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Research on the Application of Knowledge Graph and AI Task Engine in Empowering Personalized Instruction for Fundamental Computer Science Courses

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Abstract: Against the backdrop of the profound integration of professional accreditation in engineering education with the digitalization of education, computer-related foundational courses, serving as pivotal vehicles for talent development, generally confront salient challenges such as fragmented knowledge delivery, inadequate personalized instruction, an onerous teaching workload for educators, and a superficial infusion of ideological and political education into the curriculum. To tackle these pressing issues, this study leverages the sophisticated knowledge graph, AI task engine, multimedia educational resources, and question bank system of the Fanya Learning Platform, in conjunction with frontline teaching reform initiatives, to investigate a curriculum development pathway that seamlessly integrates AI technology with the knowledge graph while intertwining ideological and political education throughout the curriculum. Through the refinement of platform-based teaching materials, the construction of dynamic cognitive profiles for students, and the incorporation of ideological and political elements such as the spirit of craftsmanship and patriotism, a comprehensive closed-loop precision teaching and collaborative education model is established. This model offers theoretical insights and practical guidelines for the digital and ideological transformation of computer-related foundational courses, thereby facilitating the cultivation of high-caliber professionals endowed with both ethical integrity and professional prowess.

Keywords: Knowledge Graph, AI Empowerment, Fundamental Courses in Computer Science, Personalized Instruction, Educational Reform.

1. Introduction

Guided by the professional accreditation framework in engineering education, the cultivation of computer science professionals must closely align with industry needs and graduation requirements, integrating knowledge transmission, skill development, and value orientation. Lower-level professional foundational courses, such as data structures, object-oriented programming, and database principles, serve as the cornerstone of talent development. They not only provide essential support for subsequent core professional courses but also play a pivotal role in facilitating students' further education, enhancing their employability, and fostering their ideological and political awareness. Taking software engineering as an example, foundational courses in the discipline and specialty form the core support of the practical teaching system, acting as a crucial link between fundamental theory, engineering practice, and ideological and political education. These courses directly influence the integrity of students' knowledge systems, the formation of professional competencies, and the establishment of correct values.

In recent years, the teaching team has continuously advanced teaching model reforms, progressing through three developmental stages: accumulation, research, and innovation. They have gradually established a "trinity" teaching objective, implemented task-driven instruction, and achieved notable improvements in teaching quality. However, with the in-depth implementation of digital education strategies, technologies such as artificial intelligence and big data have profoundly reshaped educational paradigms. The role of teachers must shift from that of "knowledge transmitters" to "creators of learning environments." The traditional one-size-fits-all teaching approach is no longer adequate to meet the diverse and individualized learning needs of students. Tailoring education to individual aptitudes has thus become a central focus of current curriculum reform.

As a structured knowledge representation framework, knowledge graphs can dissect disciplinary knowledge into fine-grained conceptual and skill-based nodes, clearly delineating prerequisite and dependency relationships among knowledge points. This provides a semantic foundation for personalized instruction and the integration of ideological and political education. AI technology, particularly intelligent task engines, enables real-time monitoring and dynamic adjustment of students' learning progress and ideological and political development. The deep integration of these technologies offers a novel approach to addressing challenges in computer science foundational course instruction and promoting the routine incorporation of ideological and political education into the curriculum.

Based on existing teaching reform experiences and leveraging established resources such as knowledge graphs, AI task engines, video materials, and question banks on the Fanya Learning Platform, this paper systematically explores an application framework for constructing computer science foundational courses that integrate knowledge graph and AI empowerment with ideological and political education. Through theoretical exploration, platform resource optimization, and teaching practice, it aims to facilitate the intelligent and ideologically informed transformation of course instruction, providing a reference for similar curriculum reforms.

2. Current Teaching Status and Existing Problems in Fundamental Computer Science Courses

2.1. Current Teaching Status

Currently, a certain foundation for reform has been established in the teaching of basic computer science courses. The teaching team focuses on the continuous optimization of course objectives, teaching content, and teaching methods, conducts research-based teaching practices, and gradually moves away from the traditional "teacher-centered" model towards a "student-centered" teaching philosophy. In terms of curriculum system construction, represented by software engineering, a complete curriculum system has been formed, encompassing discipline-specific foundations, professional foundations, professional core courses, and professional applications. Among them, professional foundation courses serve as the core connecting link, providing solid support for students' subsequent learning and development.

