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Innovative research on the "AI empowerment · moral cultivation and foundation consolidation" classroom teaching model for computer disciplines under the background of emerging engineering education

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Abstract
Against the dual backdrop of all-round iteration of artificial intelligence and independent breakthroughs in the Information Technology Application Innovation (ITAI) Industry, the training system for compound practice-oriented talents majoring in computer science under emerging engineering education urgently requires systematic transformation and upgrading. Currently, computer science classrooms in application-oriented undergraduate universities generally face structural problems such as difficulties in implementing precision teaching, insufficient support for personalized adaptive learning, rigid traditional teacher-student dualistic teaching relationships, and fragmented high-level innovative education systems. These manifest prominently as the disconnection between technical training and value guidance, the misalignment between knowledge instruction and innovation ability cultivation, the detachment of teaching models from industrial technology iteration, and the imbalance between single summative assessments and full-process education traceability, making it difficult to meet the urgent talent supply demands for national computing infrastructure construction and the independent controllability of the ITAI industrial chain.
Grounded in the fundamental task of fostering virtue through education in Emerging Engineering, aligned with the development trend of generative AI empowering the digital transformation of education, and relying on the hierarchical advancement theory of AI-empowered classroom teaching, this paper integrates AI large models, supercomputing technology, and smart teaching concepts to originally construct a "Five-in-One, Closed-Loop Iterative" AI-empowered new model for computer science classroom teaching. By developing discipline-specific AI agents, constructing a three-dimensional curriculum map of knowledge-ability-problem, and creating a new ubiquitous education scenario featuring "Teacher-Student-Machine" ternary collaboration, this model reconstructs a full-cycle smart education ecosystem encompassing intelligent pre-class preparation, collaborative in-class teaching, precise post-class enrichment, and intelligent full-process assessment, forming an integrated teaching practice paradigm that is "interdisciplinary, multi-platform, and adaptive," thereby achieving a fundamental transformation in the relationship between classroom teaching and learning. Synchronously, it establishes a four-dimensional education chain of "Curriculum Foundation—Project Practice—Competition Enhancement—Certification Empowerment," systematically overcoming persistent educational reform challenges such as superficial ideological and political infiltration in engineering classrooms, fragmented innovation cultivation, formalistic industry-education integration, and superficial intelligent empowerment. Parallel controlled teaching practices across multiple universities demonstrate that this model can effectively consolidate students' practical abilities in ITAI engineering, deeply cultivate their professional ethics of serving the country through science and technology, and temper their independent breakthrough innovative thinking. Simultaneously, it assists teachers in intelligent workload reduction, precision teaching, and quality and efficiency improvement, offering a replicable, low-cost, and standardized practical paradigm for the large-scale implementation of teaching reform in computer science majors at application-oriented undergraduate universities.

Keywords: Emerging engineering education, generative ai empowerment, ternary collaborative education, computer science, precision teaching, adaptive learning, five-in-one teaching architecture, teaching model innovation

Introduction

In the phase of deep digital economy penetration and rapid computing infrastructure construction, computer science has become the core backbone engineering major supporting the independent controllability of the ITAI industry, the breakthroughs of key core technologies, and the digital transformation of entire industries. The Ministry of Education continuously deepens the iterative construction of Emerging Engineering and the Excellent Engineer Training Plan, focusing on the cultivation goals for compound, practical, and innovative urgently needed engineering talents, and promotes the profound digital, intelligent, integrated, and localized innovation of engineering classroom teaching. Artificial intelligence technology, represented by generative large models, breaks the temporal and spatial constraints and rigid teaching models of traditional classrooms, forming a hierarchical empowerment system ranging from basic tool assistance and teaching capability expansion to human-machine collaborative innovation and high-order thinking shaping, providing core technical support for reconstructing the logic of engineering classroom teaching and learning and solving the pain points of precision education.

In view of the current state of computer science teaching in application-oriented undergraduate institutions, four core bottlenecks remain in classroom education: First, the homogeneous teaching model lacks academic data support, making individualized instruction superficial and preventing the normalized implementation of precision teaching, thus failing to adapt to students' differentiated growth needs; Second, the rigid teaching process lacks an intelligent adaptive support system, hindering students' autonomous inquiry and stratified advancement learning, with the cultivation of critical thinking and high-level innovation abilities showing fragmented characteristics; Third, the traditional "Teacher-Student" binary interaction model is deeply entrenched, with AI technology application mostly limited to superficial tools like attendance and grading, failing to achieve fundamental changes in teaching subjects, teaching processes, and educational logic; Fourth, professional technical training, knowledge system construction, ideological and political value guidance, and comprehensive ability cultivation are mutually separated, making it difficult to cultivate compound engineering talents suited to the AI era and the demands of the ITAI industry.

Currently, AI teaching empowerment in domestic universities generally remains at the level of basic labor substitution, not yet advancing to the higher-order forms of human-machine collaborative education and cognitive thinking reshaping, resulting in insufficient deep integration of intelligent technology and computer science teaching. Based on this, this paper takes the implementation of precision teaching, personalized adaptive learning empowerment, and fundamental changes in the teaching-learning relationship as the three core breakthrough points, integrating AI large models and supercomputing technology to reconstruct an intelligent education system. It establishes a five-in-one closed-loop teaching architecture and a full-chain implementation path, providing a feasible practical pathway for the high-quality transformation of Emerging Engineering computer education and the construction of a talent echelons for urgently needed ITAI professionals.

