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From Technical Enablement to Deep Learning: The Paradigm Shift and Mechanism Examination of University Faculty Professional Development in the Digital-AI Era

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Abstract: The deep integration of digital-AI technologies is reshaping the forms and logic of higher education teaching. However, university faculty professional development faces the limitations of the "technical enablement" paradigm, leading to a cycle of "technological anxiety–performative innovation–meaning depletion." Based on sociocultural theory, expansive learning theory, and teacher identity theory, this paper constructs a "technology-cognition-identity" co-evolution theoretical framework. It proposes a new paradigm centered on "teacher deep learning," operationalized into three dimensions: critical technological cognition, reflective practice iteration, and identity reconstruction. Accordingly, the article puts forward strategic recommendations targeting multiple stakeholders, including the state, universities, faculty development centers, and enterprises, aiming to propel teachers from "being empowered" to "self-empowerment," and to achieve the synergistic development of educational wisdom and professional autonomy in the digital-AI era.

Keywords: Deep learning; Digital-AI technologies; Teaching innovation; Sense of technological alienation

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1. Introduction

Over the past decade, "digital-AI technologies" such as artificial intelligence, big data, cloud computing, and the Internet of Things have rapidly integrated into the field of higher education. National policies like the Education Informatization 2.0 Action Plan, the Digital Education Strategy Initiative, and the "AI-Powered Teacher Team Building Pilot" have prompted universities to reconstruct the entire teaching process with a digital mindset [1]. At the institutional level, smart classrooms, learning analytics dashboards, AI teaching assistants, and automated knowledge graph generation systems have become standard. These technologies have not only altered the presentation of teaching but also reshaped its internal logic, creating an "algorithmic environment" [2]. This

environment offers teachers unprecedented "visibility," such as the datafication of learning processes, the instant feedback on teaching effectiveness, and the precision of personalized interventions. However, it also brings about "technological ensnarement" [3], where teaching rhythms are driven by data metrics, professional judgment is supplanted by algorithmic recommendations, and course evaluation relies increasingly on data rather than educational essence. Research conducted three years after policy implementation reveals that university teachers face a "three-more-three-less" dilemma: more technical training but less support for deep learning; more tool demonstration but less modeling of pedagogical understanding; more data metrics but less construction of professional identity meaning. This leads faculty professional development into a vicious cycle of "technological anxiety–performative innovation–meaning depletion," indicating a crisis for the traditional "technology-skill" training paradigm. Confronted with this dual effect, academia urgently needs to explore: What new paradigm is required for university faculty professional development in the digital-AI era? What are its core mechanisms and boundary conditions?

2. Theoretical framework and conceptual definition

2.1. Theoretical foundation

To explain "how teachers achieve their own deep learning and promote teaching innovation in the digital-AI era," this paper moves beyond a singular educational technology perspective, integrating sociocultural theory, expansive learning theory, and teacher identity theory to form a "technology-cognition-identity" co-evolution framework.

2.1.1. Sociocultural theory

Vygotsky proposed that higher psychological functions develop through the mediation of cultural tools [4]. Digital-AI technologies are not neutral tools; they carry "algorithmic logic," "data discourse," and a "politics of speed," reshaping teachers' professional perception and boundaries of action. In other words, AI recommendation systems not only offer teaching suggestions but also subtly alter teachers' definitions of "good teaching." Sociocultural theory reminds us that the process of teachers "internalizing" technology must be accompanied by a "re-externalization" of the essence of education; otherwise, they risk falling under the domination of "instrumental rationality."

2.1.2. Expansive learning theory

Engeström, building on activity theory, proposed the "expansive learning cycle," emphasizing that when individuals and collectives encounter new tools, they go through a cycle of "questioning, analysis, modeling, implementation, reflection, and consolidation" to achieve the expansion of the activity object and the restructuring of rules [5]. The introduction of digital-AI technologies into the classroom inserts a "new mediating artifact" into the teacher's activity system, potentially triggering "cognitive conflicts" and "object transformation." If teachers remain at the level of "technical operation" without completing the expansion of the activity system, they enter a state of "instrumental survival" rather than "deep learning."

2.1.3. Teacher identity theory

Beijaard categorized teacher identity into three sub-identities: "subject matter expert," "pedagogical expert," and "didactic expert" [6]. Kelchtermans added the "narrative-emotional-power" dimension, emphasizing that identity is negotiated between "self-narrative" and "external discourse" [7]. In the digital-AI era, algorithmic

evaluation, data rankings, and teaching competitions constitute a new form of "external discourse" that can fracture teachers' original narratives. For instance, when a teaching dashboard uses "student head-up rate" as a key indicator of teaching quality, a teacher insisting on "slow inquiry" might be labeled "inefficient," leading to an identity crisis. Teacher deep learning must include the process of "identity reconstruction"—that is, through critical reflection and community dialogue, transforming external data discourse into an integral part of the "self-narrative," rather than letting algorithms define "who I am."