In terms of teaching resource development, the construction of subject knowledge maps, associative question banks, and video resources has been completed on the Fanya Learning Platform, with the integration of ideological and political elements into the curriculum, laying a solid foundation for the collaborative promotion of personalized teaching and ideological and political education. In terms of teaching mode, task-driven teaching has been gradually implemented, emphasizing the coordinated cultivation of knowledge, ability, and ideological and political literacy. The development of teaching mode presents an evolutionary feature from "emphasizing knowledge mastery" to "emphasizing both knowledge and ability", and then to "the trinity teaching goal of knowledge, ability, and ideological and political education", reflecting the continuous updating of educational concepts and the deepening of teaching reforms. At the same time, relying on the technical support of the Fanya Learning Platform, various online learning functions, intelligent teaching tools, and ideological and political resources have been normalized, providing strong guarantees for the digitalization and ideological and political transformation of curriculum teaching [1].

2.2. Existing Pain Points Issues

Despite the achievements made in current teaching reforms, a systematic investigation and analysis, combined with the application of existing knowledge maps and teaching resources, reveals the following prominent issues in the teaching of computer science fundamental courses, which hinder the realization of personalized teaching and further improvement of teaching quality:

Firstly, knowledge is presented in a fragmented manner, making it difficult for students to construct their knowledge systems. Most teaching resources exist in the form of isolated videos, documents, exercises, etc., lacking structured representations of the inherent logic and connections within subject knowledge. They fail to connect scattered knowledge points into a complete knowledge network [2]. This makes it difficult for students to grasp the inherent connections between knowledge points during the learning process, and they can only memorize individual knowledge points mechanically, unable to construct a systematic knowledge system. Consequently, this affects the cultivation of flexible application and transfer ability of knowledge.

Secondly, the phenomenon of "pseudo-personalization" is widespread, and personalized teaching becomes superficial. Most existing adaptive learning systems are based on simple associations between "knowledge points and questions", and they make linear recommendations (such as pushing similar questions) based on test scores, failing to deeply diagnose students' weak knowledge points, cognitive structures, and ability deficiencies. This kind of personalized recommendation only stays at the static level of result orientation, unable to adjust recommendation strategies according to students' real-time learning status, making it difficult to truly meet students' personalized learning needs.

Thirdly, the learning path planning lacks dynamism and guidance, leading to insufficient student motivation. Currently, learning paths are mostly chosen by students themselves or recommended by the system based on a single dimension, lacking a powerful "navigation engine" to dynamically adjust and actively guide based on students' real-time learning status (such as task completion, interactive behavior, learning time consumption, etc.) . This results in students easily losing direction during the learning process, having unclear learning goals, insufficient motivation for autonomous learning, and difficulty achieving efficient learning.

Fourthly, teachers bear a heavy burden, making it difficult to implement precise teaching interventions and ideological and political guidance. Basic computer science courses often have large class sizes, making it challenging for teachers to design personalized learning plans and provide precise ideological and political guidance for each student individually. A significant amount of energy is consumed on repetitive tasks such as unified teaching and homework correction, leaving insufficient time for precise personalized learning interventions, ideological and political conversations, and value guidance. It is difficult to balance students' individual differences and the cultivation of their ideological and political literacy [2].

3. Knowledge Graph and AI-Enabled Course Construction: Technical Foundation and Core Advantages

3.1. Technical Foundation

The knowledge graph and AI task engine established on the Fanya Learning Platform provide solid technical and resource support for the intelligent and ideological reform of computer science basic courses. The built-in knowledge graph of the platform, consisting of "entity-relationship-entity" triples, has achieved fine-grained decomposition of core concepts and skill points in computer science basic courses, clearly defining prerequisites, dependencies, and associations between knowledge points. At the same time, it integrates ideological and political nodes (such as national sentiment, craftsmanship spirit, scientific integrity, network security and the rule of law) to form a "knowledge + ideological and political" dual-dimensional structured "knowledge map", enabling synchronous visual presentation of knowledge impartation and value guidance [2].

