



Exploration of Blended Teaching Reform for the "Network Service Configuration and Management" Course Based on Knowledge Graph

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Abstract. Aiming at addressing issues such as the fragmentation of cross-platform cognition and the disconnection between theory and practice in the traditional teaching of the Network Service Configuration and Management course, this paper proposes a blended teaching reform scheme based on a knowledge graph. This scheme integrates the scattered knowledge points of service configuration into a knowledge graph by constructing a course knowledge graph that combines the Windows and Linux operating systems, thereby systematically presents the course knowledge framework. In teaching implementation, the knowledge graph is utilized to provide personalized path navigation for online fragmented learning, serve as a "visual blueprint" for offline experiments and comprehensive projects, and provide dynamic learning data to support the core formative assessment process. Teaching practice demonstrates that this model effectively guides students in achieving a cognitive transition from "point-based" memorization to "network-based" construction, significantly enhancing their ability to integrate and apply knowledge in complex engineering scenarios. It offers a valuable reference for the digital teaching reform of similar practical courses.

Keywords: Knowledge Graph; Blended Teaching; Network Service Configuration; Fragmented Learning; Teaching Reform.

1 Introduction

With the rapid development of mobile internet technology, micro-content forms represented by short videos, audio courses, and knowledge cards are increasingly favored by learners. The fragmented learning model thereby fostered allows learners to utilize scattered time to acquire concise knowledge units through smart terminals. This model, characterized by lightweight content and short learning cycles, lowers the psychological threshold for learning and makes it easier to maintain motivation and a sense of immediate achievement^[1]. However, its inherent defects are also significant: fragmented knowledge is often isolated and decontextualized. Due to the lack of logical connection to the overall knowledge structure and systematic practical feedback, it

leads to low knowledge retention, weak transferability, and difficulty in applying it to solve complex real-world problems [2].

To fully leverage the advantages of fragmented learning while effectively overcoming its inherent shortcomings, the knowledge graph, with its powerful semantic reasoning and structured representation capabilities, provides an ideal pathway for constructing a systematic knowledge system [3]. In recent years, application research of knowledge graphs in the education field has been heating up. The growth trend of related research literature in the China National Knowledge Infrastructure (CNKI) database is shown in Figure 1. This trend indicates that knowledge graphs have attracted widespread attention from educational researchers and practitioners, and their value in optimizing knowledge structures and enhancing cognitive efficiency has been preliminarily verified [6].

This paper integrates the knowledge graph with the concept of fragmented learning, taking the "Network Service Configuration and Management" course as an example, and proposes a blended teaching scheme based on a knowledge graph. The scheme aims to deconstruct course content into refined micro-resources by drawing on the fragmented learning concept; and relying on knowledge graph technology, to construct a global logical framework for them, thereby guiding learners to start from scattered knowledge points, gradually build a systematic cognitive picture, stimulate interest in in-depth exploration, and ultimately achieve deep construction from "information points" to "knowledge bodies". Through this practice, we hope to provide a feasible solution for problems such as insufficient knowledge system construction and poor integration of theory and practice in traditional teaching, and contribute a practical case with reference value for promoting the digital transformation of higher education [4].

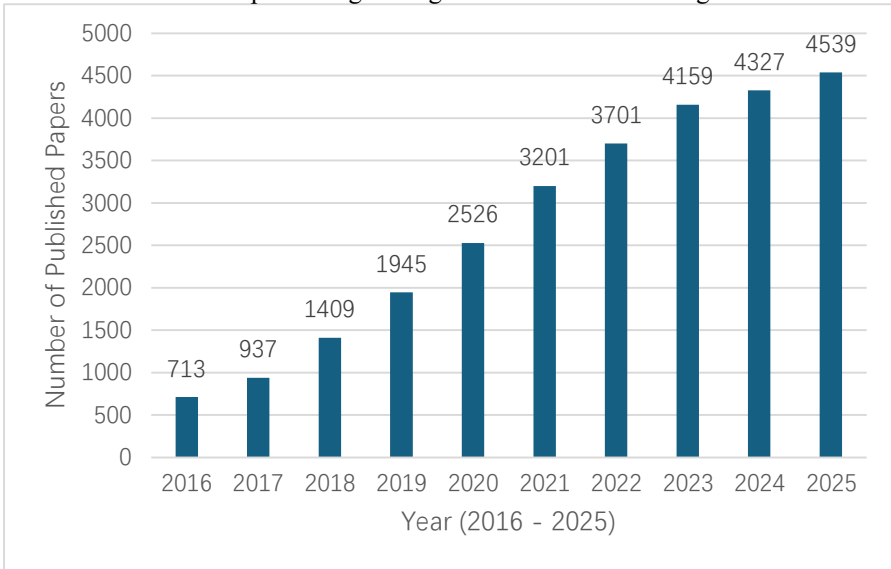


Fig. 1. Search results for related papers on knowledge graphs in CNKI over the past 10 years.

