examine and balance the relationships among TK, PK, and CK during the design process, learning by “doing” and integrating through “dialogue”, effectively bridging the “Knowing-Doing Gap” between theoretical knowledge and practical application.

### **3. Realistic Challenges and Deep Dilemmas of Applying AI Agents to Teacher TPACK Development**

Although AI Agents depict a broad prospect for teacher TPACK development, the

“last mile” from theoretical conception to educational practice remains thorny. We must critically scrutinize the deep-seated challenges and potential risks at technological, individual, organizational, and ethical levels.

Inherent Limitations of Technology and Algorithms represent the primary explicit challenge. First is the “Algorithm Black Box” and the crisis of explainability. The decision-making processes of current mainstream AI Agents (especially deep learning models) are largely opaque. When an agent recommends an “optimal” teaching strategy, if the teacher cannot understand the reasoning and data sources behind it, this “Lack of Explainability” will severely hinder critical acceptance. Specifically, this opacity blocks the development of teachers’ Technological Pedagogical Knowledge (TPK). If teachers cannot comprehend the pedagogical logic behind an AI recommendation, they cannot validate its alignment with learning objectives, reducing them to passive executors rather than active designers. Teachers may fall into a binary opposition of “blindly following algorithms” or “total rejection”, which runs counter to the professional autonomy advocated by TPACK. Second is algorithmic bias and the ossification of teaching models. The “intelligence” of AI Agents stems from their training data. If the training data inherently contains preferences for specific pedagogies (e.g., exam-oriented, highly controlled direct instruction due to ease of quantification) or stereotypes about specific student groups, the agent may “objectively” replicate and amplify these biases. It might recommend “efficient” but “anti-educational” practices, leading to the atrophy rather than development of pedagogical innovation (TPACK). Third is the scarcity of contextual awareness. The real classroom is a dynamic ecosystem full of “contingency”, “emotionality”, and “complex interactions”. AI Agents currently have extremely limited capabilities to perceive this subtle, non-verbal classroom atmosphere and the emotional states of teachers and students. The “standard solutions” or “average solutions” they provide are often difficult to adapt to the unique needs of specific classes and students—lacking the “Context-specific” wisdom emphasized by TPACK. This limitation directly impacts the application of Pedagogical Content Knowledge (PCK), as the agent fails to capture the subtle student misconceptions or emotional cues that usually trigger a teacher’s dynamic adjustment of instructional content. Fourth is the risk of “Generative Hallucination” and Factuality Issues. LLM-based agents may confidently generate plausible but factually incorrect subject content. This unreliability poses a direct threat to Content Knowledge (CK) accuracy. If teachers frequently encounter such errors, their “Trust in Automation” will rapidly degrade, making them hesitant to treat AI as a reliable pedagogical partner, thus hindering the practical integration of technology.

Cognitive, Belief, and Practical Barriers of Individual Teachers are the core bottlenecks for implementation. First is the structural deficiency in digital literacy and AI literacy. TPACK development presupposes that teachers possess basic TK. However, facing new technologies with “agency” like AI Agents, teachers need not just operational skills, but “Educator Literacy in the AI Era”, including data inter-

pretation, algorithmic critique, and human-AI collaboration. The widespread lack of such high-order literacy causes many teachers to be either “daunted” (technophobia) or “superficial” (using AI only for substitutive tasks like copywriting). Second is the deep conflict between professional identity and pedagogical beliefs. This is the most fundamental obstacle. The intervention of AI Agents blurs the boundary between human and machine, challenging teachers’ professional identity. If a teacher relies excessively on AI for instructional design and decision-making, where does their “professionalism” lie? Can the emotional and value care in “teaching and educating” be replaced by algorithms? When the agent’s suggestions based on “maximization of efficiency” conflict with the teacher’s educational beliefs based on “holistic development” (deep integration of PK and CK), do teachers still have the courage and ability to hold their ground? If this “human-machine conflict” is not properly reconciled, teachers may adopt “defensive” or “superficial” application strategies. Third is practice burnout and “Automation Complacency”. The “efficiency improvement” brought by AI Agents is a double-edged sword. While liberating teachers from repetitive labor, it may also lead to “Automation Complacency” or “De-skilling”. Teachers might abandon independent thinking and creative design due to over-reliance on the agent’s “one-click generation”. Over time, their TPACK capabilities may atrophy rather than improve.