The AI intelligent task engine of the Fanya Learning Platform, serving as a "teaching scheduling center", relies on technologies such as big data analysis and machine learning to collect real-time interaction data (such as learning duration, quiz accuracy, error types, repeated learning behaviors, and feedback on ideological and political views) from students on the platform's knowledge graph nodes (including ideological and political nodes). It precisely perceives and analyzes students' learning status and ideological and political literacy performance, thereby enabling the dynamic generation, allocation, and scheduling of learning tasks and ideological and political tasks [3]. The platform's established knowledge graph is deeply integrated with the AI task engine, enabling intelligent linkage among "knowledge structure, ideological and political elements, and teaching progress", providing a solid foundation for the collaborative promotion of personalized teaching and ideological and political education.

3.2. Core Advantages

Compared to traditional teaching models and the application of single technology, the integration of knowledge graph and AI in the construction of computer science foundational courses offers the following core advantages:

Firstly, it facilitates the structured presentation of knowledge, aiding students in constructing a systematic knowledge system. Knowledge graphs can break down the fragmented barriers of teaching resources, connecting and integrating scattered knowledge points to form a complete knowledge network. This enables students to clearly grasp the inherent logic between knowledge points, helping them transition from "fragmented learning" to "systematic learning" and enhancing their knowledge construction ability [1].

Secondly, it aims to achieve precise personalized teaching and tackle the challenge of "pseudo-personalization". By integrating knowledge graphs with AI task engines, it can deeply mine students' learning data, accurately depict their cognitive profiles, and quantify their mastery and ability levels of each knowledge point. Subsequently, it can push targeted learning tasks and resources, realizing personalized teaching that caters to the unique needs of each individual student [3].

Thirdly, it achieves dynamic optimization of learning paths and strengthens learning guidance. The AI task engine can dynamically adjust learning paths based on students' real-time learning status, push remedial resources for unmastered knowledge points, and push challenging tasks for already mastered knowledge points. It plays the role of an "AI tutor", actively guiding students to learn efficiently and enhancing their learning motivation and efficiency [1].

Fourthly, it aims to reduce teachers' burden and enhance the precision of teaching interventions. AI technology can automate repetitive tasks such as homework correction, learning data statistics, and personalized task delivery, freeing teachers from heavy administrative work. This allows them to focus on core tasks such as precise teaching interventions and teaching design optimization, thereby improving teaching quality [2].

Fifthly, we should build an integrated closed loop of "teaching, learning, and evaluation" to promote continuous optimization of teaching and ideological and political education. Knowledge graph + AI empowerment can achieve seamless connection between the learning process, evaluation feedback, path adjustment, and ideological and political guidance. By collecting students' learning data and ideological and political performance data in real time, we can dynamically evaluate the effectiveness of teaching and ideological and political education, and further optimize teaching content, teaching methods, task design, and ways of integrating ideological and political education, forming a continuous iterative teaching closed loop that integrates "knowledge impartation, ability cultivation, and value guidance" [3].

4. Knowledge Graph & AI-Enabled Construction of Basic Computer Major Courses: Application Paths and Specific Operation Methods-"Advanced Language Programming" as an Example

This curriculum reform is based on "Advanced Language Programming" and leverages the integrated platform of XueXiTong to host knowledge graphs, question banks, and task scheduling capabilities. It incorporates an AI-based intelligent recommendation mechanism, establishing cross-curricular knowledge connections between this course and fundamental computer science courses such as data structures, algorithm design, compilation techniques, computer organization principles, and digital logic. Relying on the cross-curricular knowledge network and comprehensive student learning behavior data, a dynamic cognitive profile is constructed. Combined with an AI-driven intelligent task engine, it precisely identifies students' weak spots in individual courses and cross-curricular knowledge. It automatically matches and recommends multi-modal resources such as micro-video lessons, tiered exercises, and practical case studies, achieving a personalized adaptive teaching model that "precisely fills gaps in individual courses and consolidates knowledge across curricula through tracing back to the source." The overall implementation is divided into four layers: the integrated construction layer of cross-curricular knowledge graphs, the modeling layer of dynamic cognitive profiles driven by AI, the construction layer of the embedded AI-based intelligent task engine within XueXiTong, and the layer of integrated teaching practice and reform effectiveness verification. Each layer is accompanied by standardized implementation procedures.

