

# Research on Cultivation Paths for Intelligent Education Literacy of Pre-service Preschool Education Teachers in the Era of Artificial Intelligence

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## Abstract:

Empowering preschool teacher education through artificial intelligence represents an imperative of the digital era, aligning with the national educational digitalization strategy, reshaping the paradigm of early childhood care and education, and cultivating a new generation of preschool educators. Grounded in a five-dimensional framework of intelligent education literacy, this study systematically delineates the multifaceted value of fostering intelligent education literacy among Pre-service preschool education teachers. However, the cultivation process is beset by practical challenges at multiple levels, including conceptual misalignment, curricular insufficiency, inadequate practice-based training, and underdeveloped support mechanisms. Drawing on the distinctive attributes of preschool education, this study constructs an integrated cultivation pathway spanning four dimensions — renewing cultivation philosophies, restructuring curricular systems, intensifying practice-based empowerment, and strengthening institutional safeguards — thereby offering both a theoretical framework and practical guidance for enhancing the quality and effectiveness of intelligent education literacy cultivation among Pre-service preschool education teachers in the generative AI era.

## Keywords:

Artificial Intelligence, Pre-service Preschool Education Teachers, Intelligent Education Literacy

## 1. Introduction

As artificial intelligence technologies progressively permeate educational settings and the integration between the two deepens, mastery of intelligent education literacy has become an indispensable core competency for contemporary teachers. In January 2025, the Outline of the Plan for Building a Strong Educational Nation (2024–2035) explicitly mandated the formulation and refinement of digital literacy standards for both teachers and students, as well as the deepening of AI-driven teacher workforce development [1]. Evidently, cultivating teachers' intelligent literacy constitutes a priority that cannot be overlooked in advancing high-quality educational development in China. Preschool education, as the foundational stage of the entire national

education system, determines — through the caliber of its teaching workforce — the very bedrock of China's educational modernization. At present, artificial intelligence applications continue to expand in scope: from creating instructional materials and designing children's play activities, to assessing early childhood development and facilitating home-kindergarten communication and collaboration, they are continually reshaping the modes through which preschool education is delivered. It follows, therefore, that pre-service preschool teachers must also develop intelligent education literacy to support their professional growth.

Intelligent education literacy denotes the comprehensive competency that pre-service preschool teachers require to carry out childcare and educational practices and to achieve professional growth against the backdrop of digital educational transformation. It encompasses five key dimensions: intelligent education awareness, intelligent education knowledge, intelligent education competence, intelligent education ethics, and intelligent education professional development [2]. Specifically, intelligent education awareness refers to pre-service preschool teachers' stable value recognition and proactive learning disposition toward artificial intelligence, intelligent teaching tools, and other technologies that empower early childhood education. Intelligent education knowledge constitutes an integrated theoretical framework that underpins developmentally appropriate intelligent childcare and education, including mastery of approaches to integrating artificial intelligence with instruction across the five curricular domains, and familiarity with the applicable contexts of preschool intelligent teaching aids, virtual simulation teaching tools, and the like. Intelligent education competence denotes the practical, hands-on abilities required to implement intelligent childcare and education in authentic settings — such as the instructional design capacity to use artificial intelligence in developing children's games, picture books, and personalized activities, and the pedagogical implementation capacity to leverage intelligent devices in conducting classroom interactions and differentiated guidance. Intelligent education ethics represents the value baseline and behavioral norms governing pre-service preschool teachers' intelligent childcare and education activities, including privacy protection for children's facial and behavioral data, and regulation of children's screen time. Intelligent education professional development concerns the sustainable literacy that supports pre-service teachers' long-term autonomous growth — for instance, active participation in intelligent early childhood education teaching-and-research communities and the exchange of practical experience in childcare and education based on artificial intelligence. Situated within the context of widespread artificial intelligence adoption and the distinctive characteristics of preschool education, this study centers on the cultivation of intelligent education literacy among pre-service preschool teachers, systematically identifies the challenges involved, and offers targeted recommendations.

## **2. The Value of Cultivating Intelligent Education Literacy Among Pre-service Preschool Education Teachers**

Pre-service preschool teachers constitute the core reserve force of the early childhood education profession. Their level of intelligent education literacy bears directly on the quality of the national preschool teaching workforce and the developmental caliber of intelligent early childhood education — a relationship that carries multidimensional value.