Structural Risks regarding Ethics, Data, and Governance are the fundamental guarantees for the sustainability of technology application. First is data privacy and surveillance anxiety. For AI Agents to intervene as “teaching coaches”, they must collect and analyze vast amounts of data on teachers’ instructional behaviors, design drafts, and interactions with “virtual students” around the clock. Where are the boundaries for privacy protection, ownership, storage security, and usage of this highly sensitive “professional practice data”? If this data is used for improper performance appraisal or ranking, it will undoubtedly trigger widespread panic and resistance among teachers, leading to the alienation of technology application. Second is the ceding of professional autonomy and algorithmic power. As the “suggestions” of AI Agents (algorithms) are endowed with increasing “authority” (e.g., based on “big data proof” of effectiveness), to what extent will teachers’ Professional Autonomy be eroded? In the decision-making flow of “human-AI collaboration”, how is accountability defined? If an instructional plan recommended by AI and executed by a teacher leads to adverse consequences, does the fault lie with the algorithm or the teacher? The expansion of “algorithmic power” may reduce teachers from “subjects with professional autonomy” to “executors of algorithmic decisions”. Third is equity and the widening digital divide. The R&D and maintenance costs of high-quality AI Agents (especially high-order models that “understand pedagogy”) are high. Will this exacerbate the existing “digital divide” between different regions and schools? Will teachers without access to high-quality AI tools experience further lag in TPACK development, thereby worsening educational inequity?

#### 4. Practical Strategies and System Construction for Promoting Collaborative Development of AI Agents and Teacher TPACK

Facing the intricate challenges mentioned above, we must discard the optimistic fantasy of “technological determinism” and the pessimistic conservatism of “technological threat theory”, adopting instead a systematic coping strategy of “Human-AI Collaboration, Teacher-Centeredness, and Ethics-First”. This requires synergistic efforts across three levels: technological R&D, teacher training, and policy governance, to construct a benignly interactive and dynamically evolving development ecosystem.

Optimization of Technological Design: Constructing Explainable, Intervenable, and “Pedagogy-Aware” AI Agents. Technology itself is not neutral; it carries the values of its designers. Therefore, the starting point must return to technological design. First, tackle “Explainability” (XAI). Developers must place “pedagogical transparency” on par with “model performance”. When providing teaching suggestions, agents must clearly display the underlying educational theoretical basis (PK), key data sources, and decision logic chains in a way understandable to teachers. This is not only the foundation for establishing teacher Trust but also a process of transforming the “black box” into a “transparent teaching aid”—teachers’ own TPACK (especially TPK and TCK) is exercised while scrutinizing AI logic. Second, ensure “Intervenability” and “Human-in-the-Loop”. Teachers must be granted the ultimate power to intervene, customize, and veto AI Agents. The role of AI should be “Co-pilot”, not “Pilot”. Teachers should be able to adjust the agent’s parameters, correct its suggestions, or selectively adopt them based on their grasp of the specific context. This “Human-in-the-Loop” design philosophy is the technological bottom line for ensuring teacher professional autonomy and decision-making subjectivity. Finally, and most critically, develop “Pedagogy-Aware” AI. The core optimization goal of AI Agents should not be the pursuit of short-term, quantifiable “teaching efficiency” or “student scores”, but the enhancement of long-term, complex “teacher reflective capacity” and “student higher-order thinking”. This means AI needs to be implanted with “pedagogical wisdom”—it should be designed to proactively “expose problems” rather than “hide them”, to “stimulate diverse perspectives” rather than “provide a single answer”, and to “encourage teachers to take innovative risks” rather than “adhere to the optimal path”. Only such AI can truly become a “catalyst” for teacher TPACK development.