Level 1: Rely on XueXiTong to build a knowledge graph for integrating cross-disciplinary basic courses

Breaking through the knowledge boundaries of individual courses, with "Advanced Language Programming" as the core hub, we sort out the cross-related knowledge points between it and computer science basic courses such as data structures, algorithm design and analysis, compilation technology, operating systems, and digital logic. On the XueXiTong platform, we construct a dual-layer knowledge network consisting of an internal graph of a single course and an associative graph of multiple courses. We annotate logical relationships such as predecessor, successor, cross-application, and underlying support between courses, providing an underlying knowledge framework for AI to identify cross-course knowledge gaps and facilitate the linkage and promotion of cross-disciplinary resources.

Table 1 illustrates the correlations between selected fundamental computer courses and key knowledge points of high-level programming languages, along with recommended practical cases. Ideological and political elements can be integrated into these corresponding cases.

Table 1. Relevant Knowledge Points of Computer Majors and High-Level Language Programming

Course Name	Related Knowledge Points of Computer Major Courses	Associated Knowledge Points of Advanced Language Programming	Cases
Data Structure	Basic operations of sequentially stored linear lists	Storage of array elements	Access of one-dimensional array elements
	Definition and basic operations of singly linked list	Linked list	Linked list operations
	Static search	Application of one-dimensional array	Sequential search, Binary search
	Internal sorting	Application of one-dimensional array	Bubble sort
Algorithm Design and Analysis	Application of divide and conquer algorithm	Recursive function	Tower of Hanoi problem
	Greedy algorithm	Branch statements	Money change problem
	Backtracking algorithm	Nested loops	Find common elements
Compilation Technology	Design of lexical analyzer	Application of character array	Classify words by initial characters
	Recursive descent analysis method	Recursive function	Syntax analysis of arithmetic expression grammar

Level 2: Build an AI-driven dynamic student cognitive portrait model based on interaction data from XueXiTong

Relying on XueXiTong, we collect students' full-process learning interaction data, covering knowledge point learning duration, video playback, quiz accuracy, types of incorrect answers, repeated practice, and quality of practical training completion. We synchronously summarize data from "Advanced Language Programming" and related professional basic courses to build a unified learning data set.

Set multi-dimensional behavior weights, and AI normalizes and calculates the mastery degree of each knowledge point on a scale of 0-100, dividing it into four levels: unmastered, preliminary mastery, proficient mastery, and proficient expansion. Combined with the cross-course knowledge association network, AI can trace the deep-seated causes of incorrect answers, accurately identify the shortcomings in prior course knowledge, such as identifying weaknesses in one-dimensional arrays and static search when losing points in binary search.

Configure XueTong AI learning situation visualization dashboard: The teacher terminal can view the weak points of the class curriculum, synchronizing the distribution of corresponding gaps in pre-requisite basic course knowledge; the student terminal automatically generates cross-course diagnostic reports, clearly displaying individual subject loopholes and the missing links in associated pre-requisite knowledge, providing complete learning situation support for AI intelligent resource push.

Level 3: Build an AI-powered personalized task engine leveraging the XueXiTong platform

Utilizing the knowledge graph, cross-course associations, and AI cognitive portraits from XueXiTong as data sources, and relying on the platform's native tasks, learning paths, and conditional distribution functions, teachers can build an AI intelligent task engine that integrates path planning, dynamic scheduling, and cross-course multimodal resource push functions. By binding resources such as videos and question banks to the platform, AI can automatically identify weak knowledge points and push resources in a layered manner, linking this course with related foundational courses. This achieves single-point leak detection and cross-course traceability consolidation, eliminating the need for additional system development.