Review of Current Research

1. International Research and Practice Progress

Developed countries in Europe and America have taken the lead in deploying AI-empowered engineering education reforms, starting earlier and achieving relatively mature systems in areas such as intelligent teaching tool development, AI ethics education, and human-machine collaborative teaching scenario innovation. The European Union, through the "Erasmus+" special program, coordinates the advancement of the AI engineering education system, focusing on basic ethical scenarios like data privacy compliance and algorithm risk prevention and control, building standardized AI course clusters, and achieving the normalized permeation of AI ethics education in classrooms. Top universities like MIT and Stanford in the United States have deeply cultivated intelligent teaching empowerment innovation, developing intelligent programming ethics detection tools, proposing a "value alignment" education framework, adopting a dual-teacher collaborative teaching model, and preliminarily realizing the integrated implementation of AI technology and classroom teaching.

Overall, existing international teaching and research achievements have significant localized adaptation deficiencies: their educational scenarios mostly focus on civilian lightweight intelligent applications, not aligning with China's hardcore strategic scenarios such as chip localization, supercomputing power breakthroughs, and full-stack ITAI autonomous controllability; the value education system is built on Western social ethical frameworks, disconnecting from the core educational values of China's engineering field, such as serving the country through science and technology, technological independent controllability, and cyberspace security; technology empowerment mostly remains at the basic assistance and capability expansion level, not achieving the deep empowerment form of ternary collaborative education and high-order thinking shaping. Thus, only basic technology application ideas can be drawn upon, and they cannot be directly implemented in domestic Emerging Engineering classrooms.

2. Domestic Educational Reform Exploration and Existing Shortcomings

Domestic universities and industry entities continuously advance Emerging Engineering computer science teaching reforms and AI-empowered education innovation, yielding diverse teaching and research results. In terms of talent training models, Guo Bohua *et al*. proposed an AI-empowered "Six-Dual Integration" education model, promoting the bidirectional integration of professional teaching and competency cultivation; Cao Jiangqian *et al*. focused on cultivating "Three-Innovation" talents (innovation, creation, entrepreneurship), exploring reform paths for computer science courses to strengthen students' capabilities in these areas. In terms of intelligent teaching models, Liu Xuejie *et al*. conducted research on adaptive intelligent teaching models, providing ideas for personalized stratified education; Xie Youru *et al*. and Song Yu *et al*. systematically explored the path for AI to empower the reconstruction of university classroom teaching, proposing a teaching transformation logic from knowledge transmission to thinking stimulation. In terms of curriculum practical reform, Zhang Kailong *et al*. explored AIGC-empowered teaching for computer system courses, Yan Binyu *et al*. used first-class courses as a carrier to implement AI classroom reform, and Su Xiaohong *et al*. focused on innovating teaching and learning scenarios in programming courses, providing practical examples for intelligent subject teaching. Meanwhile, many studies focus on personalized learning, intelligent evaluation, and experimental system construction: Zhai Jie *et al*. achieved dynamic recommendation of personalized learning resources based on lightweight educational large models; An Xiaochun *et al*. optimized personalized teaching strategies based on multimodal information fusion; Zou Yongpan specifically considered the reconstruction path of the computer science teaching evaluation system in the AI era; some scholars improved AI general education and practical education systems through the construction of teaching-assessment dual-driven platforms and intelligent experimental systems. Additionally, research focusing on localized talent cultivation, human-machine collaborative dual-teacher models, and intelligent monitoring of classroom behavior has formed diversified educational reform achievements.

However, overall, four prominent shortcomings persist in current domestic educational reform practices: First, most research focuses on single-course or single-link reforms, lacking a systematic architecture design covering the entire teaching process, making it difficult to normalize a data-driven full-process precision teaching system; Second, the adaptive learning mechanism is incomplete, mostly limited to superficial resource recommendation, without forming a complete chain of academic situation assessment, dynamic adaptation, and closed-loop enrichment, leading to fragmented personalized student development and critical thinking innovation ability cultivation; Third, human-machine collaborative education is formalistic, with most studies merely introducing AI auxiliary tools without fundamentally reconstructing the ternary subject relationship among teachers, students, and machines, thus the core relationship in classroom teaching and learning has not achieved essential innovation; Fourth, the integration of AI, supercomputing, localized technologies, and disciplinary teaching is superficial, failing to form an integrated education system of knowledge, ability, and problem, and most reform models have high investment costs and weak universality, making them difficult to promote on a large scale in application-oriented undergraduate universities.

3. Research Bottlenecks and the Direction of This Paper

By comprehensively reviewing existing research, common bottlenecks exist in the current AI teaching reform of Emerging Engineering computer science: imperfect precision education mechanisms, lack of adaptive learning systems, rigid traditional teaching relationships, insufficient depth of technology-teaching integration, and singular evaluation of educational effectiveness. Addressing these issues, this paper, based on the hierarchical empowerment of generative AI and the theory of human-intelligence collaborative intervention, breaks through the limitations of existing single-link reforms. It focuses on the three core breakthrough points of precision teaching, personalized adaptive learning, and the transformation of teaching-learning relationships. Integrating AI large models and supercomputing technology, it builds a systematic five-in-one teaching architecture, innovatively constructs a three-dimensional map education system of knowledge-ability-problem, creates a "Teacher-Student-Machine" ternary collaborative ubiquitous education scenario, and forms a low-cost, replicable, high-level interdisciplinary integrated teaching paradigm, effectively filling the theoretical and practical gaps in the current educational reform field.

