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AN INNOVATIVE PEDAGOGICAL MODEL FOR DEVELOPING THE PROFESSIONAL COMPETENCE OF PRESCHOOL EDUCATION TEACHERS ON THE BASIS OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES

Khasanova Shakhnoza Omonbayevna
Methodologist in Preschool Education, Khorezm Region
Centre for Pedagogical Excellence, Uzbekistan
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Abstract. The accelerating integration of artificial intelligence (AI) into education has reshaped the expectations placed on early-childhood practitioners, yet systematic mechanisms for cultivating their professional competence in AI-rich environments remain underdeveloped. This article proposes and substantiates an innovative pedagogical model for developing the professional competence of preschool education teachers on the basis of AI technologies. Drawing on a competence-based approach, andragogical principles, and the logic of adaptive learning, the model integrates four interconnected components: a diagnostic-motivational block, a content-technological block, a procedural-activity block, and an evaluative-reflexive block. The study combines a review of contemporary scholarship with a design-based methodology to specify the structure, functions, and pedagogical conditions of the proposed model. The findings indicate that AI-supported instruments — including intelligent tutoring systems, learning analytics, generative content assistants, and adaptive recommendation services — can meaningfully strengthen the cognitive, technological, methodological, and reflexive dimensions of teacher competence when embedded within a coherent pedagogical framework rather than adopted as isolated tools. The article concludes that the effectiveness of the model depends on organisational support, ethical safeguards, and the sustained motivation of practitioners.

Keywords: artificial intelligence, professional competence, preschool education, teacher, pedagogical model, adaptive learning, digital transformation, lifelong learning.

1. Introduction

The contemporary transformation of education is inseparable from the rapid diffusion of digital and, increasingly, intelligent technologies. Artificial intelligence has moved beyond experimental laboratories into everyday professional practice, altering the way information is produced, curricula are designed, and learning is monitored. In this context, the preschool stage occupies a special position: it lays the cognitive, emotional, and social foundations upon which all subsequent learning is built, and the quality of these foundations depends directly on the professional competence of the teacher who mediates the child's first structured educational experiences.

Although a considerable body of research addresses the digitalisation of higher education and secondary schooling, the professional development of early-childhood practitioners in relation to intelligent technologies has received comparatively little systematic attention. Teachers in preschool organisations are frequently expected to adopt new tools without a coherent framework that connects diagnostic assessment of their current abilities, targeted content, practical activity, and reflection on outcomes. As a result, technology adoption tends to be fragmentary and short-lived, and its potential to enhance pedagogical quality remains largely unrealised.

The purpose of this article is to design and substantiate an innovative pedagogical model that develops the professional competence of preschool education teachers on the basis of AI technologies. The study pursues three objectives: to clarify the structure of professional competence relevant to AI-supported early-childhood practice; to formulate the components, functions, and pedagogical

conditions of the model; and to outline the criteria by which its effectiveness can be evaluated. The novelty of the work lies in treating AI not as a set of isolated applications but as an integral environment that reorganises the entire cycle of professional growth.

2. Literature Review

Scholarly discussion of professional competence has long moved away from a narrow understanding of knowledge and skills toward an integrative interpretation that unites knowledge, abilities, values, and the capacity to act effectively in changing conditions. Within this competence-based tradition, the professional competence of a teacher is commonly described as a dynamic system comprising cognitive, technological, methodological, communicative, and reflexive components. Applied to early-childhood education, this system additionally emphasises the ability to design a developmentally appropriate, play-based environment that remains sensitive to each child's individual trajectory.

Research on the digital and information competence of educators has established that mere access to technology does not translate automatically into improved practice. What matters is the teacher's ability to select tools purposefully, to align them with pedagogical goals, and to critically evaluate their consequences. Studies of technology integration frameworks stress the interaction between technological, pedagogical, and content knowledge, suggesting that competence develops only when these dimensions are cultivated jointly rather than in isolation.

A growing strand of literature examines the specific affordances of artificial intelligence for teacher development. Intelligent tutoring systems and adaptive platforms are reported to personalise professional learning by tailoring content to the learner's pace and prior knowledge. Learning analytics offer continuous, evidence-based feedback that replaces episodic and often subjective evaluation. Generative language models increasingly assist practitioners in preparing activities, adapting materials for children with diverse needs, and reflecting on their own practice. At the same time, scholars caution against uncritical adoption, drawing attention to algorithmic bias, data-privacy risks, the erosion of professional autonomy, and the danger of substituting human judgement with automated recommendation.

Despite this progress, the reviewed studies reveal a persistent gap. Few works propose an integrated pedagogical model that specifies how AI technologies should be sequenced across the full cycle of competence development — from initial diagnosis, through content mastery and practical activity, to reflective evaluation — in the particular setting of preschool education. The present study addresses this gap directly.

3. Methodology

The study adopts a design-based research approach, which is well suited to the construction and justification of pedagogical models. Rather than testing a fixed hypothesis in a single experiment, this approach iteratively develops a theoretically grounded artefact — in this case, a pedagogical model — while clarifying the principles that explain why and under what conditions it is expected to work.

Three complementary methods were combined. First, a theoretical analysis of scholarly sources on competence-based education, adult learning, and educational applications of artificial intelligence was conducted to establish the conceptual foundations of the model. Second, a structural-functional modelling procedure was used to decompose professional competence into measurable components and to align each component with appropriate AI-supported instruments and pedagogical actions. Third, expert evaluation was employed to assess the internal consistency, feasibility, and anticipated effectiveness of the proposed structure.