2 The Importance of Introducing Knowledge Graphs into the Course

2.1 Building a Unified Understanding of Cross-platform service Architecture

This course delivers instruction on network services across both Windows and Linux platforms in parallel, covering services such as DHCP, DNS, WEB, FTP, VPN, and email services, among others [5]. The traditional chapter-by-chapter, platform-separated teaching model tends to lead students to perceive network services that perform the same functions across different operating systems as isolated knowledge points, making it difficult to develop a cross-platform, unified understanding of network service architecture. The introduction of a knowledge graph can effectively address this cognitive fragmentation. By treating core knowledge points from the course syllabus—such as "DNS resolution principles"—as nodes and establishing semantic relationships among them, a visualized, cross-platform knowledge system can be constructed. For example, a knowledge graph for a comprehensive "enterprise portal website" can illustrate how the website simultaneously relies on the Apache service node on Linux and the DNS service which could be hosted on either Windows or Linux, with its access security constrained by firewall policies on both Linux and Windows systems. Through its intuitive presentation, the knowledge graph actively guides students to understand the roles and interactions of different services within the overall network ecosystem. It integrates the "knowledge fragments" scattered across chapters in the syllabus into an organic cognitive network, thereby laying a solid cognitive foundation for achieving the ultimate course objective of comprehensively applying services based on both Windows and Linux systems.

2.2 Precise Navigation of Learning Paths in Blended Teaching

This course adopts a blended online-offline teaching model based on a knowledge graph, as illustrated in Figure 2. The course assessment emphasizes process-oriented evaluation. Students inevitably have varying levels of mastery over knowledge points during lab operations and online learning. The knowledge graph can serve as a dynamic "learning navigator," supporting students in conducting adaptive learning.

As can be seen from Figure 2, during the online learning phase, students can autonomously select learning paths within the graph according to their own situations. For example, a student weak in Windows routing services can backtrack along the relationship lines in the graph to its prerequisite knowledge, "Routing and Packet Forwarding Principles." A student with a strong interest in Linux email services can delve deeper into knowledge nodes related to advanced configuration and security settings for Sendmail and Dovecot. In the offline lab sessions, such as the comprehensive experiment "Configuration and Management of WEB and FTP Servers on Linux," students can clarify the multiple theoretical knowledge points on which the experimental steps depend through the knowledge graph, avoiding "blind configuration." This process not only aligns with the reform concept of blended teaching but also generates learning

path data that enables teachers to gain precise insights into class learning conditions, implement differentiated tutoring, thereby effectively supporting process-oriented assessment links like "classroom experiments" and "classroom tests," and enhancing teaching efficiency.

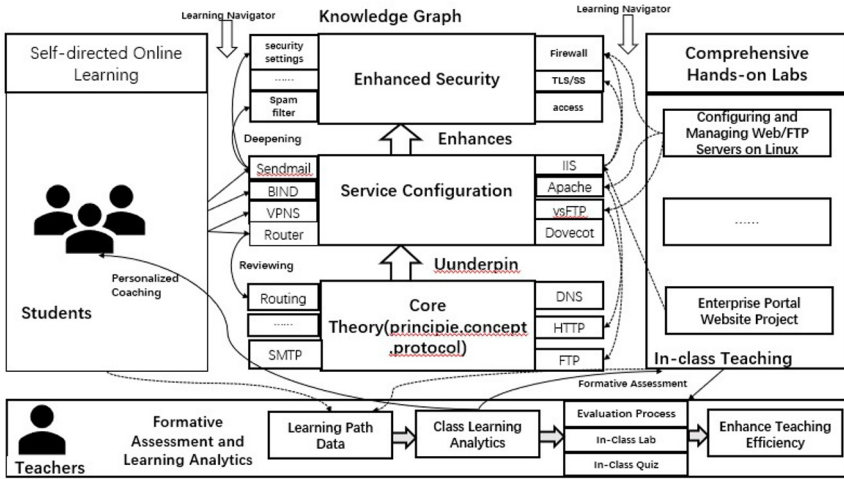


Fig. 2. Structure of the knowledge graph-based blended teaching model.