Core Architecture and Educational Logic of the Teaching Model

1. Core Objectives and Educational Logic

This model strictly anchors the core concepts of Emerging Engineering's fostering virtue through education, strengthening foundations, and precision education, aligning with the educational requirements of the Excellent Engineer Training Plan. It follows the four-level hierarchical advancement law of generative AI, from tool assistance and capability expansion to human-machine collaboration and cognitive shaping. Relying on the theory of human-intelligence collaborative learning intervention, it establishes four-dimensional core educational objectives and closed-loop educational logic. First, the precision teaching quality objective: construct a full-process data-driven intelligent education system, relying on multimodal perception, academic portrait, and intelligent judgment technologies to achieve precise targeted teaching across all links of teacher preparation, instruction, tutoring, and assessment, solving the pain points of homogeneous and undifferentiated education in traditional teaching. Second, the adaptive growth empowerment objective: build an AI-driven personalized learning chain, relying on discipline-specific AI agents and dynamic resource recommendation mechanisms to adapt to the differentiated development needs of students at different basic and ability levels, systematically cultivating students' autonomous learning, critical innovation, and human-machine collaboration abilities. Third, the teaching relationship innovation objective: completely break the shackles of the traditional teacher-student binary teaching, reshape the "Teacher-Student-Machine" ternary collaborative education relationship, and achieve fundamental changes in teacher roles, student roles, and teaching logic. Fourth, the comprehensive competency soul-casting objective: integrate localized technology practical training and engineering ethics education to realize the synchronous three-in-one education of technical foundation strengthening, thinking advancement, and value soul casting, adapting to the urgent needs for compound talents in the ITAI industry. The overall formation is a "Five-in-One" layered coupling, closed-loop iterative educational logic of "Technology Empowerment for Foundation, Map Construction for Quality, Scenario Reconstruction for Empowerment, Relationship Transformation for Efficiency, Closed-Loop Iteration for Optimization," constructing an all-round, full-process, full-scenario closed-loop education system, providing core architectural support for intelligent precision teaching.

2. Detailed Design of the Five-in-One Overall Architecture

This paper, integrating existing research findings on AI-empowered teaching, top-level designs a "Five-in-One" overall teaching architecture (shown as **Figure 1**) featuring "Technology Integration + Map Construction + Scenario Reconstruction + Relationship Transformation + Teaching Closed Loop," with layered coupling and closed-loop iteration. The five core modules empower independently, coordinate jointly, and iterate in a closed loop, thoroughly solving the problems of fragmented traditional teaching systems, superficial integration, and low educational efficiency, comprehensively supporting the implementation of precision teaching and personalized adaptive learning. The detailed design of each module is as follows:

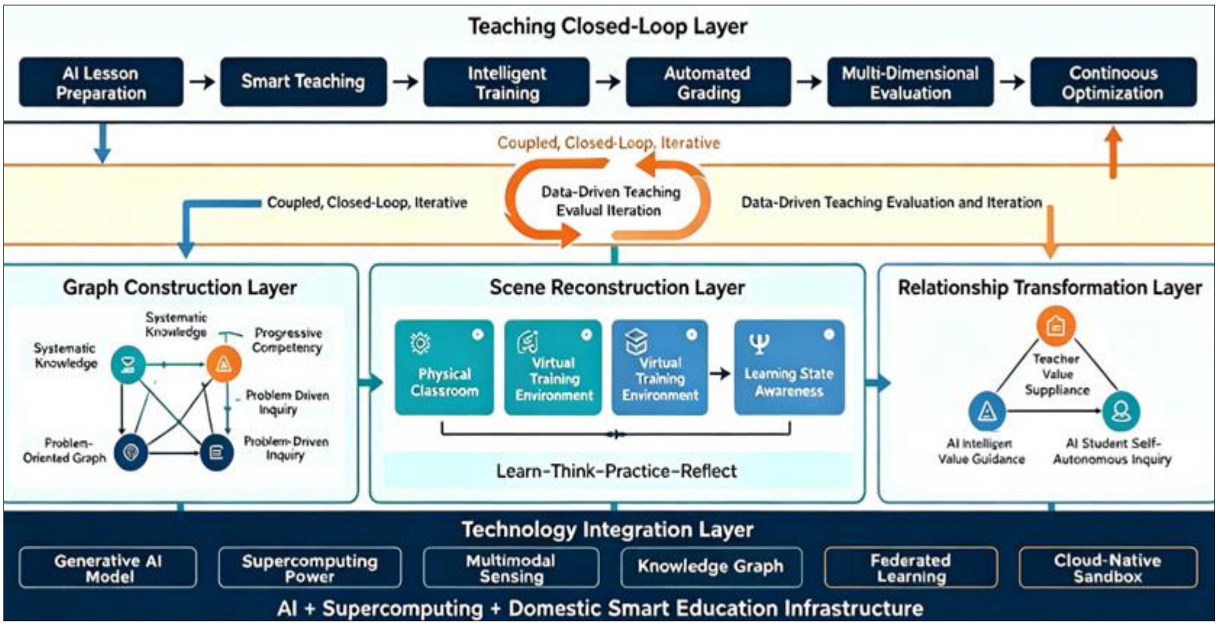

Fig 1: Five-in-One AI-Empowered Teaching Architecture

First, the Technology Integration Layer: AI + Supercomputing + Localized Smart Teaching Integrated Technology Base. This module is the underlying support of the entire teaching model, centrally addressing the problems of superficial intelligent empowerment, technology-teaching disconnection, and lagging practical training scenarios. Different from traditional single AI tool assistance models, this module integrates six core technologies: generative AI large models, supercomputing power, multimodal perception, knowledge graphs, federated learning, and cloud-native sandboxes, to build a lightweight, highly adaptable, low-cost discipline-specific intelligent teaching technology base. On one hand, based on large model lightweight fine-tuning technology, it develops discipline-specific AI agents for computer science, integrating six core functions: intelligent lesson preparation, academic situation assessment, code quality inspection, ethical screening, resource push, and behavior analysis, overcoming the shortcomings of general AI tools' insufficient professionalism and poor adaptability. On the other hand, it links supercomputing power platforms with the domestic Kunpeng and Ascend technology systems to build a cloud-based virtual training sandbox, supporting high-level practical training scenarios such as large-scale algorithm simulation, distributed system development, and large model quantitative compression, solving the pain points of insufficient hardware resources and missing high-level training scenarios in application-oriented universities. Simultaneously, it integrates offline smart classrooms, cloud training platforms, and mobile ubiquitous learning terminals to construct a multi-terminal linked smart teaching network, providing full-domain technical support for full-process precision teaching and adaptive learning.

Second, the Map Construction Layer: Knowledge-Ability-Problem Three-Dimensional Integrated Education Map System. This module is the core carrier for precision teaching and structured education, solving the core problems of fragmented student knowledge, one-sided abilities, and aimless learning, differing from the traditional single knowledge point teaching model. First, the course knowledge map: relying on AI knowledge extraction and association analysis technology, it comprehensively sorts out the hierarchical relationships, logical structures, and distribution of key and difficult points of core computer science course knowledge, breaking down knowledge barriers between courses like data structures, operating systems, computer networks, artificial intelligence, and ITAI adaptation, forming a visual, structured, and complete knowledge system to guide students in establishing a systematic disciplinary cognition. Second, the core competency map: benchmarked against Emerging Engineering talent standards and ITAI enterprise job competency models, it deconstructs five major competency dimensions: practical R&D, cross-border innovation, teamwork, engineering ethics, and autonomous learning. It details stratified progressive competency indicators from freshman to senior year, dynamically updates students' digital competency portraits based on academic data, and achieves precise benchmarking and ladder advancement in competency cultivation. Third, the problem-oriented map: integrating common classroom error-prone knowledge points, practical training difficulties, core problems in discipline competitions, urgent industry job pain points, and typical engineering ethics issues, it intelligently matches knowledge points, training projects, solutions, and ideological-political cases, constructing a problem-driven inquiry-based education system to realize learning for application and promoting thinking through practice. The three major maps are interconnected and dynamically iterated, forming a closed-loop educational logic of "Knowledge Consolidation—Capability Advancement—Problem Breakthroughs," providing core content support for the implementation of the five-in-one architecture.

Third, the Scenario Reconstruction Layer: Teacher-Student-Machine Ternary Collaborative Ubiquitous Education Scenario System. This module is the core scenario support for the transformation of the teaching-learning relationship. Relying on the human-intelligence collaborative education theory, it breaks the temporal and spatial limitations of traditional single classrooms, creating a ubiquitous education scenario integrating physical real scenes, cloud virtual environments, and mental state assessment. Physical real scenes focus on face-to-face intensive teaching of key and difficult points, group discussions, and practical Q&A, implementing value guidance and emotional empowerment. Cloud virtual scenes, relying on cloud-native sandboxes, support hundred-person-level collaborative programming, cross-terminal joint debugging, and localized system adaptation training, solving the problems of limited offline training scale and lagging scenarios. Mental state assessment scenarios, based on multimodal perception technology, non-intrusively capture students' classroom concentration, emotional fluctuations, interaction willingness, and learning confusion, achieving dynamic assessment of the academic situation and real-time intervention. The three major scenarios are deeply integrated and linked across the entire domain, constructing an adaptive "Learning-Thinking-Practicing-Realizing" full-chain education mechanism, synchronously supporting the implementation of teacher precision teaching and student personalized adaptive learning, serving as the scenario implementation carrier for the five-in-one architecture.

Fourth, the Relationship Transformation Layer: Ternary Subject Collaborative Education New Teaching Relationship System. This module is the core innovation point of this educational reform, completely subverting the traditional binary rigid teaching relationship of "teacher-led, student-passive." It reconstructs a ternary collaborative education relationship of "Teacher Value Guidance + AI Intelligent Empowerment + Student Autonomous Inquiry": Teachers shed repetitive transactional work, transforming into instructional designers, value shapers, thinking guides, and innovation inspirers, focusing on high-level education and personalized guidance; AI agents undertake full-process intelligent auxiliary work such as intelligent lesson preparation, academic situation analysis, resource push, code correction, behavior monitoring, and effectiveness statistics, achieving teaching workload reduction and efficiency enhancement, and precise data empowerment; Students transform from passive knowledge recipients into learning subjects who plan autonomously, inquire actively, collaborate innovatively, and reflect critically, fully activating their autonomous learning and innovation potential, achieving a fundamental and substantive transformation of the teaching-learning relationship, providing the main mechanism support for the five-in-one architecture.

