

A Literature Review of Teachers' Digital Competence from the Perspective of Artificial Intelligence

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Abstract

Against the backdrop of deep integration between artificial intelligence and educational digitalization, teachers' traditional ability to apply information technology fails to meet the demands of intelligent teaching, and teachers' digital competence has become a vital topic in educational transformation. Based on the literature research method, this paper retrieves 277 papers published from 2019 to 2026 from CNKI, EBSCO and other databases using keywords such as "teachers' digital competence", "digital competence", "competence model" and "artificial intelligence" + "teachers' digital competence", including 25 Peking University Core articles and 15 CSSCI papers. The review explores four aspects of teachers' digital competence in the artificial intelligence context: conceptual evolution, constituent dimensions, assessment methods and promotion paths. Through comparative analysis of domestic and international theoretical frameworks of teachers' information capability, digital competence and intelligent teaching capability, three developmental phases are summarized: basic ICT literacy, general digital competence, and competence for artificial intelligence literacy education. A diversified assessment system combining self-report scales, performance assessment and mixed evaluation has been established, alongside ecological and sustainable teacher cultivation pathways. However, current research has obvious deficiencies: shortage of localized models, incomplete dynamic assessment systems, impractical implementation paths and delayed research on emerging technologies. Therefore, future research is expected to build localized and differentiated teacher competence frameworks, improve intelligent dynamic evaluation systems, optimize teacher training mechanisms and advance interdisciplinary frontier research, so as to offer theoretical support for the advancement of teachers' digital capabilities and high-quality development of educational digitalization in the intelligent era.

Keywords

Artificial Intelligence, Teachers, Digital Competence

1. Introduction

The rapid development of artificial intelligence and in-depth digital transformation of education are reconstructing teaching modes and competency standards for teachers. Traditional classroom evaluation systems that take knowledge memorization and standardized learning outcomes as the core have gradually become obsolete. Instead, education focuses more on cultivating students' high-order literacy including critical thinking, innovation and problem-solving capacity. Correspondingly, teachers' professional roles need thorough transformation. They should no longer merely deliver knowledge, but act as designers of intelligent learning environments, companions for students' personalized growth, coordinators of human-machine collaborative teaching and instructors of AI ethics. Traditional standards for information technology competence cannot meet the demands of intelligent teaching, so upgrading teachers' digital competence has become a core task of educational digital transformation. Under such circumstances, exploring ways to improve teachers' digital competence in the AI context not only responds to the national strategy of educational digitalization, but also serves as a vital approach to realize intensive teaching development and boost instructional efficiency.

2. Research on the Evolution of Core Concepts: From Technology Integration Literacy to Intelligent Educational Competence

Evolved from information literacy, teachers' digital competence keeps advancing and expanding with technological progress and educational conceptual innovation, focusing more on teachers' integrated professional capabilities.

2.1. Foreign Research on Core Concepts

Early overseas studies mainly focused on teachers' ICT literacy, which refers to the capacity to integrate information and communication technologies into classroom teaching and highlights basic tool operation. A representative achievement is the TPACK framework proposed by [Mishra & Koehler \(2006\)](#). As digital technologies penetrated every segment of education, the European Commission Joint Research Centre released the European Framework for the Digital Competence of Educators (DigCompEdu) in 2017. It divides educators' digital competence into six domains and 22 specific capabilities: professional engagement, digital resources, teaching and learning, assessment, empowering learners and supporting learner development. Among these domains, it particularly emphasizes educators' ability to apply technologies critically, creatively and responsibly to improve teaching

practice (Redecker & Punie, 2017). In recent years, with the rise of artificial intelligence, scholars have proposed incorporating AI literacy as an indispensable dimension into digital competence frameworks. For example, Celik et al. (2022) constructed a three-dimensional framework for teachers' digital competence under AI, covering cognition, technology and ethics. It indicates that foreign research on teacher competence is expanding from universal digital capabilities to new competency requirements brought by artificial intelligence.

