International Society of the Learning Sciences

# Beyond Teacher-AI Dyads: A Triadic Synergy Model for Transforming Teacher Professional Development

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**Abstract:** Traditional expert-led teacher professional development models often struggle with personalization, scalability, and sustainability. While AI offers new possibilities, the prevailing AI-enhanced models often rely on teacher–AI dyads, raising concerns about opacity and reduced teacher agency. Drawing upon Connectivism and Hybrid Intelligence, we propose the Triadic Synergy Model. This framework formalizes a three-way, networked, and synergistic relationship that strategically integrates the teacher's agency, AI's analytical power, and the human expert's contextual wisdom.

## Introduction

Effective teaching remains one of the most important school-based influences on student learning, and high-quality teacher professional development (TPD) is therefore central to educational improvement (Hattie, 2023; Kennedy, 2016). Yet traditional TPD models, such as expert-led workshops and seminars, often struggle to achieve personalization, scalability, and sustainability (Breault, 2013; Van Veen et al., 2012). Teachers may receive standardized input and often lack sustained and personalized support that can translate professional learning into lasting classroom change (Dzingel et al., 2025).

Against this background, AI has emerged as a promising force in TPD. AI tools can provide on-demand pedagogical support, generate personalized learning pathways, and analyze classroom data to offer immediate feedback (Tan et al., 2025). These affordances suggest that AI may help address some of the long-standing constraints of traditional TPD. However, current AI-integrated TPD models often rely on a direct teacher–AI relationship, and this dyadic structure has important limitations. For example, AI-generated feedback may be difficult to interpret or experienced by teachers as opaque and difficult to trust (Jacobs et al., 2024). At the same time, a strong emphasis on automation may position teachers as passive recipients of recommendations, thereby weakening the professional agency that effective TPD requires (Li et al., 2025). These challenges suggest that the issue is not simply whether AI should be introduced into TPD, but how it should be integrated in ways that are both easy to understand and able to preserve teacher agency.

To address this gap, this paper proposes the Triadic Synergy Model, a model that helps to move beyond teacher–AI dyads by incorporating a third participant: the human expert. Drawing on Connectivism (Siemens, 2005) and Hybrid Intelligence (Cukurova, 2025), the model conceptualizes TPD as a networked and synergistic relationship among teacher, AI, and expert.

## The Triadic Synergy Model: A synthesis of teacher, AI, and expert

To resolve the tensions inherent in dyadic structures, the Triadic Synergy Model emphasizes triadic synergy, where learning capacity arises from the networked interaction among three key participants: the teacher, the AI, and the human expert. The model is theoretically grounded in Connectivism, which posits that learning in the digital age occurs through the formation of connections across a distributed network (Siemens, 2005). This ensures that knowledge transfer is not unidirectional (AI-to-teacher) but multidirectional. Furthermore, drawing on principles of Hybrid Intelligence (Cukurova, 2025), the model envisions a strategic division of labor that combines the strengths of humans and AI.

As the agentic driver, the teacher remains at the center of the professional learning process. They are not passive recipients but the active orchestrators of their professional development. These core capacities of goal-directed action and strategic self-management are similar to the principles of Self-Regulated Learning (SRL), which provides the theoretical grounding for the teacher's role in our model (Zimmerman, 2002). By actively deciding when to engage with AI analytics for specific practice opportunities and when to seek the human expert for deeper pedagogical reasoning, teachers could develop adaptive agency gradually (Tao & Gao, 2017). This centrality prevents TPD from becoming a generic exercise and fosters a deep sense of ownership.

As the scalable analyst, AI contributes what traditional expert-led TPD often struggles to provide consistently: rapid data processing, pattern recognition, and personalized support at scale. These capabilities can

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be operationalized in several ways to support teacher development. For example, AI captures and interprets vast streams of multimodal data (e.g., student engagement patterns, teacher discourse) to reveal insights often invisible to the human eye (Zhai et al., 2021). Building on this analysis, the AI can then generate immediate, personalized feedback for the teacher, highlighting specific moments for reflection (Demszky et al., 2024). Beyond analysis and feedback, AI's generative capacity is instrumental in creating dynamic support and practice environments (Zhang et al., 2025).

However, analytics alone are not enough. This is where the human expert plays a necessary role as the contextual scaffolder. The expert's scaffolding can be realized through several vital actions. For example, they can provide an interpretive bridge to address the AI's black-box effect. By co-interpreting the AI's output with the teacher, the expert helps transform abstract data points into a coherent pedagogical narrative that resonates with the teacher's classroom experience. Moreover, the expert models pedagogical wisdom, guiding the teacher through complex situations and facilitating reflective dialogue that requires high levels of social and emotional intelligence, a domain where AI currently falls short (Li et al., 2025). The expert can also serve as an ethical guardian, promoting responsible use of AI and maintaining a critical perspective. In essence, while the AI provides the "what" (performance data), the expert helps the teacher understand the necessary technological context, construct the "so what" (pedagogical significance), and the "now what" (actionable next steps).

Emerging research on human–AI collaboration in education points in a similar direction. For instance, Cosentino et al. (2025) found that a teacher who provided guidance, posed reflective questions, and adjusted the difficulty of AI-generated problems was crucial for optimizing the learning experience. Shifting the focus to mentorship, Huang et al. (2025) discovered a complementary relationship between graduate student mentors and generative AI. Closer to our direct context of teacher education, Yu et al. (2025) developed a Hybrid Intelligence Feedback (HIF) system that uses AI to structure and summarize peer feedback on teaching videos for pre-service teachers. Their findings showed that this AI-enhanced process led to significantly deeper and more diverse reflections. The Triadic Synergy Model builds on this insight by offering a model for how such collaboration might be structured in teacher learning.

## The future of the Triadic Synergy Model

The Triadic Synergy Model offers a conceptual paradigm shift from viewing AI as a mere tool to understanding it as a participating node within a collaborative human network. To move this model from conceptualization to transformative practice, several avenues for future research could be pursued.

A primary area for future research involves the intricate design and orchestration of interaction within the triadic network. As Vaccaro et al. (2024) found that effective human–AI synergy requires appropriately allocating subtasks to whichever partner is best suited for them. While existing work from student learning provides proof-of-concept for such triadic interactions, future work is encouraged to explore the emergent dynamics of the fully integrated three-node network within teacher education. This includes developing specific protocols for orchestrating three-way interactions, creating structured activities that leverage each participant's strengths, and establishing clear coordination mechanisms for collaboration within the triadic system.

A second research direction concerns sustainability. One of the model's longer-term possibilities is a teacher-to-expert pathway, in which experienced participants gradually develop the capacity to scaffold others within the triadic network. This transition is feasible because the model synergizes the three participants to redefine and streamline the expert's responsibilities. With AI handling activity delivery and teachers driving the learning process, the primary role of experts is to facilitate dialogue and co-interpret AI-generated suggestions. This less burdensome role becomes much more manageable for experienced practitioners to adopt. Nevertheless, future studies are needed to investigate what kinds of knowledge, dispositions, and AI literacy are needed for teachers to move credibly into this expert role, and whether such near-peer experts can provide support comparable to that of instructional coaches, researchers, or master teachers.

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## Acknowledgement

This work was supported by Hong Kong RGC, University Grants Committee (Grant No.: 17619325).