Specific Operations:

(1) Teachers complete the adaptation of AI engine with various modules of XueXiTong, connecting data from the graph, question bank, video, and task modules. All learning resources are uniformly deployed on the platform, and AI automatically distributes personalized tasks based on graph association and learning situation portrait.

(2) AI combines pre-class assessment profiles and knowledge constraints to generate differentiated initial paths. Weak students are prioritized to learn foundational resources first, while top students directly engage in comprehensive practice. Teachers can adjust the paths in the background.

(3) Set AI-triggered scheduling rules: When mastery is insufficient, lock advanced content and simultaneously push remedial resources for the current course along with supporting materials for the prerequisite basic course; when standards are met, unlock regular learning content; after mastery, push cross-course comprehensive practical training and extended exercises.

(4) AI automatically combines multimodal resources such as videos, exercises, and programming simulations, and synchronously pushes related course learning materials for cross-curriculum shortcomings, achieving cross-knowledge linkage and consolidation.

As shown in Figure 1, this is the display effect of the OOD task engine on the student client. Students are required to complete tasks in accordance with the level requirements configured in the system. If students fail to meet the task criteria, the AI will intelligently push relevant tutorial videos and practice exercises to them.

Figure 1. OOD task engine

Level 4: Teaching Practice and Effect Verification of Learning Link + AI Integrated Cross-curriculum Knowledge System

By integrating the cross-curricular knowledge graph, AI cognitive portrait, and platform AI intelligent task engine, we have established an integrated personalized teaching system tailored for computer science foundational courses. Taking "Advanced Language Programming" as a pilot project, we cover the entire process from pre-class preview, in-class precision teaching, to post-class layered reinforcement. Through parallel class control experiments, teacher and student surveys, and multi-dimensional comparison of grades, we verify the teaching effectiveness of the "knowledge graph + AI cross-curricular intelligent push" model, and iteratively refine the graph association relationships, AI portrait weights, and resource push rules.

In addition, the supporting guarantee of curriculum construction is to build a complete support system from three aspects: teacher training, resource update and data security. First, carry out special training on Digital Teaching in cross teaching and research section, organize teachers of multiple computer core courses to participate in the training, learn practical skills such as knowledge mapping, AI learning Kanban and intelligent task engine configuration, and strengthen teachers' digital precision teaching level. The second is to establish a regular update mechanism for cross course resources. Each semester, according to the training plan and the industry's new technology, we will iterate the knowledge map, teaching videos, and hierarchical question bank, optimize the matching logic of AI resources, and ensure that the curriculum knowledge system closely follows the industry's development. The third is to introduce the student learning data security management specification, control the whole process authority of learning situation and AI cognitive portrait data according to the platform rules, improve the teaching data archiving mechanism, delimit the teachers' access boundary, protect students' privacy in an all-round way, and prevent the risk of data leakage.

5. Conclusion

The intelligent and ideological and political education-oriented construction of computer science basic courses is an inevitable choice to adapt to the digital education strategy, engineering education professional certification requirements, and the fundamental task of cultivating students with moral integrity. Relying on the knowledge graph and AI technology already established on the Fanya Learning Platform, combined with the integration of ideological and political education into courses, it provides an effective path to address pain points such as fragmentation, pseudo-personalization, heavy teacher burden, and insufficient integration of ideological and political education in course teaching.

Based on existing teaching reform practices, as well as the basic resources already established on the Fanya Learning Platform, such as the knowledge graph, AI task engine, video resources, and question bank, this paper constructs an application path for the construction of computer science basic courses with knowledge graph + AI empowerment and collaborative ideological and political education in courses. By optimizing platform resources and engines, building a dual-dimensional student cognitive profile of "knowledge + ideological and political education", and promoting collaborative teaching practice of "knowledge + ideological and political education", a closed-loop operation of personalized teaching and ideological and political education is achieved. This can effectively enhance students' knowledge construction ability, autonomous learning ability, and ideological and political literacy, reduce teachers' burden, improve the quality of course teaching and the effectiveness of ideological and political education, and help cultivate high-quality computer science professionals with both moral integrity and professional competence.

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