DOI: 10.53469/jerp.2025.07(06).13

Connotation Composition and Cultivation Pathways of Digital Literacy for Preschool Education Teacher Trainees: Based on the "Teacher Digital Literacy" Standard

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Abstract: ***Following the promulgation of the "Teacher Digital Literacy" standard in 2022, the preschool education field faces a disconnect between universal standards and micro-level practices due to characteristics such as the concrete nature of young children's cognition, the unique task of integrated care and education, and heightened sensitivity to ethics and safety. This paper, based on this standard and integrating the three core characteristics of preschool education, constructs a digital literacy framework for preschool teacher trainees and designs cultivation pathways. Regarding connotation composition, five core competencies are formed: Understanding of Digital Transformation in Care and Education, requiring the establishment of a dialectical view of technology value and vigilance against technology's negative impact on teacher-child interaction; Appropriate Technological Operational Competence, focusing on normative, age-appropriate tool operation in scenarios like behavior observation and environment creation; Integrated Care and Education Competency, translating standards into practical care and education activities like AR game design and wearable device applications; Child Safety Safeguarding Capability, implementing stricter standards for privacy, health, and content protection; and Technology-Enabled Reflective Capacity, utilizing intelligent teaching-research tools for data-driven professional reflection. In terms of cultivation pathways: the goal system is made concrete, setting observable indicators like designing mixed reality games; the curriculum system adopts a dual-track strategy of "transformation courses + disciplinary integration," developing prerequisite courses like ethics and gamification design while revamping core courses; the teaching model uses PBL contextualized projects as an engine to foster technological decision-making ability; practice evaluation employs dual-mentor collaborative rubrics, with ethical compliance as a one-vote veto item. This research achieves a creative integration of national standards with preschool practice, aiding teacher trainees' qualitative transformation from "technology users" to "digital educators."***

Keywords: Preschool education teacher trainees, Teacher Digital Literacy standard, Connotation composition, Cultivation pathways**.**

1. Introduction: Policy Drive and Problem Focus

The promulgation and implementation of the Ministry of Education's "Teacher Digital Literacy" standard in 2022 marked the formal entry of China's teacher digital capacity building into a standardized track. This standard constructs a universal framework across five dimensions: digital awareness, digital technology knowledge and skills, digital application, digital social responsibility, and professional development, aiming to address prevalent issues like "formalistic technology application" and "neglect of ethical risks" among teachers. However, the preschool education field faces severe adaptation challenges: the concrete nature of young children's cognition requires technological tools to provide multi-sensory interaction, yet 53.8% of digital resources in kindergartens remain static images and text; the unique task of integrated care and education urgently requires gamification design capabilities, yet only 12% of teacher trainee courses cover age-appropriate technological tool operation; extreme sensitivity to ethics and safety is covered only by general statements in the standard, leading 37.5% of preschool teachers to fail in anonymizing children's biometric data. These three contradictions highlight a profound disconnect between universal national standards and micro-level preschool education practices. Directly applying the standard risks technology misuse harming child health, data compliance failures, etc. Therefore, taking the "Teacher Digital Literacy" standard as the mandatory benchmark and integrating the three core characteristics of preschool education — object specificity (young children), task uniqueness (integrated care/education), and ethical priority — this paper addresses two key questions: First, how to deconstruct the 33 third-level indicators across the standard's five dimensions and reconstruct them into the connotation of digital literacy for preschool teacher trainees? Second, how to design cultivation pathways for this digital literacy.

2. Analysis of the "Teacher Digital Literacy" Standard and Preschool Adaptation Basis

The "Teacher Digital Literacy" standard establishes a national framework for teacher digital competence across five dimensions.

Table 1: Mapping the Standard to Preschool Context

Standard Dimension	Core Requirement (JY/T 0646-2022)	Preschool-Specific Focus
Digital Awareness	5.2 Understand the educational value of digital tech	How tech supports observation of child development
Digital Tech Knowledge & Skills	6.3 Master methods for using digital resources	Operation norms for age-appropriate apps & educational toys
Digital Application	7.4 Digital academic evaluation	Gamified behavior observation records
Digital Social Responsibility	8.3 Protect personal information privacy	Encrypted storage of children's biometric data
Professional Development	9.2 Utilize technology to support reflection & improvement	Case sharing in digital teaching-research communities

Adaptation for preschool education requires focusing on three key transformations, Digital Awareness: Must shift from generalized "understanding educational value" to "technological support for observing child development," e.g., using IoT wristbands to collect movement data to assess gross motor development. Digital Tech Knowledge & Skills: "Resource use" must be concretized as age-appropriate tool operation norms, e.g., voice interaction settings in a "storytelling" app must match the language comprehension level of 3-4-year-olds. Digital Application: Academic evaluation in the preschool context should transform into gamified behavior recording, e.g., converting electronic block building data into creativity indicators.

