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Exploring the Application of Artificial Intelligence in Basic Education Through the Lens of Human Learning Mechanisms

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ABSTRACT
To explore the value positioning of artificial intelligence (AI) in basic education, this paper reconstructs an educational framework centered on developing higher-order thinking based on the intrinsic logic of human learning. Through theoretical deliberation and literature analysis, it elucidates three fundamental characteristics of human learning: the understanding of the essence of tacit knowledge, the attention-driven mechanism of deep learning, and the inherent contextuality and embodied nature of cognition. It further argues that AI-driven transformations in knowledge production necessitate shifting foundational education goals from knowledge acquisition to cultivating higher-order competencies. Analysis reveals that current AI applications often deviate from the intrinsic demands of deep learning. Consequently, this paper redefines AI-supported foundational education pathways: constructing embodied, contextualized intelligent environments; emphasizing the foundational value of basic knowledge in supporting higher-order thinking; establishing learning mechanisms where knowledge and skills mutually construct and coexist; and designing human-centered auxiliary systems with information filtering capabilities.

KEYWORDS
Human learning mechanisms; Artificial intelligence; Basic education

1 Introduction

Artificial intelligence has deeply permeated the educational ecosystem. Its decisive power to reshape knowledge forms and social relations aims to overcome the limitations of traditional classroom teaching through personalized pathways, instant feedback, and vast resources, thereby achieving large-scale differentiated instruction. This technological transformation not only updates teaching tools but also touches upon the core questions of education: The essence of learning in an era where knowledge acquisition costs approach zero must be redefined, and the core objectives of human cognitive development require re-anchoring as machines excel at high-level analytical tasks. However, the computational paradigm embodied by technology's operational logic (data, algorithms, computing power) inherently cannot fully map education as an organic growth process rooted in nonlinear structures, ambiguous experiences, emotional connections, and embodied practices. Current AI applications in education predominantly focus on enhancing functional efficiency, with insufficient attention paid to the underlying educational philosophy they presuppose. Without clarifying AI's role in academic settings based on the principles of cognitive development, technology may not only fail to drive educational progress. Still, it could reinforce superficial learning and strip education of its humanistic foundations. Therefore, the critical challenge in this field is to reflect on the intrinsic structure of learning and redefine the value positioning of artificial intelligence.

2 Core Dimensions of Human Learning Mechanisms and Implications for Education

2.1 The self-evidence of knowledge and the essence of human understanding

The scope of human knowledge far exceeds what can be clearly articulated through language, a dimension often summarized as tacit knowledge. Unlike the structured, symbolic, explicit knowledge processed by artificial intelligence, human understanding is a holistic grasp rather than a simple information aggregation. Consider a child recognizing a cat: this occurs not by sequentially cross-referencing a mental checklist of traits like "furry, four-legged, vocal," but through an instantaneous, intuitive cognition based on holistic patterns [1]. This Gestalt-like process signifies that genuine learning transcends the mechanical accumulation of knowledge points; it involves establishing and reorganizing internal cognitive schemas or mental models. For learners, knowledge's meaning does not exist in isolation; it emerges only when deeply connected to an individual's existing network of experiences. This inherent interconnectedness and wholeness form the foundation of knowledge's self-evidence—meaning knowledge is ultimately "grasped" by the individual rather than merely "memorized."

2.2 The driving force of cognitive processes: attention mechanisms and the principles of deep learning

The emergence of deep learning hinges on high-quality attentional engagement. Attention is not a passive state of reception but an active, selective mechanism for allocating cognitive resources. Only when learners sustain stable, focused attention on specific objects can working memory effectively process and encode information, forging deep connections with existing knowledge in long-term memory to form a structured understanding. This process demands mental effort and requires overcoming distractions, yet precisely this active cognitive exertion constitutes the essence of learning. Cognitive load theory in modern cognitive psychology emphasizes that learners' minds are fully activated only under moderate cognitive challenge. However, many contemporary digital environments are designed to sustain users' fleeting engagement through fragmented content and high-frequency instant feedback. While this model sustains superficial activity, it may systematically undermine the immersive state essential for deep learning.

2.3 Contextuality and embodiment: the fundamental embeddedness of human cognition

Human cognition is not an abstract program operating autonomously within the skull, detached from context and the body. Its essence lies in profoundly contextual and embodied processes: individual thinking, learning, and understanding are continuously interwoven with the physical environment, social interactions, and sensory-motor experiences tied to the body. We interact directly with the world through bodily perception and action, gaining primary first-person experiences that form the foundation for constructing abstract concepts and deepening understanding. For instance, understanding "buoyancy" extends far beyond verbal descriptions of formulas; it is rooted in the tangible bodily sensation of resistance experienced when forcefully pushing an object through water. This cognitive mode of "being-in-the-world" dictates that the most effective learning occurs when knowledge is organically integrated with its practical context [2]. However, conventional classroom instruction and numerous online applications frequently extract knowledge from its original context, delivering it to students in a decontextualized and disembodied form. This inevitably leads to a knowledge inertia effect: learners retain the knowledge but cannot effectively discern when or how to transfer it to complex real-world situations.

3 The transformation of article production and educational objectives

3.1 The transformation of the knowledge production system

The rise of artificial intelligence, particularly generative AI, is profoundly disrupting the knowledge production system of human society. Historically, knowledge production, curation, and dissemination were primarily carried out by human experts, scholars, and authoritative institutions—a relatively slow, stable, and highly structured process. One of education's primary missions has been to efficiently transmit this crystallization of human knowledge to the next generation [3]. However, in the AI era, a fundamental paradigm shift has occurred in knowledge production. Large-scale language models can reorganize, integrate, and generate vast amounts of information at unprecedented speeds, creating new texts, code, and even scientific hypotheses. This has led to an exponential explosion in the total volume of knowledge and an extraordinary enrichment of its forms. Simultaneously, this has eroded the authority of knowledge and created a landscape of mixed information quality. Any individual can become a content producer with AI tools. In this era of decentralized knowledge production and highly intermingled true and false information, the mere possession of knowledge is rapidly losing value.