Innovation in Teacher Development: Reconstructing a New TPACK Training Model Based on Human-AI Collaboration. No matter how advanced the technology, it can only be transformed into educational productivity through teachers’ “professional absorption”. Drawing from “Human-AI Teaming” research in Human-Computer Interaction (HCI), we must move beyond simple interaction to “Mixed-Initiative Interaction”, where both teacher and AI can proactively contribute to the goal. The traditional “Empowerment Model” of training is failing

and must shift to a “Co-evolution Model”. First, a shift in training goals: from “Technological Usage” to “Collaborative Wisdom”. The focus of future teacher training is no longer “how to use” a certain AI tool, but “how to collaborate efficiently with AI”, “how to critically evaluate AI output”, “how to harness AI for pedagogical innovation”, and “how to uphold educational ethics in human-AI collaboration”. This requires integrating “AI Literacy” into the TPACK framework, forming a new “AI-TPACK” integrative capability—potentially the “Technological-Human Collaborative Knowledge” (T-HCK) mentioned in the outlook. Second, reconstruction of training modes: from “Centralized” to “Situated”. The AI Agent itself is the best training tool. Teacher TPACK development should not idle in “training rooms” but occur in “authentic teaching contexts” supported by the “situated scaffolding” of AI Agents. Teachers should be encouraged to “use AI, evaluate AI, and modify AI” in their daily lesson planning, teaching, and reflection. For instance, a “Adversarial Co-Design Workshop” can be introduced. In this activity, teachers act as “Critical Reviewers”. They actively challenge an AI Agent to generate a lesson plan for a specific topic, then identify its pedagogical flaws (e.g., lack of emotional engagement) and iteratively refine the prompts until the AI output meets expert standards. This process trains teachers’ evaluative judgment and collaborative competency simultaneously. Third, transformation of training organizations: building “Human-AI Collaborative” Professional Learning Communities (PLCs). Relying solely on individual teachers is insufficient to navigate the complex challenges brought by AI. Online-offline blended professional learning communities must be established where teachers share, discuss, and debate their experiences, confusions, success stories, and failures in “working with” AI Agents. AI Agents can serve as “data assistants” and “connecting mediators” for this community, while human wisdom (especially the tacit knowledge in PCK and TPACK) becomes “explicit” and rises spirally through peer exchange, collision, and reflection.

Construction of Governance Framework: Establishing Robust Data Privacy, Ethical Review, and Policy Guidance. A healthy human-AI collaborative ecosystem cannot exist without the safeguard of “good laws and governance”. First, establish a rigid “Ethical Firewall”. The formulation of AI ethical norms and data governance regulations in education must be accelerated. Following the principles of “minimal collection, strictest protection, and clearest authorization”, full-cycle supervision should be conducted on the data behavior of AI Agents used for teacher development. The red line between “educational use” and “punitive use” of data must be clearly defined to resolutely prevent AI from becoming a “Digital Leviathan” style surveillance tool, thereby eliminating teachers’ worries. Second, introduce an independent “Algorithmic Review Mechanism”. Educational administrative departments or third-party professional bodies should establish mechanisms for “algorithmic ethics and bias review” of educational AI Agents. Before AI tools enter schools, pre-assessments of their algorithmic transparency, data fairness, and embedded “educational values” must be conducted to ensure align-

ment with the fundamental goal of “moral education”. Finally, leverage the role of policy as an “Active Navigator”. Government and education department policies should not stop at “regulation” but manifest in “guidance”. Through special funds, demonstration projects, and reform of teacher evaluation systems, active encouragement and support should be given to the R&D and application of “Good AI” that genuinely aims to enhance teacher TPACK, promote educational equity, and stimulate pedagogical innovation. Policy should clearly signal: We reward not AI that “thinks instead of teachers”, but AI that “empowers teachers to think deeply”.

## 5. Limitations and Outlook

This study primarily provides a systematic theoretical analysis and conception of the complex relationship between TPACK and AI Agents based on the TPACK framework and frontier technological characteristics. However, limitations exist. First, given that the practical application of AI Agents, especially Generative AI with high autonomous interaction capabilities, in teacher professional development is still in the early stages of large-scale eruption, the arguments largely rely on theoretical deduction, literature review, and analogical application of relevant educational theories (such as constructivism, situated cognition, reflective practice). The effectiveness and feasibility of the proposed mechanisms and strategic frameworks await verification through large-scale, longitudinal empirical data.