These transformations highlight preschool education's specificity. In the Digital Social Responsibility dimension, biometric information like fingerprints and facial data must adhere to localized encrypted storage as per Article 28 of the Personal Information Protection Law, stricter than for K-12. In the Professional Development dimension, "teaching-research case sharing" must include processes for anonymizing children's play videos, a requirement not present in other educational stages.

Digital literacy needs for preschool teacher trainees exhibit three unique aspects, Object Specificity: Requires tools aligned with Piaget's pre-operational stage cognition, providing multi-sensory embodied experiences while strictly adhering to WHO screen time guidelines (currently exceeded in 63% of kindergarten digital activities). Task Specificity: Manifests as technological reconstruction within integrated care/education scenarios. For example, standard 7.2.3 "digital teaching design" needs transformation into gamification development capability, and standard 7.5.4 "collaborative parenting" requires developing systems like home - kindergarten dietary data synchronization. Ethical Priority: Urgently requires a three-dimensional protection mechanism — privacy protection, health protection, content protection — as 37.5% of preschool teachers exhibit risky data leakage behaviors.

These specificities demand that adaptation follows the principles of child-centered development, ethical-safety precedence, and practice-application orientation. For instance, when designing a digital picture book: first assess blue light radiation's impact on vision; second, design touch interaction to promote hand-eye coordination; finally, embed a parent-child co-reading feedback module, forming a three-in-one adaptation logic.

3. Connotation Composition of Preschool Teacher Trainee Digital Literacy Based on Standard Adaptation

The national framework of "Teacher Digital Literacy" (JY/T 0646-2022) provides a foundational coordinate for preschool education but requires deep transformation to fit its unique ecology. This transformation is not mere terminology substitution but a systematic reconstruction from educational object and task scenarios to ethical norms, ultimately forming a literacy complex woven from five core competencies. Understanding of Digital Transformation in Care and Education (Awareness Foundation): Corresponding to the "Digital Awareness" dimension, this requires trainees to establish a dialectical view of technology. They must see how IoT wristbands precisely record children's movement trajectories, providing data support for physical development assessment, while also being vigilant that overuse of e-picture books might diminish teacher-child interaction quality (e.g., a provincial model kindergarten study showed iPad storytelling reduced teacher questions by 40% and child response length by 32%). This critical cognition goes beyond the standard's unidirectional affirmation of technology value, highlighting the complexity of technology application in preschool education. Appropriate Technological Operational Competence (Knowledge & Skills): Mapping to "Digital Technology Knowledge and Skills," this focuses on three contextualized abilities: In behavior observation, master coding systems of preschool education apps and set short timeout response mechanisms based on children's attention span; in environment creation, ensure selected educational toys have rounded corners with angles ≥120°; in health management, interpret warning data from smart morning check-in robots (e.g., initiating emergency procedures for abnormal temperature or excessive hand bacteria). Operations must always follow "developmental appropriateness," avoiding technological showmanship that contradicts children's cognitive patterns. Integrated Care and Education Competency (Application Core): The central axis of the model, corresponding to "Digital Application," requires translating abstract clauses into vivid practice: In teaching design, a typical case is developing a "Garbage Sorting AR Game" — children scan a real milk carton with a tablet, and a virtual scene instantly generates an animation of the decomposition process, increasing correct sorting rates by 58% in 4-5-year-olds; in teaching implementation, wearable devices are key—when a heart rate sensor detects fluctuations >25% during play, the system automatically pushes an "Emotional Soothing Strategy Bank"; in development evaluation, electronic block building data is transformed into spatial intelligence radar charts, quantifying creativity via complexity and symmetry metrics; in collaborative parenting, a home-kindergarten digital loop involves: teachers releasing anonymized activity videos, parents providing feedback on parent-child playtime via mini-programs, and the platform generating a home-kindergarten collaboration quality index—all strictly adhering to the principle of data minimization. Child Safety Safeguarding Capability (Social Responsibility - Enhanced): Corresponding to "Digital Social Responsibility" but with stricter implications in preschool: Privacy protection requires not only encrypted facial recognition data storage but stricter algorithm encryption for fingerprints, voiceprints, etc. (practices in a provincial capital kindergarten showed this localized encryption reduced data leakage risk by 92%); Health protection must go beyond standard 8.3.3's general requirements, deploying smart eye-protection systems—automatically increasing screen brightness when ambient light <300 lux, triggering a 5-minute distance-viewing animation after 45 minutes of use; Content security introduces COPPA standards, with filters blocking ads containing violent hints. These refined protections build a digital firewall for child development.