2.2. Domestic Research on Core Concepts

In domestic research on teachers' digital competence, frequently-occurring keywords include information literacy, information-based teaching ability, educational informatization, primary and secondary school teachers, information technology, teachers' professional development, pre-service teachers/student teachers, promotion strategies, and TPACK. It can thus be found that digital competence has not yet become a mainstream term in Chinese academic circles. Most researchers focus on the development of capabilities at the micro level, such as the information-based teaching ability of in-service and pre-service teachers. In the initial stage, relevant domestic research was mainly driven by policies and centered on "primary and secondary school teachers' information technology application ability". Conceptually, research on teachers' digital ability used to pay more attention to teachers' technical skills in specific professional practices, with insufficient attention to teachers' broader identity as digital citizens. The concept of "teachers' digital competence" was first put forward by Ren Youqun and Yang Xiaozhe in 2017. They argued that teachers should possess corresponding capabilities to foster students' digital competence and regarded digital competence as one of students' core literacies (Ren & Yang, 2017). With the advancement of the Digital China Strategy, the concepts of "digital literacy" and "digital competence" have attracted growing academic attention. While drawing on international frameworks, Chinese scholars are actively exploring localized theoretical construction. For instance, Ren Youqun and Li Feng pointed out that "focusing on digital competence and enhancing citizens' digital literacy" is an arduous mission of information technology education in primary and secondary schools in Shanghai. They embedded digital competence within digital literacy and clarified that it refers to comprehensive capabilities required for specific occupational roles (Li et al., 2017). Yan (2018) established a teacher digital literacy model covering digital learning and innovation, digital instructional design and implementation, and digital social responsibility. Targeting higher education amid AI development, Zhu (2018) systematically analyzed role transformation and competency demands for teachers in intelligent education at an early stage, pointing out that teachers ought to transform from knowledge transmitters to learning designers, data analysts and emotional tutors.

Overall, there is no unified consensus on the concept of teachers' digital competence in domestic scholarship. However, the operational definitions formulated

by Chinese scholars, which mirror the professional practice boundaries of specific teacher groups, provide references for investigating digital competence across different types of teachers.

3. Research on Constituent Dimensions and Assessment of Teachers' Digital Competence

The structural dimensions and assessment of teachers' digital competence are two core research branches, which will be discussed separately below.

3.1. Research on Constituent Dimensions of Teachers' Digital Competence

Early studies on competency dimensions mostly centered on integrated theoretical frameworks. Mishra and Koehler (2006) put forward the TPACK (Technological Pedagogical Content Knowledge) framework, which holds that teachers' digital competence lies in the interaction among technology, pedagogy and subject knowledge. The DigCompEdu framework released by the European Union defines six dimensions of educators' digital competence: professional engagement, digital resources, teaching and learning, assessment, empowering learners and facilitating learner growth, stressing critical, creative and responsible technology application throughout the whole educational process (Redecker & Punie, 2017). Entering the AI era, relevant dimensional research has made further progress, requiring data literacy and AI literacy to be added to traditional competency frameworks. Gummer and Mandinach (2015) regarded data literacy as a core skill that enables teachers to collect, analyze and utilize data to optimize teaching decisions. Celik et al. (2022) divided teachers' AI literacy into cognitive, technological and ethical dimensions. Domestic scholars share the same viewpoint, arguing that data literacy and AI literacy are essential components of teacher competence. For instance, Zhu (2018) stated that teachers working with AI need to possess multiple identities including learning designers, data analysts and emotional guides.

In summary, teachers' digital competence in the AI era is built on traditional competency systems and supplemented with data literacy and AI literacy. Its core dimensions include cognition and operation of intelligent technologies, instructional design in smart environments, digital professional collaboration and digital leadership.

3.2. Research on Assessment of Teachers' Digital Competence

Three mainstream assessment methods are summarized in existing research: standardized self-rating scales, performance-based assessment and mixed-method evaluation.

3.2.1. Standardized Self-Rating Scales

Standardized self-rating scales are the most widely adopted assessment tool. The SELFIE for TEACHERS instrument developed based on DigCompEdu can conduct large-scale measurements of teachers' digital competence and greatly im-

prove assessment efficiency. Learning from foreign assessment tools, Chinese scholars have developed localized measurement systems. A typical representative is the evaluation index system for university teachers' teaching ability in the AI age constructed by [Li and Zhang \(2020\)](#), which is a classic domestic standardized self-assessment scale.

3.2.2. Performance-Based Assessment

The development of digital technology makes performance-based assessment feasible through analyzing massive digital traces. In the field of learning analytics, objective teaching data from learning management systems and forum interactions can accurately reflect teacher-student interaction patterns and students' classroom engagement, forming a feasible paradigm for intelligent teaching effect evaluation. On this basis, Trust et al. integrated questionnaires, in-depth interviews, classroom observations and other qualitative approaches, and carried out empirical research via social network analysis. This mixed performance assessment approach enables more comprehensive and authentic measurement of teachers' digital teaching behaviors and improves the validity of relevant evaluations ([Trust et al., 2016](#)).

3.2.3. Mixed-Method Evaluation

Mixed evaluation combines the strengths of quantitative and qualitative research. By integrating questionnaires, in-depth interviews and classroom observations, it avoids the one-sidedness of single assessment methods and realizes comprehensive, context-oriented evaluation of teachers' digital competence ([Trust et al., 2016](#)).