2.3 Enhancing the Ability to Solve Complex Engineering Problems

The final stage of the course requires students to complete comprehensive network application service configurations in a cross-platform environment, which is the ultimate test of students' knowledge application ability. When students have only mastered scattered configuration commands through fragmented learning, they often find themselves at a loss when facing such complex scenarios.

The knowledge graph plays a key role as the "project blueprint" here. Teachers can directly map the final "Comprehensive Network Application Service Configuration" project onto a complex subgraph of the knowledge graph. When designing and troubleshooting the project, students can follow the logical guidance of the graph to systematically analyze dependencies between services, rather than relying on blind trial-and-error based on experience. For example, when troubleshooting the compound fault "Linux Web service cannot be accessed via Windows client domain name," students can systematically check the entire chain from Windows DNS configuration to Linux Apache service status, to network routing and firewall policies, based on the course knowledge graph. This process greatly trains students' engineering thinking and systematic troubleshooting abilities, ensuring they deeply integrate and flexibly transfer the dispersed skills learned in the course—"principles, configuration, and operation and maintenance"—to solve real, complex problems in future professional scenarios. This ultimately effectively supports the course's graduation requirement to "analyze, explain, and summarize experimental results, and derive reasonable and valid conclusions through information synthesis."

3 Knowledge Graph-Based Course Teaching Strategies

3.1 Systematic Design of Course Content

Based on the significant value of knowledge graphs in integrating knowledge fragments, and to achieve the course teaching objectives of "understanding and mastering various network services based on Windows and Linux systems" and ultimately achieving "comprehensive application," this course abandons traditional linear content arrangement and integrates knowledge graph thinking throughout the teaching process. Core concepts such as "DNS Resolution Principles," "VPN Tunnel Protocols," "DHCP Allocation Mechanisms," etc., as well as service configurations such as "Windows IIS Site Deployment," "Linux Apache Virtual Host Configuration," etc., are all designed as knowledge nodes, connected according to their inherent logical relationships such as "dependency," "collaboration," and "protection."

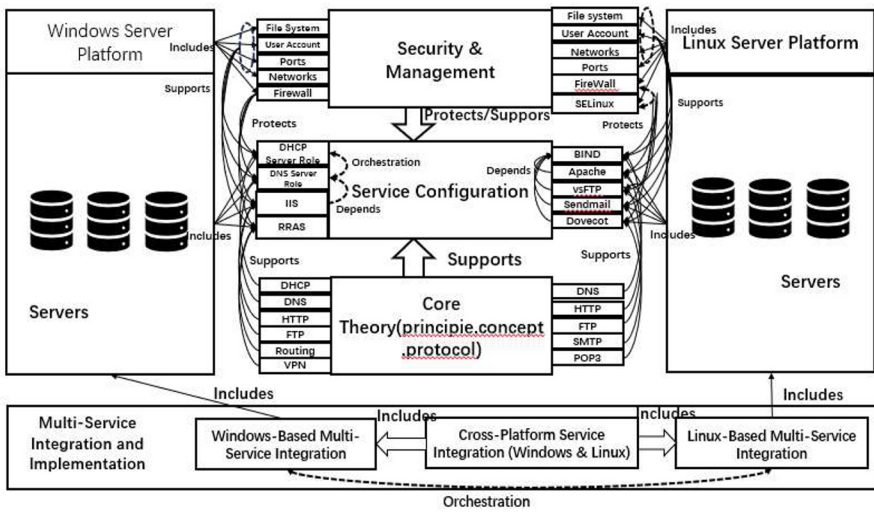


Fig. 3. Course knowledge graph overview

A global overview of the knowledge graph covering the two major operating systems and seven service types is presented to students in the very first class, as shown in Figure 3. Through this diagram, students can establish an intuitive overall architectural understanding of the network service ecosystem and comprehend the cross-platform comprehensive service capabilities the course ultimately aims to achieve. During the teaching process, the graph dynamically grows and expands as chapters progress. For example, after completing the teaching of DNS on the Windows platform, introducing the BIND service on the Linux platform, the graph links both to the core parent node "DNS Resolution Principles" through a "supports" relationship, effectively resolving the cognitive disconnection in dual-platform learning and integrating fragmented platform-specific knowledge into a unified technical framework. This "growing" graph structure not only clearly reveals the progressive path from basic networking technologies to complex service comprehensive application but also guides students to complete

the cognitive transition from isolated "point-based" memorization to systematic "network-based" understanding, laying a solid foundation for achieving the teaching goal of comprehensive application of various network services.

