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# The study of Big Unit Teaching Design in K12 Artificial Intelligence Curriculum

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**Abstract: With the evolution of AI education policies and the growing urgency to transition from fragmented instruction to big unit teaching, this paper systematically examines the design logic and implementation pathways for bigunit teaching in AI curricula for primary and secondary schools. The study indicates that current research focuses on the reconstruction of subject content based on big concepts, the development of project-based themes in real-world contexts, and human-machine collaborative teaching models. Implementation pathways must be tailored to different educational stages, and an intelligent assessment system should be established that shifts from evaluating single outcomes to assessing multidimensional processes. Despite challenges such as resource scarcity, insufficient teacher capacity, and ethical risks, future efforts should be dedicated to building a systematic curriculum framework, deepening interdisciplinary integration, and advancing the digital transformation of education and the implementation of core competencies.**

**Keywords: K12 Artificial Intelligence Curriculum; Big Unit Teaching Design; Big Ideas**

## 1. Introduction

With the rapid global advancement of artificial intelligence (AI) technology, integrating AI into basic education has become a key strategy for enhancing national core competitiveness and cultivating future innovative talent. From the issuance of the Development Plan for the Next Generation of Artificial Intelligence to the Curriculum Standards for Information Technology in Compulsory Education (2022 Edition), China's AI education policies have undergone a profound evolution, progressing from macro-level strategic planning to micro-level curriculum implementation. In the transition from policy advocacy to classroom practice, AI instruction faces the severe challenge of fragmentation: teaching content is often limited to isolated explanations of knowledge points or simple tool operations, lacking a systematic logical framework and in-depth competency development, making it difficult to support the development of students' higher-order thinking and comprehensive innovative abilities. How to break through the barriers of traditional lesson-based teaching and construct a large-unit teaching model based on big concepts and real-world contexts has become a central point of debate in current educational research and practice. This paper aims to clarify the theoretical foundations, content restructuring logic, implementation pathways, and evaluation systems for large-unit AI instruction in primary and secondary schools, with the goal of providing theoretical support and practical references to advance the transformation of AI education from superficial technical experiences to the deep-rooted development of competencies.

## 2. Characteristics and Theoretical Foundations

### 2.1 Characteristics of Big Unit teaching

Big unit instruction promotes the development of students' core competencies by integrating fragmented knowledge, constructing a systematic content framework, and creating authentic contexts. Yan Ge and Junhui Zhu explicitly advocate for restructuring junior high school information technology curriculum content based on subject-specific big ideas [1], noting that big unit instruction must achieve an effective integration of teaching and learning through the design of authentic contexts, the establishment of clear objectives, the organization of activities, and the implementation of assessments. Jinliang Li and

Tao Ma constructed a big-unit teaching framework for high school information technology [2], emphasizing the enhancement of students' understanding and application of artificial intelligence concepts through the interconnection of cross-case studies. Xuefen Mo proposed that big-unit design should replace traditional knowledge-and-skill-based classrooms [3], aiming to cultivate computational thinking through the construction of a spiral-ascending knowledge structure and task clusters. Juan Lin [4], within the context of big unit teaching, constructed a deep learning model for elementary school information technology, emphasizing the advancement of thinking through the restructuring of unit themes, the creation of tiered tasks, and the integration of assessment rubrics.

### 2.2 Core Objectives

The objectives of artificial intelligence education have gradually evolved from early-stage knowledge dissemination and skill training to a competency-based cultivation model guided by core competencies, utilizing big concepts and big unit teaching as vehicles, and deeply integrating generative AI technologies. Xuefen Mo explicitly proposed a design framework for elementary school AI unit-based learning oriented toward cultivating computational thinking [3]. Junjun Gao explored a unit-based teaching model for junior high school information technology aimed at deep learning, with the goal of promoting the development of higher-order thinking under the "Double Reduction" policy [5]. Yan Li, adopting a big-idea perspective, proposed strategies such as analyzing unit content and creating authentic scenarios to address current issues in high school information technology unit instruction [6]. Zhibin Feng et al. used "Co-creating a Digital Cultural Museum" as the central theme of their unit, enabling students to master technical principles and cultivate innovative abilities through hands-on practice [7].