The methodological framework rests on three principles. The competence-based approach defines the target outcomes as integrated abilities to act rather than as discrete units of knowledge. The andragogical approach recognises that practising teachers are self-directed adult learners whose motivation depends on the perceived relevance of learning to their immediate professional tasks. The

systemic approach ensures that the components of the model function as an interdependent whole, so that a change in one element produces coordinated effects across the others.

4. The Innovative Pedagogical Model

The proposed model conceptualises the development of professional competence as a continuous, cyclical process supported at every stage by artificial intelligence. Its architecture consists of four interconnected blocks — diagnostic-motivational, content-technological, procedural-activity, and evaluative-reflexive — which together form a closed loop of professional growth. Each block performs a distinct function while feeding information forward to the next, so that the output of the reflexive block re-enters the diagnostic block and initiates a new, higher-order cycle of development.

4.1. The diagnostic-motivational block

This block establishes the starting point of professional growth. AI-based diagnostic instruments assess the current level of each teacher's cognitive, technological, methodological, and reflexive competence through adaptive testing, analysis of digital activity, and self-assessment supported by intelligent questionnaires. The results are aggregated into an individual competence profile that visualises strengths and gaps. Equally important is the motivational function: by presenting personalised evidence of development needs and demonstrating the practical value of AI for everyday tasks, the block converts external requirements into internal, self-directed learning goals.

4.2. The content-technological block

The second block defines what teachers learn and with which tools. Content is organised into modular, adaptive learning trajectories that respond to the competence profile generated earlier. Intelligent tutoring systems adjust the difficulty and sequence of materials, while generative assistants help translate abstract methodological concepts into concrete, age-appropriate classroom scenarios. The technological dimension familiarises practitioners with the responsible use of AI instruments — from adaptive recommendation services to tools for creating visual and interactive materials — always in connection with clear pedagogical purposes rather than as ends in themselves.

4.3. The procedural-activity block

Competence is consolidated through action. In this block, teachers apply AI-supported approaches directly in their professional practice: they design play-based activities with the assistance of generative tools, personalise tasks for children with diverse developmental needs, and use analytics to observe and interpret children's engagement. Collaborative formats — professional learning communities, mentoring, and joint project work — extend individual learning into shared practice. The role of AI here is to lower the threshold of experimentation, provide immediate feedback, and free the teacher's attention for the distinctly human aspects of early-childhood pedagogy.

4.4. The evaluative-reflexive block

The final block closes the developmental loop. Learning analytics and AI-based observation instruments provide continuous, evidence-based feedback on the dynamics of competence growth, replacing occasional and subjective judgement with a transparent picture of progress. Reflection, however, remains a human act: supported by structured prompts and visualised data, teachers interpret their own development, identify new goals, and reformulate their professional trajectory. The outcomes of this reflection return to the diagnostic-motivational block, transforming the process into an ascending spiral of lifelong professional growth.

4.5. Pedagogical conditions

The functioning of the model depends on a set of pedagogical conditions. These include the readiness of the educational organisation to provide the necessary digital infrastructure and time resources; the ethical and legal protection of personal data belonging to both teachers and children; the sustained motivation of practitioners through recognition and career incentives; and the presence of methodological support that helps teachers interpret AI outputs critically rather than accept them

automatically. Without these conditions, even a well-designed model risks remaining a formal declaration.

5. Discussion

The proposed model reframes teacher professional development as an integrated, technology-supported cycle rather than a series of disconnected training events. Its principal contribution is the demonstration that artificial intelligence delivers the greatest pedagogical value when it is woven into every phase of the developmental process — diagnosis, content, activity, and reflection — instead of being introduced as an occasional supplement. This systemic embedding helps to overcome the fragmentation that undermines many current initiatives.

The model also clarifies the changing role of the early-childhood teacher. Far from making the practitioner redundant, AI redistributes professional effort: routine, data-intensive operations are delegated to intelligent systems, while the teacher concentrates on relationship-building, ethical judgement, and the creative design of developmental experiences. This complementary division of labour is consistent with the view that automation should augment rather than replace professional expertise.

Several limitations warrant attention. The model is theoretically grounded and expert-validated but requires longitudinal empirical testing across diverse institutional contexts to confirm its effectiveness. The availability of infrastructure and the digital readiness of teachers vary considerably, which may condition the model's transferability. Finally, the ethical governance of children's data and the mitigation of algorithmic bias remain open challenges that extend beyond the scope of a single pedagogical framework and call for coordinated institutional policy.

6. Conclusion

This article has proposed and substantiated an innovative pedagogical model for developing the professional competence of preschool education teachers on the basis of artificial intelligence technologies. Structured as a closed loop of four interconnected blocks — diagnostic-motivational, content-technological, procedural-activity, and evaluative-reflexive — the model integrates AI instruments into a coherent, cyclical process of professional growth grounded in competence-based, andragogical, and systemic principles.

The analysis indicates that intelligent technologies can strengthen the cognitive, technological, methodological, and reflexive dimensions of teacher competence, provided they are deployed within a purposeful pedagogical framework and supported by adequate organisational, ethical, and motivational conditions. Future research should focus on the empirical validation of the model through longitudinal studies, the development of reliable instruments for measuring competence dynamics, and the elaboration of ethical safeguards that protect the interests of both teachers and children in AI-supported early-childhood education.

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