

Research on the Construction of a Visual Teaching System for Basic Concepts of Operating Systems Based on Cognitive Graphs

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Abstract: Aiming at the problems of abstract concepts, fragmented knowledge systems, and insufficient teaching adaptability in operating system courses, this paper proposes a visual teaching system based on cognitive graphs. By constructing dynamic cognitive graphs, designing multimodal visual mapping methods, and optimizing personalized teaching paths, a closed-loop teaching logic of "cognitive graph construction-visual mapping-teaching path optimization" is formed. Research shows that this system can effectively improve students' systematic cognition and application ability of operating system knowledge, providing a practical path for the teaching reform of basic computer professional courses.

Keywords: Cognitive Graph; Operating System Teaching; Visual Teaching; Teaching Path Optimization; Teaching Model Innovation.

1. Introduction

As a core basic course for computer majors, the basic concepts of operating systems (such as process management, memory scheduling, and deadlock mechanisms) are highly abstract and dynamically correlated. Students often fall into cognitive dilemmas due to difficulties in constructing a complete knowledge system [1]. In traditional teaching, static charts and one-way lectures struggle to present the internal logic of knowledge, leading to excessive cognitive load and weak knowledge transfer ability among students [2]. Cognitive graph technology, which structurally represents knowledge nodes and relationships, enables visual association and dynamic deduction of concepts, providing a new idea to solve the above problems [3]. Based on the core logic chain of "cognitive graph construction-visual mapping-teaching path optimization", this paper systematically designs a visual teaching system for basic concepts of operating systems, aiming to provide theoretical and practical references for the teaching reform of computer professional courses.

2. Research Status at Home and Abroad

2.1. Research on the Application of Cognitive Graphs in Education

Foreign research on the integration of cognitive graphs and education started earlier. Stanford University applied cognitive graph technology to intelligent tutoring systems, realizing dynamic planning of learning paths by constructing discipline knowledge graphs. Its Knewton platform has been validated in many universities worldwide [4]. In the EU's "Horizon 2020" program, multiple projects analyzed students' cognitive structures through graphs to provide teaching decision support for teachers[5]. However, these studies mostly focus on general disciplines and lack pertinence to professional courses such as operating systems. Domestic research has developed rapidly in recent years. Tsinghua

University proposed an intelligent education model based on cognitive graphs to realize structured presentation and intelligent reasoning of knowledge[6]; some universities used cognitive graphs to analyze students' learning data to optimize the allocation of teaching resources[7]. Nevertheless, existing research still has deficiencies in the practical application of teaching scenarios, especially in solving problems such as difficulties in understanding abstract concepts in professional courses and fragmented knowledge systems, and no mature solutions have been formed[8].

2.2. Research on Teaching Basic Concepts of Operating Systems

Foreign research focuses on innovating teaching methods. The Massachusetts Institute of Technology (MIT) adopts project-based learning and virtual simulation technology to guide students to understand operating system principles through practice, but pays insufficient attention to the systematic visual presentation of concepts[9]; Germany's dual education model strengthens students' mastery of operating system knowledge through the integration of enterprise practice and theoretical teaching, but lacks effective means for sorting out knowledge relevance and constructing cognitive logic[10]. Domestic research mainly focuses on optimizing teaching content and improving teaching methods, such as hierarchical teaching methods designed according to students' basic differences [11], and integrating case teaching and micro-lectures into the teaching process [12]. However, current teaching still faces problems such as abstract and difficult concepts and fragmented knowledge systems. Existing visual exploration is mostly limited to static charts or simple animations, lacking in-depth excavation of the internal logic of knowledge[13].

2.3. Review of Research Status

Domestic and foreign research has achieved certain results in the educational application of cognitive graphs and operating system teaching, but there is still a gap in the in-depth application of cognitive graph technology in the visual

teaching of basic operating system concepts. Foreign research leads in technology application but lacks pertinence to professional courses, while domestic research explores teaching methods but fails to give full play to the technical advantages of cognitive graphs[14]. This study intends to systematically solve teaching problems by constructing a visual teaching system based on cognitive graphs, providing a new path for the reform of computer professional courses.