### 2.3 Key Theories

Understanding by Design (UbD) Theory: The Understanding by Design (UbD) theory guides artificial intelligence courses to shift from the fragmented transmission of knowledge to a holistic, unit-based design oriented toward core competencies, using backward design to clarify expected learning outcomes. Gao Yu [8] explicitly incorporated UbD theory to construct a unit-based AI teaching model centered on big ideas for elementary school information technology courses. Jing Li developed a core competency-oriented implementation framework for large-unit instruction based on UbD theory [9], emphasizing the characteristics of knowledge integration, real-world context, and transferability inherent in large-unit teaching. Qingchao Ke et al. Further proposed an "understanding-first" instructional design framework for AI large-unit teaching and validated the effectiveness of this model in enhancing students' learning interest and computational thinking skills through a quasi-experimental comparative study [10].

Reconstructing the Essence of Disciplines from a "Big Ideas" Perspective. How to systematically and structurally reconstruct the essence of teaching content in artificial intelligence and related disciplines with subject-specific big ideas at the core. Quanhua Hu designed a foundational artificial intelligence unit for junior high school based on the "understanding-first" philosophy [11], advocating for big ideas to guide experiential learning and emphasizing that experiential learning helps students deeply understand the essence of artificial intelligence. Xiaoyu Bai developed a big-idea-oriented unit for the "machine learning" curriculum in junior high school [12], validating the effectiveness of designing large-scale units centered on disciplinary big ideas for cultivating core competencies. Yan Li ocused on high school information technology unit instruction from a big-idea perspective, proposing four key strategies: analyzing unit content [6], creating authentic contexts, designing task clusters, and refining problem chains. Qingchao Ke et al. confirmed through empirical research that this model effectively enhances students' deep understanding of core AI concepts [10].

Guidance from deep learning theory on the cultivation of higher-order thinking. Deep learning theory guides students to move beyond superficial memorization in AI learning, thereby developing higher-order thinking and core competencies. Junjun Gao proposed that scenario creation and task-driven strategies effectively foster the emergence of higher-order thinking in students [5]. Xuefen Mo designed a large-unit AI curriculum for elementary schools, achieving a progression from knowledge and skills to thinking abilities [3]. Yan Ge and

Junhui Zhu utilized real-life scenarios to stimulate deep thinking, systematically cultivating students' core digital literacy [1]. Meishi Qu demonstrated that large-unit teaching can effectively overcome the fragmented nature of traditional lesson-based instruction and promote the development of digital literacy [13].

## 3. Case Analysis

### 3.1 Systematic Integration of Subject Content Based on Big Ideas

Artificial intelligence courses can adopt a core concept as a "big idea" and, through the design of large-unit instruction, transition from the transmission of fragmented knowledge to the systematic cultivation of competencies. Xiaoyu Bai designed a junior high school AI unit centered on the "machine learning" big idea, aiming to construct systematic instructional content to cultivate core competencies [12]. Junjun Gao using "Introduction to Artificial Intelligence" as an example, explored a large-unit teaching model for junior high school information technology focused on deep learning [5]. Jinliang Li and Tao Ma, using the high school information technology unit "Artificial Intelligence and Its Applications" as an example, detailed the process of constructing a large-unit curriculum [2] By linking key concepts through real-world cases such as intelligent translation robots and smart homes, their research findings indicate that this model effectively enhances high school students' systematic understanding of AI concepts and technologies, as well as their application skills.

### 3.2 Project-Based Theme Development in Real-World Contexts

Fengli Jin used the project "Designing a Micro-Smart Library Lending System" as a vehicle to create a large-unit teaching scenario closely aligned with students' daily lives, aiming to help them understand the basic concepts and principles of artificial intelligence [14]. Zhibin Feng et al., using "Co-creating a Digital Cultural Museum" as the unit's central theme, guided students to experience the appeal of AI technology firsthand through the design of digital cultural artifacts [7]. Xiaochun Jiang and Ping Yang designed a deep learning-based large-unit lesson centered on the theme "AI-Powered Sprouted Potato Sorter," guiding students to master key technologies such as image recognition and decision-making control by simulating intelligent sorting tasks in agricultural scenarios [15]. Lixia Liang leveraged Arduino open-source hardware and Mind+ graphical programming to design a project-based learning case titled "Smart Lighting Enriches Life," systematically demonstrating the complete engineering process from requirements analysis to hardware integration and software debugging [16].