Fifth, the Teaching Closed-Loop Layer: Teaching-Assessment Dual-Driven Full-Process Intelligent Iterative Education System. This module is the core guarantee for improving educational effectiveness, solving the problems of traditional single assessment, untraceable education, and optimization without basis. Relying on the teaching-assessment dual-driven education concept, it constructs a six-link full closed-loop iterative mechanism of "Intelligent Preparation—Intelligent Teaching—Intelligent Training—Intelligent Grading—Intelligent Assessment—Intelligent Optimization." It integrates multi-source information from classroom behavior data, training achievement data, knowledge mastery data, capability advancement data, ideological-political competency data, and competition and certification data, establishing a five-dimensional intelligent quantitative evaluation model to make educational effectiveness measurable, evaluable, traceable, and optimizable. Through normalized data review and model iteration, it continuously optimizes teaching plans, resource allocation, and educational strategies, forming a long-term educational iteration mechanism to ensure the scientificity, adaptability, and dynamic iterative capacity of the five-in-one teaching architecture.

Core Implementation Path of the Teaching Model

Based on the five-in-one overall architecture of this paper, combined with the professional characteristics of computer science—strong practicality, fast iteration speed, prominent localization urgency, and high engineering ethics requirements—and relying on existing AI-empowered teaching practice experience, this section details a full-chain, implementable, and replicable practical implementation path from four dimensions: technology integration implementation, three-dimensional map empowerment, ternary scenario operation, and education paradigm upgrade. It implements the functions of the five core modules layer by layer, comprehensively realizing precision teaching and personalized adaptive education, transforming the five-in-one architecture from theoretical design into an implementable classroom teaching practice system.

1. Solidifying the Technology Base of the Five-in-One Architecture

Centered on the first layer of the five-in-one architecture, the technology integration base, this breaks through the barriers to deep integration of AI, supercomputing, localized technologies, and classroom teaching, advancing intelligent technology from superficial tool application to deep education empowerment, solidifying the underlying support for the entire teaching model's map construction, scenario operation, relationship transformation, and closed-loop iteration. First, dynamic iteration of intelligent teaching resources: relying on discipline-specific AI agents, automatically deconstruct course key and difficult points based on the three-dimensional education map, and, combined with the iterative dynamics of cutting-edge ITAI industry technologies, update localized practical cases, interdisciplinary project materials, engineering ethics cases, and gradient exercise banks in real-time. Push differentiated resources for basic consolidation, capability enhancement, and innovation expansion to students at different academic levels, achieving precise resource supply and dynamic adaptation. Second, intelligent reconstruction of the curriculum system: deeply embed cutting-edge content such as supercomputing parallel computing, AI large model quantitative optimization, domestic operating system adaptation, chip architecture design, and network security compliance into core courses like data structures, computer organization principles, operating systems, and algorithm design, reconstructing course knowledge modules and training systems to solve the problem of disconnection between course content and industrial technology. Third, multi-platform collaborative empowerment implementation: integrate offline smart classroom interaction systems, cloud supercomputing training platforms, domestic ITAI training terminals, discipline competition platforms, and professional certification platforms to achieve data interoperability, scenario linkage, and resource sharing across multiple platforms, supporting students to conduct ubiquitous autonomous training and personalized inquiry learning anytime, anywhere, and supporting teachers in full-scenario precision teaching. Fourth, multimodal academic data collection: rely on smart cameras, non-inductive sensors, and classroom behavior analysis systems to collect multi-modal information such as students' classroom concentration, interactive behavior, operational trajectories, and error data in real-time, providing comprehensive data support for academic portrait creation, precise intervention, and adaptive enrichment, ensuring the core advantage of data-driven implementation of the five-in-one architecture.

2. Consolidating the Technical Foundation of the Five-in-One Framework

Relying on the second layer of the five-in-one architecture, the three-dimensional education map system, this implements stratified individualized instruction and personalized adaptive learning, systematically solving the problems of fragmented student knowledge, homogeneous abilities, and directionless advancement, providing structured content support for full-mode education. At the knowledge construction level, relying on AI visual knowledge maps, assist students in sorting out knowledge logic throughout the entire process before, during, and after class. Before class, intelligently deconstruct preview key and difficult points and clarify knowledge associations; during class, dynamically present knowledge frameworks to break through cognitive blind spots; after class, intelligently summarize the knowledge system and generate personalized error ledgers, guiding students to build a systematic and structured disciplinary knowledge system, fundamentally changing the fragmented memorization and mechanical practice learning model. For key and difficult modules like linked list architectures, low-level instruction sets, and algorithm logic, AI intelligently matches corresponding expanded cases and decomposition tutorials to help weaker students fill gaps and assist outstanding students in deepening and expanding.

At the capability advancement level, based on students' digital capability portraits, a stepped stratified enrichment system is established. The basic layer focuses on course foundational practical abilities, suitable for lower-grade students or those with weaker foundations, relying on AI adaptive push of basic training tasks and standardized operation tutorials to consolidate basic abilities in coding, hardware debugging, and system adaptation. The advanced layer focuses on comprehensive application ability, suitable for intermediate-level students, pushing small and medium-sized project development and system debugging training tasks to cultivate problem-solving and collaborative practical abilities. The innovation layer focuses on high-level breakthrough capabilities, suitable for top students, pushing interdisciplinary innovation projects, localized breakthrough topics, and original algorithm design tasks, linking discipline competitions and science innovation projects to temper students' independent innovation and system R&D capabilities, achieving stratified advancement and personalized growth for every student, and implementing the stratified education goal of the five-in-one architecture.