3.2 Shift in educational objectives

Faced with this fundamental transformation in the knowledge production system, basic education goals should undergo a corresponding strategic shift. If industrial-era education was positioned to cultivate workers proficient in standardized knowledge and adaptable to mass production, then in the AI-dominated era, education's primary purpose lies in nurturing individuals capable of harmonious coexistence with machine systems while possessing unique human value that cannot be mechanically replicated. Consequently, this shift in educational focus inevitably demands a transition from explicit knowledge—which can be encoded and algorithmically processed—toward more profound and complex higher-order cognitive abilities and comprehensive competency systems. The core components of this system include: critical thinking to discern information authenticity and recognize deep logical structures; creative thinking to integrate cross-disciplinary knowledge and generate original insights; the ability to understand complex systems and solve open-ended problems without predetermined answers; and collaborative communication skills to reconcile diverse perspectives and achieve consensus-based objectives. Notably, in an environment of high external uncertainty, individuals' metacognitive abilities—such as self-awareness, emotional regulation, and autonomous learning planning—

and intrinsic character values like resilience and open-mindedness, become critically important.

4 A new landscape for basic education: ai-supported development of higher-order thinking and competencies

4.1 Building embodied, contextualized intelligent learning environments

To effectively foster higher-order thinking, the key application pathway for AI lies in constructing embodied, contextualized intelligent learning ecosystems that transcend the boundaries of textbooks and conventional classrooms. Its core value is creating a deeply immersive "learning environment" that guides students to confront complex tasks approximating real-world scenarios. For instance, virtual reality technology enables students to conduct historical investigations within reconstructed ancient Roman urban spaces or observe biological evolutionary dynamics by regulating multidimensional parameters in simulated ecosystems. Through active participation and nonlinear interactions, students develop an embodied, experiential understanding of complex systems [4]. Such environments support students in conducting error-tolerant exploratory experiments. The immediate, visual causal response mechanisms triggered by their actions establish robust learning feedback loops and profoundly stimulate intrinsic motivation.

4.2 Reaffirming the irreplaceable value of static knowledge acquisition in the AI era

While advancing higher-order competency development, we must remain acutely aware that advanced thinking cannot be established without sufficient knowledge reserves. An individual lacking a fundamental conceptual system and cognitive framework—even with AI tools—struggles to generate profound questions, let alone achieve genuine creative output. Therefore, the AI era fails to diminish the importance of systematic knowledge acquisition and demands even higher standards for its quality and efficiency. In this process, AI can serve as a crucial "cognitive coach," leveraging adaptive assessment technologies to identify knowledge-structure gaps and providing personalized reinforcement plans based on cognitive science principles such as spaced repetition and interleaved practice.

4.3 Establishing a new "knowledge-competency" co-constructive learning mechanism

The ultimate vision for basic education lies in deconstructing the traditional dichotomy between knowledge acquisition and competency development, constructing a new learning paradigm that fosters their mutual generation and synergistic evolution. This signifies that the learning process should be shaped as an iterative, ascending cycle of cognitive deepening. Learners first systematically master foundational knowledge units in specific domains with AI support. They then immediately engage in AI-enabled learning environments centered on complex problem scenarios or project-based practices, applying prior knowledge to solve authentic, open-ended, unstructured challenges. During this knowledge transfer and practical application, learners not only hone composite competencies like collaborative communication and critical reflection. More crucially, they achieve a deeper, contextually embedded cognitive internalization of previously acquired conceptual knowledge. This process enables them to identify gaps in their mental structures, thereby driving the next round of purposeful, targeted knowledge construction.

4.4 Building human-centered, effectively filtered intelligent support systems

In an era where information overload poses systemic challenges, learners require intelligent support systems with efficient navigation and filtering capabilities. However, the architectural logic of such systems must fundamentally preserve learners' cognitive agency. They should not become black boxes that substitute for student decision-making or output standardized answers, but rather serve as cognitive support frameworks that foster the development of information literacy and autonomous judgment [5]. Core capabilities of such systems include: During exploratory learning, intelligently presenting high-quality resources with diverse perspectives and representations based on learners' questions and existing cognitive frameworks, while clearly labeling sources and underlying cognitive biases; They can assist in deconstructing complex argumentative structures and conducting fact-checking, yet the ultimate authority for discernment and judgment remains with the learner. Crucially, the system should further guide learners to examine the underlying logic of their information retrieval and filtering strategies, thereby achieving training objectives at the metacognitive level.

5 Conclusion

The core value of artificial intelligence in basic education lies not in simulating teachers but in serving as a fundamental cognitive interface that catalyzes novel learning ecosystems transcending traditional models. Current conceptual deviations in technological practice stem from insufficient understanding of the intrinsic attributes of human learning—including organic growth, autonomous construction, and social interdependence. Future development must pivot from technology-centric to learner-centric approaches: AI should be positioned as a catalyst for cognitive development, an architect of learning environments, and an empowerment system for intellectual growth. Building embodied intelligent learning spaces, reinforcing foundational knowledge, integrating dynamic cognitive-practical processes, and cultivating students' information management skills—only through such foundations can technology substantively support nurturing future citizens with advanced competencies and sound minds.

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