## 4. Implementation Strategies and Approaches.

### 4.1 Innovation and Transformation of Teaching Models

Big-unit teaching requires a restructuring of the teaching process, shifting from "one-way knowledge presentation" to "student-driven inquiry." This transforms the classroom from a traditional model of one-way knowledge transmission by the teacher to an interactive model that uses real-world contexts to stimulate students' active inquiry and deep thinking. Xuefen Mo proposed a design approach for large-unit teaching that involves clarifying competency goals, designing life-themed units, and constructing a spiral knowledge structure, with the aim of cultivating computational thinking [3]. Junjun Gao explored a large-unit teaching model for junior high school information technology that focuses on deep learning [5]. Yan Li proposed four key strategies: analyzing unit content, creating authentic contexts, designing task clusters, and refining problem chains [6]. Xiaoya Su utilized Arduino tools and smart fan design as a vehicle to enhance students' practical skills and innovative thinking [17].

In the practice of AI-based unit teaching, a collaborative teaching model has been established, with teachers playing a central and leading role and AI technology serving as a powerful auxiliary. Zhong Sun et al. [18], based on research into AI-assisted classroom teaching analysis, proposed an evolutionary path from fully human-led to human-machine collaboration. Zhibin Feng et al. [7], using the "Co-creation of a Digital Cultural Museum" as an example, demonstrated how teachers can design a unit's central narrative to enable students to master the principles of AI technology through hands-on practice. In innovative teaching practices for basic education supported by generative AI, Ke Li defined a new teaching model characterized

by "teacher-led—AI-empowered—student-centered" approaches [19]. Jiaxin Hao et al. constructed a multidimensional evaluation model for large-unit teaching supported by generative AI agents [20], demonstrating AI's auxiliary functions in curriculum design, task design, and evaluation feedback. Chunsheng Chen proposed that generative AI can transform static teaching materials into dynamic inquiry scenarios, serving as a "cognitive catalyst" to advance students' thinking [21].

Leveraging virtual programming platforms and open-source hardware to support classroom instruction, Guihua Gao focused on the 3D One AI virtual programming platform to conduct large-unit teaching in junior high school information technology [22], finding that the platform effectively promotes students' understanding of artificial intelligence and programming maker education. Lixia Liang designed a project-based learning case for a major unit by integrating the Arduino open-source hardware teaching kit with the Mind+ graphical programming software [16], thereby validating the practical value of open-source hardware in junior high school information technology and artificial intelligence courses. Xiaoya Su utilized Arduino IoT tools to design and build a smart fan as the vehicle for a major unit project [17].

### 4.2 Differentiated Implementation Approaches for Different Educational Stages

At the elementary school level, AI concepts are primarily integrated into large-unit instructional design through experiential learning activities and computational thinking initiation strategies. Xuefen Mo, using the school-based curriculum Elementary School AI Programming as an example, proposed a large-unit design approach that involves defining clear competency goals, designing real-life themes, and constructing a spiral knowledge structure [3]. Juan Lin focused on the "AI Fundamentals: Experiencing Human-Computer Interaction" unit to construct a deep learning model for large-unit instruction in elementary school information technology [4]. She proposed strategies such as restructuring unit themes, creating tiered tasks, and embedding assessment rubrics to drive students' cognitive progression.