At the problem-driven level, relying on the problem-oriented map, a closed-loop learning mechanism of "Discovering Problems—Exploring Problems—Solving Problems—Reviewing and Improving" is constructed. AI intelligently captures students' normalized learning error-prone points and practical training pain points, automatically matches corresponding knowledge points and solutions, and generates personalized problem rectification lists. Classroom practical projects are designed based on industry job urgent problems, guiding students to conduct inquiry-based learning from an engineering perspective. In the process of solving complex engineering problems, knowledge is consolidated, abilities are tempered, and compliance ethics are cultivated simultaneously, fully activating the problem-driven education advantage of the five-in-one architecture.

3. Implementing the Educational Scenarios of the Five-in-One Architecture

Relying on the third layer of the five-in-one architecture, the ternary collaborative ubiquitous scenario, this comprehensively implements teacher precision excellent teaching and student personalized adaptive learning, fundamentally transforming traditional teaching and learning models, achieving the core goal of the fourth layer's teaching relationship innovation, and realizing the scenario-based, normalized operation of the entire architecture.

Full-process Implementation of Teacher Precision Teaching: First, intelligent precise pre-class preparation: based on class academic big data and three-dimensional map weakness ledgers, AI intelligently generates layered teaching plans, key and difficult point teaching designs, differentiated training tasks, and suitable ideological-political cases, replacing repetitive tasks of traditional manual preparation, improving preparation precision and efficiency. Second, dynamic precise in-class teaching: relying on the multimodal academic monitoring system, real-time capture fluctuations in student concentration and learning confusion, dynamically adjust teaching pace, depth of key/difficult point explanations, and classroom interaction forms. Focus intensive teaching on common problems and provide precise answers to individual issues, achieving targeted teaching and dynamic intervention. Third, precise layered post-class tutoring: based on classroom academic data, AI generates layered enrichment lists, pushing personalized consolidation tasks and expansion resources to students at different levels. Teachers focus on students' high-level problems, innovative thinking, and value competency for targeted guidance. Fourth, full-process intelligent precise assessment: relying on the fifth layer's teaching-assessment dual-driven closed-loop system, integrate multi-dimensional data to generate dynamic teaching diagnostic reports, accurately locate teaching weaknesses and student capability defects, provide data support for teaching iterative optimization, and comprehensively achieve teacher workload reduction, efficiency enhancement, and precision quality improvement.

Full-chain Implementation of Student Adaptive Learning: First, adaptive learning and thinking empowerment: based on students' personal portraits, AI dynamically adapts learning resources and pace. Students can autonomously plan their learning progress, choose suitable learning content, and the system guides students to deeply think about knowledge logic and analyze technical principles, continuously cultivating autonomous learning and critical thinking. Second, adaptive practice empowerment: relying on cloud-based virtual training scenarios, students can autonomously choose gradient training projects based on their own abilities, engage in autonomous practice, collaborative breakthroughs, and repeated iteration, tempering engineering practical abilities. Third, adaptive realization empowerment: AI dynamically matches ideological-political cases such as serving the country through science and technology, independent breakthroughs, and engineering compliance, conducting seamless immersive education combined with students' practical training, synchronously advancing knowledge internalization, capability enhancement, and value sublimation. Fourth, adaptive mutual evaluation and improvement: relying on the intelligent evaluation system, students can view personal capability weaknesses and learning gaps in real-time, autonomously carry out targeted reinforcement, forming an adaptive closed loop of "Autonomous Learning—Intelligent Monitoring—Precise Reinforcement—Continuous Advancement," fully realizing the educational value of the five-in-one architecture.

4. Achieving Full-Domain Empowerment of the Five-in-One Architecture

Leveraging the synergistic empowerment advantages of the five modules of the five-in-one architecture, break down disciplinary barriers, platform barriers, and educational level barriers, innovate and upgrade the education paradigm, form an integrated education model suitable for the AI era and the needs of the ITAI Industry, and maximize the educational effectiveness of the entire architecture. In terms of interdisciplinary integrated education, integrate knowledge from computer science, artificial intelligence, network security, software engineering, engineering ethics, and supercomputing applications to design comprehensive breakthrough projects such as system-level simulation development, localized system adaptation, AI algorithm optimization, and network security protection, breaking the limitations of single-course knowledge and cultivating students' cross-border integration thinking and complex engineering problem-solving abilities, activating the content advantage of the map construction layer. In terms of multi-platform collaborative education, deepen the linkage of the five platforms: "Classroom Teaching + Cloud Training + Science Innovation Competition + Professional Certification + School-Enterprise Practice," deeply connecting classroom theoretical teaching, intelligent practical training, discipline competition innovation, industry authoritative certification, and enterprise project practice to achieve integrated education of learning, practice, innovation, competition, and certification, expanding the educational boundaries of the scenario reconstruction layer. In terms of adaptive closed-loop education, relying on the real-time academic situation assessment capability of AI agents, dynamically adjust teaching content, training difficulty, assessment standards, and enrichment plans to comprehensively adapt to students with different foundations, specialties, and development needs, thoroughly solving the educational limitations of homogenization and one-size-fits-all in traditional teaching, consolidating the iterative advantage of the teaching closed-loop layer. Simultaneously, continue to deepen the four-dimensional education chain of "Curriculum Foundation—Project Practice—Competition Enhancement—Certification Empowerment," promoting students' full-dimensional growth from knowledge mastery and capability enhancement to competency formation and employment adaptation, comprehensively improving the quality of talent cultivation and industrial suitability, and fully realizing the systematic education goal of the five-in-one architecture.