3.2 Classroom Interaction Strategies for Blended and Fragmented Learning

Aiming at the "blended online-offline teaching" mode of this course, the knowledge graph becomes the core hub connecting systematic teaching and fragmented learning [7], promoting the transformation of classroom teaching from "knowledge impartation" to "knowledge generation."

In offline classrooms, teachers use key nodes in the graph, such as "Web Service Configuration," as anchors to design guided questions and thematic discussions. For example, by posing the question, "What associated nodes and their security policies need to be considered in the graph when configuring a Web server accessible externally?" students are guided to actively explore the complex relationships between nodes like "Apache Service," "Firewall and SELinux," "DNS Resolution," and "VPN Access." The process of students adding/deleting connections and annotating layers on the graph is precisely the process of their active knowledge construction and deepening understanding.

In the online learning segment based on the fragmented learning concept, the knowledge graph provides precise navigation for students' independent learning. The course creates micro-videos, configuration command cards, and other fragmented resources for core knowledge points, directly associating them with graph nodes. Students can quickly locate corresponding nodes in the graph based on weak points exposed in classroom tests or lab operations, using scattered time for targeted learning and reinforcement. This "following the map to seek the horse" model transforms disorderly fragmented learning into goal-oriented systematic cognitive reinforcement [8], perfectly aligning with the requirements for students' autonomous learning ability in blended teaching and directly supporting process-oriented assessment links such as "classroom tests" and "lab reports."

3.3 Knowledge Graph-driven Precise Tutoring for Experimental Projects

This course includes numerous verifying and comprehensive experiments, and a final comprehensive project. The knowledge graph plays a key role as the "project navigation and troubleshooting sandbox" in this phase. In tiered experiments, the graph helps students clarify the multiple theoretical nodes involved in each experimental task. For example, when conducting the "Email Services" experiment, students can use the graph shown in Figure 3 to clearly visualize the relationships among nodes such as "DNS," "Sendmail," "Dovecot," and user accounts. This enables them to consider the entire system holistically during design, avoiding isolated configurations. In the comprehensive project of this course, students need to complete cross-platform service integration. The knowledge graph serves as the "blueprint" for project implementation, allowing

students to conduct plan simulations before hands-on work, systematically reviewing dependencies and potential conflicts between services. When faults occur in the project, students can perform systematic troubleshooting based on the logical paths in the graph, rather than blind trial-and-error. Teachers can accurately identify students' knowledge weaknesses and thinking misconceptions by observing their access and editing records on the graph, enabling tiered tutoring and personalized Q&A, thereby effectively supporting the achievement of related course graduation requirements.

3.4 Process-oriented Learning Evaluation and Feedback

The effectiveness of teaching strategies requires validation through a scientific learning evaluation system. The knowledge graph provides multidimensional dynamic evaluation criteria for the process-oriented assessment in this course. The system automatically records students' learning trajectories, including the frequency of accessing various knowledge nodes, dwell time, completion rates, mastery levels, and transition paths between nodes. By analyzing these data, teachers can trace students' cognitive pathways, identify common cognitive blind spots within the class, and pinpoint individual learning difficulties. For instance, if a student's mastery level of the working principles of email services is 15%, teachers can implement precise interventions and guidance based on this insight^[8]. This data-driven evaluation mechanism transforms teaching feedback from static score-based judgments into dynamic formative guidance, ultimately fostering the continuous optimization of teaching effectiveness and the comprehensive enhancement of students' systematic engineering thinking abilities.

4 Conclusion

Implementing blended teaching reform based on a knowledge graph in the "Network Service Configuration and Management" course is a forward-looking and practical exploration. By constructing a cross-Windows and Linux knowledge system, this study effectively addresses the pain points of knowledge fragmentation and platform cognitive disconnection in the course, integrating isolated service configuration knowledge points into an organically linked cognitive network. Teaching practice shows that the knowledge graph demonstrates significant advantages in guiding students to achieve the cognitive transition from "point-based" learning to "network-based" construction, empowering personalized and fragmented learning path planning, and enhancing comprehensive project practice and troubleshooting capabilities.

Looking ahead, we will continue to iterate and improve the course knowledge graph, further exploring its deep integration with learning behavior data to achieve more precise learning condition diagnosis and adaptive learning recommendations. We believe this reform path not only injects new vitality into the "Network Service Configuration and Management" course but also provides a valuable reference paradigm for similar highly practical information technology courses undergoing digital transformation and

upgrading on how to systematically cultivate students' engineering thinking and comprehensive practical abilities, offering insights for the reform and innovation of similar courses.

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