### ***2.1. Responding to the National Educational Digitalization Strategy and Advancing the Modernization Transformation of Preschool Education***

The application of artificial intelligence has permeated all sectors of education. Emerging technologies such as big data and virtual simulation have profoundly disrupted traditional instructional models — a disruption that extends beyond primary, secondary, and tertiary education to encompass preschools, where digital upgrading has become an inescapable trend. A number of national teacher development policy documents have explicitly stipulated that higher education institutions must integrate digital literacy and ethics education into their teacher preparation programs and enhance pre-service teachers' capacity to blend technology with pedagogy. Cultivating intelligent education literacy among pre-service preschool teachers can help bridge the digital talent gap in the early childhood education sector, facilitate the transformation of kindergartens into smart campuses, support the implementation of intelligent educational solutions such as digital childcare and online home-kindergarten co-education, and thereby consolidate the preschool education foundation upon which the construction of a powerful educational nation rests.

### ***2.2. Refining the Pre-service Teacher Preparation System and Promoting the Digital Transformation of Teacher Education***

The pivot from traditional teacher education to a new paradigm of teacher preparation hinges upon reconstructing both the talent cultivation objectives and the curricular architecture suited to the intelligent era [3]. Teacher education in the digital-intelligence age demands a threefold upgrade — in philosophy, modality, and content — with intelligent education literacy serving as a core dimension of the new teacher preparation model [4]. Hence, cultivating intelligent education literacy among pre-service preschool teachers can strengthen their knowledge structures and competency profiles; remedy the deficiencies inherent in conventional training, i.e., the overemphasis on childcare skills at the expense of digital technology, and the privileging of theoretical instruction over hands-on integration; and spur teacher education institutions to update curricular content, establish virtual simulation training platforms, and construct human-machine collaborative teaching models — thereby forging a four-in-one cultivation pathway that synergizes theory, technology, practice, and ethics. Concurrently, this process can catalyze the deepening of digital reforms within teacher education institutions, elevate the quality of preschool education programs, lay the groundwork for the integrated development of pre-service and in-service preschool teacher education, and enrich both the theoretical and practical outcomes of teacher education's digital transformation.

### ***2.3. Addressing Practical Pain Points in Early Childhood Education and Enhancing the Quality of Future Childcare and Educational Practices***

In frontline kindergarten teaching settings, the digital literacy of early childhood educators remains unevenly developed, and teachers often struggle to independently and effectively complete intelligent educational tasks — such as lesson plan design, child data assessment, and human-machine collaborative childcare and education — using artificial intelligence alone. Pre-service preschool teachers, by contrast, are at a critical juncture in the development of their professional and technological competencies. Cultivating their intelligent education literacy can guide them toward establishing the core principle that technology serves children and is grounded in child development; through technology learning, they can gain proficiency in using a

variety of intelligent tools to create instructional materials and conduct virtual teaching, while also integrating digital methods into daily childcare and home-kindergarten communication. Fostering intelligent education literacy among pre-service preschool teachers can not only alleviate the real-world pressures novice teachers face in delivering intelligent, precision-oriented education upon entering the profession, but also deepen the integration of technology with early childhood education through the elevated intelligent education literacy of the teaching workforce — thereby enhancing the professional fitness of early childhood educators in the age of artificial intelligence.

#### ***2.4. Upholding the Baseline of Educational Ethics and Safeguarding the Healthy Development of Preschool Children***

Given that young children are physically and psychologically immature and possess limited discernment, they are highly susceptible to the influence of various digital products; the misuse of intelligent tools by children may also compromise their privacy and impede their healthy physical, mental, and long-term development. When employing artificial intelligence to support preschool instruction, therefore, ethical norms constitute an inviolable baseline, and early childhood teachers are the key agents responsible for calibrating the appropriate use of technology. In cultivating the intelligent education literacy of pre-service preschool teachers, it is essential to place particular emphasis on strengthening their data protection awareness and technology management capacity, uphold the principle of prioritizing child development and using intelligent tools judiciously, and strictly regulate device usage duration, digital content screening, and the protection of children's personal information — so as to avert problems such as excessive reliance on algorithms and prolonged exposure to electronic screens. Only pre-service teachers who possess well-rounded intelligent education literacy will be capable, upon entering the profession, of striking a balance between intelligent tools and face-to-face teacher-child interaction, thereby preserving the humanistic essence of education. By leveraging digital means appropriately while safeguarding children's rights to autonomous play and exploration, we can foster a gentle and secure digital growth environment in which intelligent technology and humanistic childcare and education are organically integrated.