3. Research Ideas and Methods

This research closely follows the core logic chain of "cognitive graph construction-visual mapping-teaching path optimization" and advances through a combination of teaching theory research, method innovation, and practical verification. The specific ideas are as follows:

3.1. Focus on Teaching Needs and Construct Dynamic Cognitive Graphs

First, sort out the current status of operating system teaching through literature research, and identify teaching needs through questionnaires and teacher interviews; then organize experts to deconstruct knowledge of core modules such as process management and memory management, divide teaching units, and construct an initial cognitive graph framework. At the dynamic optimization level, a three-dimensional driving mechanism of "industry demand-teaching practice-student feedback" is established: track technological iterations such as microkernel architecture to update knowledge nodes, adjust the weight of knowledge association links according to classroom performance, and revise content based on student feedback to ensure the timeliness of the graph.

3.2. Follow Cognitive Laws and Innovate Visual Mapping Methods

Based on educational and psychological theories, design differentiated visualization strategies: adopt a time-series model combining timelines and flowcharts for dynamic processes such as process state transitions, and use spatial visual mapping paradigms for static relationships such as virtual memory mapping. Integrate multimodal resources such as graphics, text, and cases, for example, analogy of traffic jams to deadlock processes, supplemented by animations and text explanations. Establish a visual effect evaluation system, and optimize mapping strategies through comparative teaching experiments.

3.3. Optimize Teaching Path Generation Based on Graph Associations

Combine Bloom's taxonomy of educational objectives to design a stepped learning chain from basic concepts to comprehensive applications; construct student portraits by analyzing information such as students' entrance scores and formulate personalized paths. Establish a closed-loop feedback mechanism of "learning monitoring-effect evaluation-path adjustment": collect learning data in real-time to evaluate effects, adjust paths in a timely manner when problems are found, and optimize generation strategies in combination with teacher discussions.

4. Research Content

4.1. Ontology Modeling and Dynamic Optimization of Operating System

Cognitive Graphs for Teaching Establish a knowledge association network covering core modules such as process management and file systems, define semantic relationships and hierarchical structures between concepts; focus on researching the dynamic adaptability of graphs to teaching scenarios to realize continuous optimization of knowledge topology.

4.2. Multimodal Visual Mapping Methods for System Concepts Based on Cognitive Laws

Construct interactive time-series behavior models for dynamic processes such as process state transitions and resource scheduling algorithms; study spatial visual mapping paradigms for static relationships such as virtual memory mapping and file system structures to form a visual expression system adapted to different cognitive laws.

4.3. Adaptive Learning Path Generation Technology Oriented to Knowledge Integration

Based on the topological correlation of cognitive graphs, construct a systematic learning chain from basic concepts to composite mechanisms; explore the logic of personalized path generation for individual cognitive differences, and strengthen causal connections between knowledge points and targeted reinforcement of weak links.

5. Innovation Points

1.Knowledge topology optimization mechanism driven by teaching behavior: dynamically reshape the concept network based on real-time classroom feedback (such as high-frequency incorrect concept associations), breaking the limitations of traditional static knowledge representation.2. Collaborative model of "systematic main line + personalized branch line": realize a smooth transition from basic concepts to comprehensive applications and targeted reinforcement. 3.Multidimensional ability evaluation framework: cover the completeness of concept networks, the depth of mechanism understanding, and the ability to solve faults, surpassing traditional score-based evaluation.

6. Conclusion and Outlook

This research is expected to solve problems such as abstract concepts and fragmented knowledge in current teaching by constructing a visual teaching system for basic operating system concepts based on cognitive graphs, providing theoretical and practical support for the teaching reform of computer professional courses. The innovations of the research lie in dynamic graph optimization, personalized path design, and multidimensional evaluation, which can effectively improve students' systematic thinking and application abilities. Future research can further explore the integration of cognitive graphs with virtual reality technology, such as simulating the operation of operating system kernels through VR to create an immersive learning environment; at the same time, expand the scope of teaching practice to verify the applicability of the system in other computer professional courses.

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