Model Application Effectiveness and Value Analysis

1. Teaching Practice Effectiveness

Centered on the five-in-one closed-loop architecture, this teaching model was piloted for one academic year in computer-related majors at three application-oriented undergraduate universities in the province, resulting in significantly improved full-domain education effectiveness. At the teacher level, AI intelligent empowerment effectively replaced repetitive transactional work such as lesson preparation, grading, and assessment, increasing teaching work efficiency by over 60%. Teachers could devote more energy to in-depth teaching design, personalized guidance, and thinking leadership, with precision teaching capabilities and intelligent teaching research levels continuously advancing. At the student level, the three-dimensional map helped students build a systematic knowledge system, with classroom concentration and practical participation rates increasing by over 40% compared to traditional classrooms. Autonomous learning, critical innovation, and human-machine interaction abilities were significantly enhanced. ITAI practical ability and engineering compliance ethics literacy were comprehensively improved, and the enterprise job adaptation period was significantly shortened. At the education level, core problems such as the separation of technical training and ideological-political education, lack of precision teaching, insufficient personalized education, and superficial intelligent empowerment were effectively resolved, achieving four-dimensional synergistic development of knowledge, ability, thinking, and competency, with educational effectiveness and suitability greatly improved.

2. Innovative Value

At the theoretical level, based on the hierarchical empowerment of generative AI and the theory of human-intelligence collaborative education, this paper innovatively constructs a five-in-one engineering education system deeply integrating AI + supercomputing + smart teaching. It pioneers a precise adaptive teaching paradigm empowered by a three-dimensional map, perfects the implementation logic of ternary collaborative education, clarifies the layered coupling relationship between intelligent teaching technology, content, scenarios, subjects, and evaluation, enriches the theoretical system of intelligent and precision education for Emerging Engineering computer science, and provides theoretical support for the transformation of engineering classroom teaching in the intelligent era. At the practical level, this model has the advantages of being lightweight, low-cost, easily replicable, and highly adaptable. It can be widely adapted for the normalized teaching of computer science majors in various application-oriented undergraduate and private undergraduate engineering universities, effectively filling the gap for compound, practical, and innovative talents in the ITAI industry, providing a standardized practical template for the intelligent educational reform, precision education, and large-scale implementation of engineering classrooms.

Conclusion and Outlook

Facing the historical backdrop of deepening Emerging Engineering reform, full-domain generative AI empowering education, and the independent breakthroughs of the ITAI industry, this paper takes the implementation of precision teaching, personalized adaptive learning empowerment, and fundamental transformation of the teaching-learning relationship as the core breakthrough points. It originally constructs a five-in-one closed-loop iterative teaching architecture, building a systematic, full-process, and implementable new model for intelligent computer science teaching. Through the layered coupling, synergistic empowerment, and closed-loop iteration of the five core modules, it completely breaks the shackles of traditional engineering classroom teaching, achieves precise and efficient education by teachers and adaptive growth and success for students, reshapes the core relationship between teaching and learning in engineering classrooms in the intelligent era, and highly aligns with the national strategic needs for engineering talent cultivation and the high-quality development of the ITAI industry.

Follow-up research will continuously iterate AI agent algorithms, optimize the dynamic update mechanism of 3D knowledge graphs, deepen the university-enterprise collaborative education model, and refine the dual-driven education mechanism integrating teaching and evaluation. It will further enhance the scenario adaptability and large-scale promotion efficiency of the five-in-one teaching framework, and continuously explore innovative paths for generative AI to deliver high-level empowerment to emerging engineering education. This research aims to lay a solid foundation for the high-quality development of emerging engineering education and the long-term cultivation of talent echelons for the independent breakthroughs of national core technologies.