### **3. Practical Challenges in Cultivating Intelligent Education Literacy Among Pre-service Preschool Education Teachers in the Era of artificial intelligence**

In the era of artificial intelligence, intelligent education literacy has become an essential competency for pre-service preschool teachers to adapt to the digital transformation of education, enhance the quality of childcare and education, and safeguard children's healthy development. Nevertheless, the cultivation of intelligent education literacy among pre-service preschool teachers continues to exhibit numerous shortcomings: deficiencies persist in cultivation philosophies, curricular design, practical instruction, and support mechanisms — collectively constraining the overall quality and actual effectiveness of the digital transformation of preschool teacher education.

#### ***3.1. The Conceptual Recognition Challenge: Value Identification Bias and Misalignment with Contemporary Imperatives***

At present, many higher education institutions exhibit lagging educational philosophies and a misalignment between value identification and the demands of the contemporary era in their cultivation of pre-service preschool teachers. On the one hand, some institutions simplistically equate the capacity to operate digital devices and instructional software with intelligent education literacy. This reductionist approach leads certain institutions to focus exclusively on hands-on tool operation training in classroom instruction while neglecting the deep integration of artificial intelligence with the childcare philosophy and pedagogical approaches central to preschool education — for instance, the imperative to attend to children’s developmental patterns when deploying artificial intelligence tools, to incorporate humanistic educational content, and to adhere to digital ethics. Such a technology-centric training model divorces itself from the core ethos of preschool education and severs the intrinsic connection between the application of intelligent technologies and the child-centered philosophy. On the other hand, a considerable number of pre-service preschool teachers tend toward extreme attitudes regarding artificial intelligence: some students categorically resist all intelligent tools in their learning and practice, deeming them devoid of practical value in kindergarten childcare and education, while others become excessively reliant on artificial intelligence, deploying various artificial intelligence tools indiscriminately and uncritically across instructional and practice settings without establishing the foundational principle that technology should serve education. This polarization engenders a value-driven deviation in the cultivation of their intelligent education literacy.

### ***3.2. The Curricular Provision Challenge: Structural Deficits and Disjunction from Professional Value***

At the current stage, preschool education curricula have yet to realize the deep integration of intelligent education with specialized content. Overall, these curricula suffer from outdated content, unreasonable structure, and a mismatch between supply and demand, thus failing to effectively advance pre-service teachers’ professional competence and limiting the effectiveness of digital reforms in talent cultivation. This is chiefly manifested in the fact that most institutions continue to rely on generic digital literacy instructional frameworks without incorporating targeted designs aligned with the childcare and educational characteristics of preschool education and the developmental patterns of young children. As a result, a complete cultivation system encompassing awareness, knowledge, competence, ethics, and professional development has yet to be constructed. In the majority of institutions, the intelligent education content available to pre-service preschool teachers is minimal, typically delivered in the form of elective courses or lectures, and such content has not been integrated into core courses such as preschool pedagogy and child psychology — thereby creating a disconnect between pre-service teachers’ intelligent technology learning and their professional learning. Furthermore, generative artificial intelligence courses with a distinctive preschool education focus that are aligned with market and frontline teaching needs are sorely lacking: curricular resources that address real-world job requirements — such as intelligent game design, child behavioral data analysis, and intelligent home-kindergarten co-education — are critically absent, signaling a substantial gap between curricular content and the actual demands of the profession.

### ***3.3. The Practice-Based Training Challenge: Insufficient Contextual Support and Divergence from Practical Value***

The practice component serves as the core vehicle through which pre-service preschool teachers bridge theoretical knowledge and on-the-job application. At present, however, the overall construction of this component remains relatively weak. First, in terms of on-campus practical resource development, most preschool education programs lack intelligent facilities such as dedicated childcare and education smart training workshops and virtual simulation teaching platforms for early childhood education, leaving unmet the demand of pre-service teachers for hands-on training on intelligent platforms. Second, in terms of off-campus practice settings, the application of intelligent educational technologies in most kindergartens remains superficial, plagued by problems such as idle intelligent equipment and the disconnection between technology application and routine childcare and education workflows; genuine human-machine collaborative childcare and education has yet to be realized, making it difficult to provide pre-service preschool teachers with a comprehensive intelligent on-the-job practice training platform. Third, with regard to the dual-qualification mentor workforce, university-based faculty lack combined experience in artificial intelligence and frontline kindergarten practice, while kindergarten-based off-campus mentors suffer from low levels of intelligent technology application literacy and insufficient capacity for innovative instruction — leaving both sides ill-equipped to precisely guide pre-service preschool teachers in achieving professional growth through artificial intelligence tools. Fourth, in terms of practice training content, there is a serious deficiency in the cultivation of the core high-order intelligent education competencies required for teaching positions, such as digital assessment of children's development and the implementation of human-machine collaborative childcare and education.