At the junior high school level, equal emphasis is placed on understanding principles and project-based practice. AI education at this stage builds a systematic large-unit teaching system by balancing a deep understanding of theoretical principles with project-based practice grounded in real-world contexts. Quanhua Hu designed a junior high school AI fundamentals unit based on the theory of understanding-based experiential learning, pointing out that current teaching needs to shift from fragmented operations to an essential understanding of big concepts [11]. Ge Yan and Junhui Zhu restructured junior high school information technology curriculum content based on disciplinary big concepts, effectively integrating fragmented knowledge through the design of big-unit activities set in real-life contexts [1]. Danni Hong proposed a teaching design framework based on an AI open platform, utilizing open-source resources to address the scarcity of teaching materials [23]. Xiaoyu Bai focused on the "machine learning" big concept and validated the effectiveness of big-concept-centered AI unit instruction in junior high school in fostering students' systematic thinking and core competencies [12]. Jing Li constructed an implementation framework for big units in the AI module of junior high school information technology courses based on UbD theory [9]. Meishi Qu demonstrated the critical role of unit-based instruction in junior high school AI courses for the comprehensive construction of knowledge systems and the development of digital literacy [13].

At the high school level, the unit-based teaching model guides students to shift from rote memorization to problem-solving in complex contexts, fostering innovative thinking and practical skills. Jinliang Li and Tao Ma established a theoretical framework for large-unit teaching in high school information technology and demonstrated the specific implementation process of AI unit instruction through multiple case studies; their research indicates that this model effectively enhances high school students' understanding and application of AI concepts [2]. Yan Li, adopting a big-idea perspective, proposed four major strategies addressing the current state of unit-based instructional design in high school information technology and provided a detailed elaboration using the "Approaching Artificial Intelligence" unit from the East China Normal University edition as an example [6].

## 5. Current Challenges in Research and

**Future Prospects**

### 5.1 Practical Challenges: Resource Shortages, Teacher Competency, and Ethical Risks

There is a disconnect between teaching resources and student needs. Quanhuao Hu's research indicates that AI education in primary and secondary schools lacks systematic and scientific curriculum content as well as supporting software and hardware [11]. Xiaoyu Bai argues that existing approaches often focus on tool operation or hardware assembly, failing to reveal the essence of AI and thus unable to cultivate students "transferable" thinking skills [12]. Danni Hong, focusing on the junior high school level, specifically points out concrete issues such as a scarcity of teaching resources, insufficient professional competence among teachers, and a disconnect between teaching content and students' actual needs [23]. In her curriculum development research, Yalin Liu found that domestic AI curriculum development remains underdeveloped, making it difficult to lay the foundation for national AI literacy [23]. Yongkun Quan confirmed through empirical research that without integrating AI technology into large-unit teaching, it is difficult to overcome current challenges [24].

Inadequacies in teachers' ability to adapt curriculum standards and design innovative lessons. XuetingJin noted that the current lack of unified AI textbooks in junior high schools leaves teachers facing resource shortages and a lack of standards when designing and implementing modules within secondary school information technology courses [25]. Yu Gao pointed out that existing teaching practices often focus on tool operation or rote memorization, making it difficult for teachers to grasp the essence of the subject through current experience and effectively develop students' core competencies [8].

### 5.2 Future Development Directions

In the future, AI-based unit-based instruction in K-12 schools should focus on building a systematic, coherent, and standardized curriculum system. It should integrate fragmented instructional content around the core anchor of subject-specific big ideas, thereby establishing a spiral framework of knowledge and skills. At the same time, it is essential to fully leverage generative AI technology to optimize the entire process—from instructional content development and classroom activity design to diverse assessment and feedback—and to design differentiated implementation pathways tailored to the cognitive characteristics of students at different educational levels. This will drive AI education from fragmented technical experiences toward the cultivation of in-depth competencies, ultimately achieving simultaneous improvements in teaching quality and students' core competencies.

## 6. Conclusion

Through research and exploration of "big unit" teaching in artificial intelligence courses for elementary and secondary schools, this paper outlines the theoretical foundations, case designs, and implementation pathways. The study indicates that "big unit" teaching can effectively integrate fragmented knowledge and cultivate students' core competencies. Despite challenges such as a lack of resources and insufficient teacher capacity, future efforts should focus on building a systematic curriculum framework, deepening interdisciplinary integration, and advancing the digital transformation of education. AI-focused unit-based instruction represents not only an upgrade in technological application but also a reshaping of educational philosophy. It requires collaborative efforts from the government, schools, and teachers to lay the foundation for cultivating innovative talent capable of thriving in the intelligent era.

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