Current academia has reached a basic consensus on competency dimensions and responded positively to new demands brought by artificial intelligence, while assessment methods have evolved from single to diversified forms. Nevertheless, several limitations remain. First, there is an obvious contradiction between universal competency frameworks and specific educational contexts; insufficient research explores differentiated competency structures and assessment standards for teachers from different school types and disciplines. Second, most assessment tools adopt static snapshot evaluation without longitudinal tracking of teachers' competency growth trajectories. Future research can be advanced in two directions: first, enrich context-specific and differentiated research on competency dimensions, especially for special educational fields such as applied universities; second, realize intelligent upgrading of assessment tools and methods, and explore multi-modal data analysis driven by artificial intelligence to deliver more accurate and efficient performance evaluation ([Zhang & Aslan, 2021](#)).

4. Research on Improvement Pathways of Teachers' Digital Competence

Early research on promoting teachers' digital competence focused on isolated technical training for computer and multimedia operation, mostly delivered via

short and medium-term skill workshops.

Contemporary studies recognize that improving teachers' digital competence is a complex systematic project. From the perspective of sociocultural theory, communities of practice are key to boosting teachers' digital competence. [Trust et al. \(2016\)](#) pointed out that online-offline integrated professional learning networks allow teachers to share resources, co-design lessons and reflect on teaching experience, thus stimulating instructional innovation. Domestic scholar Fan Guorui emphasized that organizational strategic support is indispensable for effective competency improvement. School leaders' digital leadership, including formulating clear digital development visions, allocating sufficient resources and incorporating digital teaching innovation into evaluation and incentive mechanisms, serves as an important guarantee for elevating teachers' digital competence ([Fan, 2018](#)).

Although abundant literature has discussed competency improvement strategies, most proposed measures lack systematic design of implementation conditions, phased arrangements and collaborative mechanisms among multiple elements, failing to form an integrated systematic framework.

5. Research Consensus, Existing Limitations and Future Prospects

5.1. Core Research Consensus

A review of domestic and foreign literature reveals four key consensus points in research on teachers' digital competence under artificial intelligence. First, consensus on connotation: Teachers' digital competence has evolved from basic tool operation skills into high-order composite capabilities covering intelligent technology application, data-driven instruction, digital instructional design, AI ethics governance and sustainable professional development ([Zhu, 2018](#); [Celik et al., 2022](#)). Second, consensus on dimensional structure: Scholars universally recognize the multi-layered composite nature of teachers' digital competence, whose core dimensions include intelligent technology operation, data literacy, integrated intelligent instructional design, digital ethics and security, and digital professional collaboration ([Redecker & Punie, 2017](#)).

Third, consensus on assessment: Research abandons overreliance on subjective self-evaluation and forms mixed evaluation modes combining scale measurement, digital trace analysis, interviews and classroom observation, highlighting contextual authenticity of assessment ([Trust et al., 2016](#)). Fourth, consensus on developmental pathways: Short-term fragmented training generates limited effects on competency growth. Sustainable improvement of teachers' digital competence relies on multi-stakeholder ecological training systems supported by school-based research, communities of practice and institutional digital leadership ([Tondeur et al., 2017](#); [Fan, 2018](#)).

5.2. Limitations of Existing Research

Despite fruitful research outcomes, prominent deficiencies still exist. Firstly, lo-

calized and differentiated research is inadequate. Mainstream competency frameworks are adapted from Western models including DigCompEdu and TPACK; most domestic studies merely interpret foreign theories without developing localized frameworks compatible with China's educational system, diverse school types and disciplinary characteristics. Secondly, assessment systems have inherent flaws. Most evaluations adopt static cross-sectional measurement without longitudinal dynamic tracking of teachers' competency growth. Specialized indicators for emerging competencies such as AI ethics and human-machine collaborative teaching remain incomplete, reducing evaluation accuracy (Li & Zhang, 2020). Thirdly, practical strategies lack operability. Most existing improvement plans are macro conceptual proposals without actionable implementation schemes and collaborative operating mechanisms. Fourth, frontier research lags behind technological development. Discussions on teaching transformation and new competency requirements brought by generative AI and educational large language models are insufficient, while in-depth research on ethical governance and mindset innovation is relatively scarce.

5.3. Future Research Prospects

Based on the comprehensive review of connotation, constituent dimensions, assessment and improvement pathways of teachers' digital competence in the AI era, future research can be carried out in the following directions. First, construct AI-oriented teacher digital competence models tailored to China's digital education strategy, considering developmental characteristics of teachers across different educational stages, school types and disciplines. Second, optimize assessment indicators for teachers' digital competence under artificial intelligence to improve the reliability, validity and efficiency of evaluation tools. Third, build a coordinated multi-level training system covering governments, schools and individual teachers. Fourth, keep pace with cutting-edge AI development to conduct in-depth research on human-machine collaborative teaching and digital ethical governance, so as to promote theoretical and practical upgrading of teachers' digital competence.

Conflicts of Interest

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

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