### ***3.4. The Support Mechanism Challenge: Lagging Ethics and Faculty Development in Conflict with Educational Values***

The cultivation of intelligent education literacy among pre-service preschool teachers is further constrained by deficiencies in the supporting institutional architecture. First, at the level of intelligent education ethics, the curricula for pre-service preschool teachers are notably deficient in specialized ethical content tailored to childcare and education settings, including the protection of children's digital privacy, age-appropriate screening of intelligent instructional content, and the management of children's screen usage. Second, from the perspective of faculty development, there is a critical shortage of high-quality, interdisciplinarily competent teacher educators who possess both a solid foundation in preschool education and proficiency in artificial intelligence applications. Third, the renewal of the extant talent evaluation system has significantly lagged behind; the assessment of pre-service preschool teachers over-emphasizes digital technology operation skills and has yet to construct a process-oriented, comprehensive evaluation system aligned with the distinctive characteristics of preschool education — one that incorporates high-order competency dimensions of intelligent education literacy such as intelligent game creation, human-machine collaborative childcare and education, and digital ethics. Finally, a multi-stakeholder collaborative cultivation mechanism involving universities, kindergartens, enterprises, and government bodies has yet to be fully established. The relevant policies, dedicated resources, and complementary institutional arrangements that support the cultivation of pre-service preschool teachers' intelligent education literacy remain inadequate, making it difficult to sustain high-quality, long-term collaborative efforts across sectors.

## **4. Optimized Cultivation Pathways for Intelligent Education Literacy of Pre-service Preschool Education Teachers in the Era of artificial intelligence**

Generative artificial intelligence provides fresh impetus for the digital transformation of preschool education while simultaneously raising the bar for pre-service preschool teachers' capacities in human-machine collaborative childcare and education, developmentally appropriate design, digital ethics, and innovative practice. Taking as its starting point the four major practical challenges — conceptual recognition, curricular provision, practice-based training, and support mechanisms — this study constructs a four-in-one optimized pathway that integrates conceptual guidance, curricular integration, practice empowerment, and institutional safeguards, thereby contributing to the enhancement of quality and efficiency in cultivating pre-service preschool teachers' intelligent education literacy and genuinely achieving the unity of technological empowerment with the essential nature of education.

### ***4.1. Renewing Cultivation Philosophies: Upholding a Child-Centered Orientation and Anchoring Contemporary Value***

A prerequisite for cultivating the intelligent education literacy of pre-service preschool teachers is that higher education institutions must re-envision their core educational philosophies from the vantage point of the national educational digitalization strategy and the broader modernization of preschool education. In the context of the digital transformation of teacher education, institutions must proactively align with the reform imperatives of preschool education in the digital-intelligence age and correctly recognize the value-driven role that the deep integration of generative AI with childcare and educational practice can play. On the one hand, universities should guide pre-service teachers to proactively refresh their professional self-conception, establish a scientifically grounded awareness of intelligent technology application, and clearly identify their core professional positioning as guardians of children's digital development and designers of intelligent childcare and educational activities. On the other hand, throughout the entire process of cultivating intelligent education literacy, both faculty and students must steadfastly uphold the essence of preschool education, remain deeply rooted in the child-centered philosophy, the spirit of play-based education, and the humanistic core of education, guard against the misuse of artificial intelligence and other intelligent technologies, and resolutely forestall problems such as the erosion of teacher-child emotional interaction by intelligent technologies and the replacement of childcare and educational decision-making by mechanical algorithms. At the same time, through diverse means — such as interpreting educational intelligence policies, conducting seminars on exemplary intelligent education cases, and fostering reciprocal interaction between artificial intelligence and preschool education through immersive teaching and research activities — institutions can help pre-service preschool teachers recognize the critical value of intelligent education literacy for their professional growth, the enhancement of preschool childcare and education quality, and children's lifelong development. This, in turn, can stimulate their intrinsic motivation, facilitating the shift from a passive “I am required to learn” to an active “I want to learn”.

### ***4.2. Restructuring the Curricular System: Deepening Preschool-Specific Integration and Enhancing Professional Provision***

First, higher education institutions must refine preschool education talent cultivation plans and improve the foundational curricular architecture of the preschool education major in light of the artificial intelligence era. This may include establishing a compulsory module on artificial intelligence applications in preschool education, offering courses such as fundamentals of artificial intelligence education, innovative design of intelligent teaching aids, cultivation of children's digital literacy, and ethical norms for AI-assisted childcare and education. Second, by advancing cross-disciplinary curricular integration, institutions can achieve the unified integration of intelligent technology with preschool education instruction — for example, by organically incorporating frontier content such as the development of intelligent teaching resources, the design of intelligent children's games, and the creation of developmentally appropriate artificial intelligence instructional content into core courses such as the five-domain curriculum and children's play theory [5]. Finally, the cultivation of pre-service preschool teachers' intelligent literacy must also strengthen education in digital ethics and cybersecurity. Such cultivation should be closely tied to authentic kindergarten childcare and education scenarios, focusing on children's privacy protection, age-appropriate screening of online content, and the management of children's screen time, so as to enhance pre-service teachers' capacity for digital ethical reasoning.