2.2. Operational definition and dimensions of teacher deep learning

Based on the above theories, this paper defines "teacher deep learning" as: a process of professional growth for university teachers in digital-AI environments, starting with critical technological cognition, progressing through reflective practice iteration and identity reconstruction, to achieve the synergistic development of teaching innovation and student deep learning. This definition emphasizes three points:

(1) "Deep learning" is not merely about mastering new technologies but involves a critical understanding of the epistemology, axiology, and power mechanisms behind the technology.

(2) "Deep learning" must be implemented in the iterative improvement of teaching practice, manifested in evidence-based course redesign, learning assessment, and teacher-student interaction.

(3) "Deep learning" ultimately points to the re-narration of teachers' professional identity, maintaining the primacy of "educational wisdom" in an algorithmic society.

Accordingly, this paper proposes three core dimensions of teacher deep learning:

(1) Critical technological cognition: The ability of teachers to discern the educational logic, data biases, and ethical risks of digital-AI technologies, and to prioritize "educational purposes" over "technological means" in teaching decisions.

(2) Reflective practice iteration: The ability of teachers to utilize multimodal data (learning analytics, classroom videos, student feedback, etc.) to cyclically improve teaching objectives, activities, and assessments, forming transferable "practical knowledge."

(3) Identity reconstruction: The ability of teachers to negotiate between personal narrative and external data discourse, integrating the "data self" and the "educational self" into a new professional identity, thereby maintaining professional autonomy and a sense of vocational meaning.

3. Research model and mechanism

3.1. Main effect path

Teacher deep learning → Teaching innovation behavior. Teaching innovation behavior refers to teachers adopting novel, effective, and appropriate methods in course design, teaching strategies, and learning assessment to enhance student learning quality. Deep learning provides teachers with the "cognitive resources," "practice resources," and "emotional resources" necessary for innovation; it is therefore hypothesized to positively influence teaching innovation.

3.2. Mediating path

The mediating role of teaching self-efficacy. Teaching self-efficacy refers to teachers' belief in their capability to organize and execute courses of action required to successfully accomplish specific teaching tasks and facilitate student academic success. When teachers undergo the "critique-practice-identity" deep learning cycle, they accumulate successful experiences and positive emotions, thereby enhancing their self-efficacy. Higher self-

efficacy, in turn, further motivates teachers to attempt innovative teaching practices.

3.3. Moderating path

The negative moderating role of sense of technological alienation. Sense of technological alienation refers to the psychological state where teachers feel controlled by algorithmic evaluations and data metrics, unable to teach autonomously according to educational purposes. When the sense of alienation is high, even if teachers possess the potential for deep learning, innovation behavior might be inhibited due to the pressure of "data performance." Conversely, when the sense of alienation is low, the promoting effect of deep learning on innovation is stronger.

4. Strategic recommendations and implementation pathways

4.1. National level

(1) Revising standards: Revise the University Teacher Digital Literacy Standards to include a "Teacher Deep Learning" dimension [8], incorporating indicators such as critical technological cognition, data ethics, and identity autonomy, providing a unified basis for training and assessment.

(2) Establishing special programs: Launch pilot initiatives focused on "deep learning orientation," selecting 3–5 universities per province, prioritizing support for the construction of "AI sandboxes + teacher learning communities," with funding tilting towards reducing the sense of technological alienation.

(3) Issuing guidelines: Commission national academic societies to publish Educational Algorithm Ethics Guidelines, restricting the use of high-risk metrics (e.g., "real-time classroom emotion recognition," "head-up rate ranking") in official evaluations, alleviating teachers' pressure for data performance.

4.2. University level

(1) Reforming evaluation: Reform teacher evaluation schemes, replacing simplistic data rankings with "evidence-based teaching improvement reports" [9], allowing teachers to submit qualitative evidence (student work, reflective journals, peer observations) as supplementary materials.

(2) Developing integrated programs: Faculty development centers should develop integrated "technology-pedagogy-identity" training programs, including workshops on algorithm deconstruction, data-driven course redesign, identity narrative, and ethics debates, each module supported by action learning groups and mentor follow-up.

(3) Building communities: Faculty development centers should establish "cross-disciplinary & human-machine" teaching innovation communities, inviting computer ethics experts, learning scientists, and frontline teachers to jointly build case libraries, facilitating multi-perspective dialogue.

4.3. Enterprise and technology provider level

(1) Opening interfaces: Provide explainable algorithm interfaces, offering teachers "reasoning reports" for recommendations to meet the need for critical technological cognition.

(2) Introducing customizable metrics: Develop a "teacher-customizable metrics" function, allowing teachers to adjust indicator weights based on course objectives, reducing reliance on external unified rankings.

(3) Co-building sandboxes: Collaborate with universities to establish "ethics sandboxes," conducting

teacher focus group assessments before new features are launched to identify potential alienation risks proactively.

5. Conclusion

Teacher deep learning is not only a subjective path for university teachers to respond to the digital-AI wave but also a strategic pivot for the transformation of education digitalization towards a "human-centered" stage [10]. Future research and practice require concerted efforts at the institutional, technological, and cultural levels to enable teachers to truly move from "being empowered" to "self-empowerment," safeguarding educational wisdom and humanistic spirit in the algorithmic age. Through continuous research and practical exploration, we can better support teachers' professional growth in the digital-AI era and promote the high-quality development of higher education.

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