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References

1. Ministry of Education, Ministry of Industry and Information Technology, Chinese Academy of Engineering. Opinions on Accelerating the Construction and Development of Emerging Engineering and Implementing the Excellent Engineer Education and Training Plan 2.0 [Z], 2018.
2. Working Group of the "101 Plan". Strategic Research Report on Talent Cultivation for Computer Majors in Institutions of Higher Education & White Paper on Core Curriculum System [M], 2023.
3. Lu Y, Tang X. The Morphological Levels and Advancement Paths of Generative Artificial Intelligence Empowering Classroom Teaching [J]. e-Education Research,2025:46(06):75-82.
4. Cao J, Sun M, Shi H. Reform of Computer Courses for Cultivating "Three-Innovation" Talents under the Background of Emerging Engineering [J]. Computer Education,2026:(5):258-262. DOI:10.3969/j.issn.1672-5913.2026.05.042.
5. Guo B, Ji M. Construction and Practice of the "Six-Dual Integration" Computer Talent Training Model from the Perspective of AI Empowerment [J]. Information Systems Engineering,2026:(3):98-101. DOI:10.3969/j.issn.1001-2362.2026.03.027.
6. Yu S, Ye J, Yin X, et al. Design and Application of Linked Human-Intelligence Collaborative Learning Intervention: Theoretical Model and Practical Framework [J]. e-Education Research,2025:46(7):93-99, 107. DOI:10.13811/j.cnki.eer.2025.07.013.
7. Zhu F, Yang S. AIGC and Educational Innovation: Opportunities, Challenges, and Future [J]. Journal of East China Normal University (Educational Sciences),2023:41(07):1-9.
8. Liu X, Zhang S, Huang L, et al. Exploration of Adaptive Intelligent Teaching Models from the Perspective of Artificial Intelligence [J]. Computer Education,2026:(5):131-137. DOI:10.16512/j.cnki.jsjjy.2026.05.037.
9. Cao J, Sun M, Shi H. Reform of Computer Courses for Cultivating "Three-Innovation" Talents under the Background of Emerging Engineering [J]. Computer Education,2026:(5):258-262. DOI:10.16512/j.cnki.jsjjy.2026.05.033.
10. Zhang K, Zheng J, Ma C, et al. Exploration of Teaching Computer System Courses Empowered by AIGC [J]. Computer Education,2025:(11):57-62. DOI:10.16512/j.cnki.jsjjy.2025.11.009.
11. Zou Y. Reflections on the Teaching Model and Evaluation System of Computer Science in the AI Era [J]. Computer Education,2025:(6):15-17. DOI:10.16512/j.cnki.jsjjy.2025.06.032.
12. Song Y. From Knowledge Transmission to Thinking Stimulation: Research on the Transformation of Classroom Teaching Empowered by Generative Artificial Intelligence [J]. China Educational Technology,2026:(6):103-109+124.
13. Xie Y, Chen W, Qiu Y. Research on the Reconstruction of University Classroom Teaching Empowered by Artificial Intelligence [J]. e-Education Research,2025:46(10):5-13. DOI:10.13811/j.cnki.eer.2025.10.001.
14. Yan B, Lin F, Feng C. Artificial Intelligence Empowering Classroom Teaching Reform: A Case Study of the AI Construction of the National First-Class Course Computer Networks [J]. Computer Education,2026:(4):180-186. DOI:10.3969/j.issn.1672-5913.2026.04.032.
15. Chen L, Huang X, Zhang Z, et al. Exploration of Introducing Artificial Intelligence Content into University Computer Course Teaching [J]. Computer Education,2023:(3):203-207. DOI:10.3969/j.issn.1672-5913.2023.03.042.
16. Zhai J, Li Y, Chen L, et al. Dynamic Recommendation of Personalized Practical Learning Materials Based on a Lightweight Educational Large Model [J]. Computer Science,2026:53(2):48-56. DOI:10.11896/jsjkx.250800002.
17. Qin X, Chen Y, Yao Y, et al. Exploration of the Path for a "Teaching-Assessment Dual-Driven" Teaching Experiment Platform to Empower AI General

Education [C]// Proceedings of the 33rd National Academic Conference on New Computer Science and Technology and Education, 2025, 1-6.

18. Zhang T, Tang X, Lin Y, et al. Construction of an Artificial Intelligence-Empowered Experimental Teaching System and Experimental Case Design [C]// Proceedings of the 9th China Computer Practice Education Academic Conference and the 18th National University Computer Practice Teaching Forum (CPEC2025), 2025, 1-6.
19. Su X, He Q. Exploration of Artificial Intelligence Empowering Teaching and Learning Scenarios and Model Innovation: Taking Programming Courses as an Example [J]. China University Teaching,2025:(6):65-72. DOI:10.3969/j.issn.1005-0450.2025.06.010.
20. Xiang L, Tao H, Chen X. Exploration of Reforming Computer System Talent Training for Artificial Intelligence and Localization [J]. China Information Technology Education,2026:(6):109-112. DOI:10.3969/j.issn.1674-2117.2026.06.032.
21. Chen R. Research on a Human-Machine Collaborative Dual-Teacher Model Integrating AI Agent Teachers [J]. Modern Educational Technology,2026:36(6):114-125. DOI:10.3969/j.issn.1009-8097.2026.06.012.
22. Chen X, Tian X, Yang S. Research on the Teaching Application of AI Large Models in the "Algorithm Design and Analysis" Course [J]. Education Teaching Forum,2026:(8):150-154. DOI:10.3969/j.issn.1674-9324.2026.08.034.
23. An X, Zhang X. Research on Personalized Teaching Strategies Based on Multimodal Information Fusion [J]. Computer Technology and Development,2025:35(12):200-204. DOI:10.20165/j.cnki.ISSN1673-629X.2025.0206.
24. Chen Y, Tang K, Shen X, et al. AI-Based Intelligent Monitoring and Analysis System for Classroom Concentration [J]. Internet of Things Technologies,2026:16(5):43-45. DOI:10.16667/j.issn.2095-1302.2026.05.011.
25. Ren Y. Research on Key Technologies of Student Face Recognition in Smart Classrooms Based on Deep Learning [D]. Yinchuan: North Minzu University, 2023.
26. Han B. Research on the Intelligence Generation Mechanism and Teaching Model Innovation of Smart Classrooms Empowered by Artificial Intelligence [J]. Computer Era,2025:(10):100-103, 108. DOI:10.16644/j.cnki.cn33-1094/tp.2025.10.019.
27. Li J. A New Track for "Artificial Intelligence + Education" Action: Teaching Design-Driven AI Programming [J]. Curriculum, Teaching Material and Method,2026:46(5):30-37. DOI:10.3969/j.issn.1000-0186.2026.05.006.
28. Meng Y, Qiu P, Sui K. Research on a Smart Classroom Behavior Analysis System Based on Artificial Intelligence [J]. Educational Information Technology,2026:(1):13-17. DOI:10.3969/j.issn.1671-3176.2026.01.004.