#### ***4.3. Strengthening Practice-Based Empowerment: Constructing Developmentally Appropriate Settings and Enhancing Childcare and Education Competencies***

Practice constitutes the key pathway through which the intelligent education literacy of pre-service preschool teachers takes root. In terms of on-campus training facilities, institutions can establish dedicated intelligent training classrooms and virtual simulation platforms tailored to preschool education, equipped with interactive intelligent devices, situated AR/VR tools for early childhood contexts, and other artificial intelligence training instruments — providing the hardware infrastructure necessary to support pre-service teachers in conducting activities such as digital simulated childcare and education and intelligent home-kindergarten interaction simulations. In the off-campus practice dimension, institutions can further deepen the multi-stakeholder U-G-S-E collaborative education model [6], i.e., selecting smart kindergartens with well-established intelligent education application capacity as practice bases, thereby enabling pre-service teachers to complete hands-on training — including organizing human-machine collaborative childcare and education activities — in authentic childcare and education settings and accumulate frontline intelligent teaching experience. A diversified dual-mentor guidance system should also be constructed, with clear delineation of roles: university faculty bear primary responsibility for guiding instructional theory and activity design; lead kindergarten teachers oversee students' on-site practical training in childcare and education; and enterprise-based technical mentors provide guidance on the application and use of intelligent tools — thereby forming a three-dimensional guidance framework that spans the entirety of students' practice process. In addition, institutions may organize activities such as intelligent childcare and education innovation competitions, AI-assisted children's picture book creation, and the development of developmentally appropriate digital teaching resources, so as to promote learning through competition and growth through practice, and to elevate pre-service teachers' practical competence in intelligent childcare and education.

#### ***4.4. Strengthening Support Mechanisms: Consolidating the Institutional Backbone and Safeguarding Long-Term Development***

The perfection of institutional mechanisms constitutes the fundamental safeguard for literacy cultivation. Concerted efforts across three dimensions — faculty, evaluation, and collaboration — are called for to construct a closed-loop support system capable of resolving the problems of faculty shortages, lagging evaluation, and insufficient coordination. A hybrid faculty corps should be built: through recruitment, training, and university-kindergarten co-development, teaching teams that combine preschool professional competence with intelligent technology literacy should be forged, with regular intelligent childcare and education teaching-and-research activities and interdisciplinary professional development sessions. A diverse and innovative evaluation mechanism should be instituted, establishing a process-oriented and comprehensive assessment system that incorporates intelligent instructional design, developmentally appropriate adaptation, human-machine collaborative capacity, and ethical decision-making as evaluation indicators, and employs methods such as portfolio assessment, simulated teaching, data profiling, and developmental records — thereby achieving improvement through evaluation and reform through assessment. A multi-stakeholder collaborative mechanism should be perfected by constructing a platform uniting higher education institutions, local education authorities, kindergartens, and technology enterprises, advancing resource sharing, joint faculty cultivation, joint scenario construction, and collaborative project research, so as to form a cultivation ecosystem characterized by government guidance, institutional primacy, kindergarten-based support, and enterprise-driven assistance. Increased financial investment and policy support should be directed toward the prioritized development of intelligent training facilities, resource repositories, and training systems, narrowing the digital divide across institutions, and providing stable, long-term support for literacy cultivation.

## **5. Conclusions**

In sum, the cultivation of intelligent education literacy among pre-service preschool education teachers in the era of artificial intelligence constitutes a systemic undertaking. It must be guided by forward-looking philosophies, grounded in systematic curricula, driven by immersive practice, and safeguarded by comprehensive institutional mechanisms. Rooted firmly in the distinctive attributes of the preschool education profession, anchored in the child-centered orientation and the original purpose of education, and propelled by the deep integration of technological empowerment with pedagogical principles, this endeavor will holistically elevate the intelligent education literacy of pre-service preschool teachers, thereby providing solid support for cultivating high-caliber, specialized, and innovative preschool educators and advancing the high-quality development of preschool education.

## **Conflicts of Interest**

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