Second, the analysis of the “teacher” group is relatively homogenous, failing to differentiate significant differences that may exist among teachers of different disciplinary backgrounds (liberal arts vs. STEM), career stages (novice vs. expert), and levels of technology acceptance when using AI Agents to develop TPACK. These differences are key to developing precise, personalized intervention strategies in the future.

Looking ahead, the research space in this field is vast and holds high practical value. First, Integration of Empiricism and Design (DBR). Future research should extensively adopt “Design-Based Research” (DBR) and “Action Research”, developing, applying, and iterating AI Agents aimed at enhancing TPACK in real educational settings. Through DBR, researchers can not only verify theories but also generate new theoretical and practical prototypes “in context”.

Second, Deepening of Processes and Mechanisms (Mixed Methods). Mixed research methods should be employed to combine “objective” process data such as human-AI interaction logs, eye-tracking data, and physiological electrical signals with “subjective” qualitative materials like in-depth teacher interviews, reflective journals, and instructional design texts. This “data triangulation” helps reveal the Micro-level Cognitive Processes of how AI Agents affect teacher TPACK development and the underlying mechanisms of change in emotions, motivations, and beliefs.

Third, Evolution of Theoretical Frameworks (TPACK 3.0). The “Agency” of AI

Agents is challenging the traditional TPACK framework. When technology is no longer a purely “objective” tool but a “subjective” collaborator, will the relationships among the seven dimensions of TPACK be reconstructed? For example, does teachers’ knowledge need a new dimension, namely “Technological-Human Collaborative Knowledge” (T-HCK) or “AI Pedagogical Knowledge” (AI-PK)? That is, knowledge of how to “divide labor” with AI, how to “manage” AI, and how to “evaluate” AI. This may be the inevitable direction of TPACK theory evolution in the intelligent era.

## 6. Conclusion

The emergence of AI Agents is not only an inevitable product of educational transformation in the intelligent era but also a key variable driving the paradigm shift in teacher professional development. It offers a highly promising yet uncertain new path to solve the long-standing problems of “difficulty in development” and “difficulty in implementation” of TPACK in teacher education. Through systematic analysis, this study aims to emphasize the “Dual Role” of AI Agents in teacher TPACK development: they are efficient “Cognitive Tools” and “Efficiency Assistants”, but more importantly, they should be positioned as “Cognitive Scaffolds” and “Reflective Catalysts” that stimulate teachers’ professional wisdom (Wang, 2021).

Their core value lies not in providing “one-click generated” standard answers to replace teachers’ professional labor, but in empowering teachers to establish deeper, dynamic, situated, and creative connections among the three pillars of Technology (TK), Content (CK), and Pedagogy (PK) by simulating complex teaching contexts, providing diverse data-based perspectives, and stimulating continuous pedagogical reflection.

From the positive analysis of “empowerment mechanisms” to the critical scrutiny of “realistic challenges”, and finally to the prudent construction of “systematic strategies”, this study consistently upholds a core argument: Technological development must serve human development, and AI’s “intelligence” should ultimately lead to teacher “wisdom”. Facing the “powerful stranger” that is the AI Agent, the response from the education sector should neither be blind embrace under “technological worship” nor irrational resistance under “technophobia”. We must “deepen our understanding of AI technology and learn to cooperate with AI” (Tian, 2021). Based on profoundly understanding the nature, limitations, and ethical boundaries of technology, we must actively construct a new professional development ecosystem that is “Teacher-Centered, Human-AI Collaborative, and Reflection-Driven”. This requires injecting educational determination and humanistic wisdom that transcend technology itself into the “code” of technological R&D, the “design” of teacher training, and the “regulations” of policy governance. This ensures that AI Agents, this epoch-making technological force, ultimately serve to cultivate teachers’ higher-order TPACK and lead to a future education that is fairer, more humane, and more creative.

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## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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