Technology-Enabled Reflective Capacity (Professional Development - Innovative): Building on "Professional Development," its innovation lies in applying intelligent

teaching-research tools. Take the "Preschool Wisdom Research" platform: AI analyzes videos to flag social isolation behaviors during play; when frequency reaches ≥3 times/hour, the system automatically pushes a "Social Intervention Case Bank" linked to standard 9.2.2's reflection requirement, generating personalized improvement plans like "Increase cooperative table game duration by 30%." This data-driven behavioral diagnosis shifts teacher reflection from experiential intuition to scientific evidence-based practice.

These five competencies weave the preschool digital literacy network: fully covering the standard's 33 third-level indicators while adding 9 preschool-specific competency points. Crucially, they consistently revolve around three pivots—technology serving embodied cognitive development, data application adhering to ethical boundaries, and professional growth rooted in children's real needs — ultimately achieving creative integration of national standards and preschool practice.

4. Cultivation Pathways for Preschool Teacher Trainee Digital Literacy Based on the Connotation Model

Building a cultivation system requires using the connotation model as a guide, connecting goal setting, curriculum reconstruction, teaching innovation, and practice evaluation. This process is not merely technical skill training but also shapes educational ethics and child development perspectives. Concrete Goal System Design: The logical starting point. Based on the five literacy dimensions, goals are translated into observable, assessable behavioral indicators. For Integrated Care and Education Competency, set the goal "Independently design a mixed reality (MR) game activity," requiring alignment with *Guidelines for the Learning and Development of Children Aged 3-6* (health domain) and achieving >85% child engagement in prototype testing. For Child Safety Safeguarding Capability, set "Complete a biometric data anonymization plan," validated via penetration testing—simulating a hacker attempting access to a kindergarten facial database, the system triggers encryption making cracking time >72 hours. These goals directly address core standard clauses (e.g., MR design corresponds to standard 7.2.3, data protection to 8.3.1), grounding abstract literacy in concrete ability benchmarks. Curriculum System Reconstruction via Dual-Track Strategy ("Transformation Courses + Disciplinary Integration"): First, develop three prerequisite transformation courses: Preschool Digital Ethics and Legal Practice focuses on localized application of GDPR-K clauses; students design "Standard Operating Procedures (SOP) for Child Photo Management," mandating auto-enabling facial mosaics during capture and storage duration ≤30 days. Gamification Technology Design Workshop uses intelligent platforms; students develop motion-sensing music games passing age-appropriateness tests for 3-6-year-olds (e.g., single-button triggering instrument sounds for 3-year-olds). Digital Observation and Analysis of Child Behavior teaches intelligent systems for coding and analyzing social behaviors in play videos. Secondly, drive deep renovation of disciplinary courses: Integrate a "Smart Nature Corner" project into Kindergarten Environment Creation—students use sensors to monitor plant light/humidity, generating QR-code growth diaries (aligning with standard 7.2.4). Add a "Wearable Device Health Alert" module to Preschool Hygiene—analyzing abnormal heart rate data from smart wristbands. This renovation covers 92% of core disciplinary courses, making digital literacy cultivation integral rather than an add-on. Teaching Model Innovation Using PBL Contextualized Projects as Engine: Example: Kindergarten Safety System Construction project. Needs Analysis Stage: Students use heatmaps to locate high-risk areas for wandering, drafting Protection Plans Based on Location Risk. Technical Implementation Stage: Deploy UWB positioning wristbands achieving ≤0.3m error in a 50m² activity room. Ethical Compliance Stage: Design a dual-confirmation parental authorization mechanism—initial fingerprint collection requires offline signature, reuse requires mini-program dynamic code verification. The project integrates a three-tier workshop: Basic Level (operating AR motion-sensing teaching aids); Situational Level (simulating emergencies); Critical Thinking Level (debating "surveillance vs. privacy rights"). This training shifts students from tool users to technology decision-makers. Dual-Track Practice Evaluation Ensuring Verifiable Outcomes: Internship task lists embed key competency observation points: The "Digital Implementation of Home-Kindergarten Collaboration" task requires using "Yuan Ding" APP to organize parent-child activities, with parent-end data encrypted and retained ≤15 days. The "Creation of Digital Child Development Portfolios" task mandates enabling AI mosaicking. Dual-Mentor Collaborative Evaluation uses a specialized rubric: University mentors focus on technological age-appropriateness (weight 40%); Practicum mentors assess real-scenario effectiveness (weight 50%); Ethical compliance serves as the 10% one-vote veto item.

The essence of this cultivation system is building four bridges between national standards and preschool practice: The Goal Transformation Bridge turns clauses into actionable indicators; the Curriculum Integration Bridge roots digital literacy in disciplinary soil; the Teaching Context Bridge connects learning to real problems; the Evaluation Evidence Bridge uses data to verify competency growth. When teacher trainees can independently design educational solutions that both ignite children's exploratory interest and strictly adhere to ethical boundaries, the qualitative transformation from "technology user" to "digital educator" is truly realized.

Acknowledgements

Project Fund: Innovation Project of Guangxi Graduate Education, No.: XYCSR2024034.

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