Exploration of Online and Offline Hybrid Enhanced Deep Teaching Guided by Project and Knowledge Graph

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Abstract. Cultivating the college students'ability of high-level thinking and solving complex problems are inseparable from in-depth teaching, and the online and offline integrated teaching method based on online teaching platforms can help achieve in-depth teaching. This paper takes the teaching of the database system course as an example. In view of the characteristics of this course, which has the characteristics of abstract concepts, many knowledge points, and strong practicality, in order to help students form a chain knowledge structure and build the overall knowledge system of the course, this paper relies on engineering project oriented teaching to construct a database system knowledge graph, and proposes an online and offline hybrid enhanced deep teaching model guided by projects and knowledge graphs. The teaching model is elaborated from three dimensions: pre class teaching planning, in class teaching implementation, and post class teaching consolidation.

Keywords: Online and Offline Hybrid Enhancement Deep teaching, Project Guidance; Knowledge Graph, Database System.

1 Introduction

In recent years, the Chinese Ministry of Education has paid great attention to the quality of higher education teaching, proposing that the curriculum content, teaching implementation process, and assessment criteria should have the characteristics of high-levelness, innovativeness and challenge. The construction of courses with "two natures and one degree" is inseparable from in-depth teaching and deep learning. The research on key technologies such as big data, deep learning and knowledge graphs is one of the main contents of the basic scientific research in education facing the era of intelligent education [1]. Deep learning is conducive to cultivating learners' high-order thinking abilities such as critical thinking, knowledge innovation and problem-solving[2]. The occurrence of students' deep learning depends on teachers' in-depth teaching. Deep teaching focuses on the profound exploration of the learning process and pursues the development of teaching. The National Natural Science Foundation of China has listed "Construction and Navigation Learning of Educational Knowledge Graphs" as an important research content. Therefore, based on the in-depth teaching theory, using knowledge graphs to construct curriculum resources and exploring the

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online-offline hybrid enhanced in-depth teaching model have important theoretical significance and practical application value for the current development of education informatization.

The "Database System" course is a main basic course in computer science and software engineering majors that combines theory and application. In order to achieve the goal of high-level, innovative, and challenging database system course construction, the teaching of the Database System course, whether it is offline or online, requires further in - depth research, exploration, and practice [3]. Taking the teaching of the "Database System" course as the research object, based on an in - depth investigation and analysis of the current learning situation of students, this paper proposes an online - offline hybrid enhanced deep teaching mode guided by projects and knowledge graphs. It constructs the implementation process of online-offline hybrid enhanced in-depth teaching driven by projects, expounds the construction ideas of the knowledge graph of the "Database System" course, and the teaching results show the feasibility and effectiveness of the proposed model and implementation method.

2 Project - and - Knowledge - Graph - Guided Hybrid Enhanced Deep Teaching Mode

Deep learning enables students to engage in active, inquiry - based, and comprehension - based learning in realistic and contextualized scenarios. It cultivates students' high - order thinking, active knowledge construction, and problem - solving abilities for knowledge transfer and application. Based on actual engineering project tasks, project - guided teaching focuses on situational, problem-based, interactive, and diverse learning outcomes for students. Project - guide teaching highly conforms to the occurrence conditions of deep learning and can serve as an effective form to support deep learning. Inspired by references [4][5][6][7], based on the deep learning route [8] and the "3P" (Prediction - Process - Outcome) model [9], and combined with the relationship between knowledge graph theory and project - guided teaching, this paper proposes the online - offline hybrid enhanced deep teaching mode guided by projects and knowledge graphs as shown in Figure 1.This teaching mode consists of three basic links: pre - class teaching planning, in - class teaching implementation, and post - class teaching consolidation. Teachers reorganize teaching content around actual engineering projects, construct a curriculum knowledge graph, and use a visual form to excavate, analyze, and display the curriculum knowledge structure and the relationships between knowledge entities. They decompose and assign high - order thinking and challenging project - based learning tasks. Students, centered around learning tasks, understand the ideas, mechanisms, purposes, and significance contained in the knowledge through learning activities such as experience, practice, inquiry, criticism, and reflection, and transfer and transform knowledge and methods using the learned knowledge. Through online and offline interactions between teachers and students and among students, teachers enhance their sense of teaching accomplishment, and students enhance their sense of learning meaning and accomplishment.

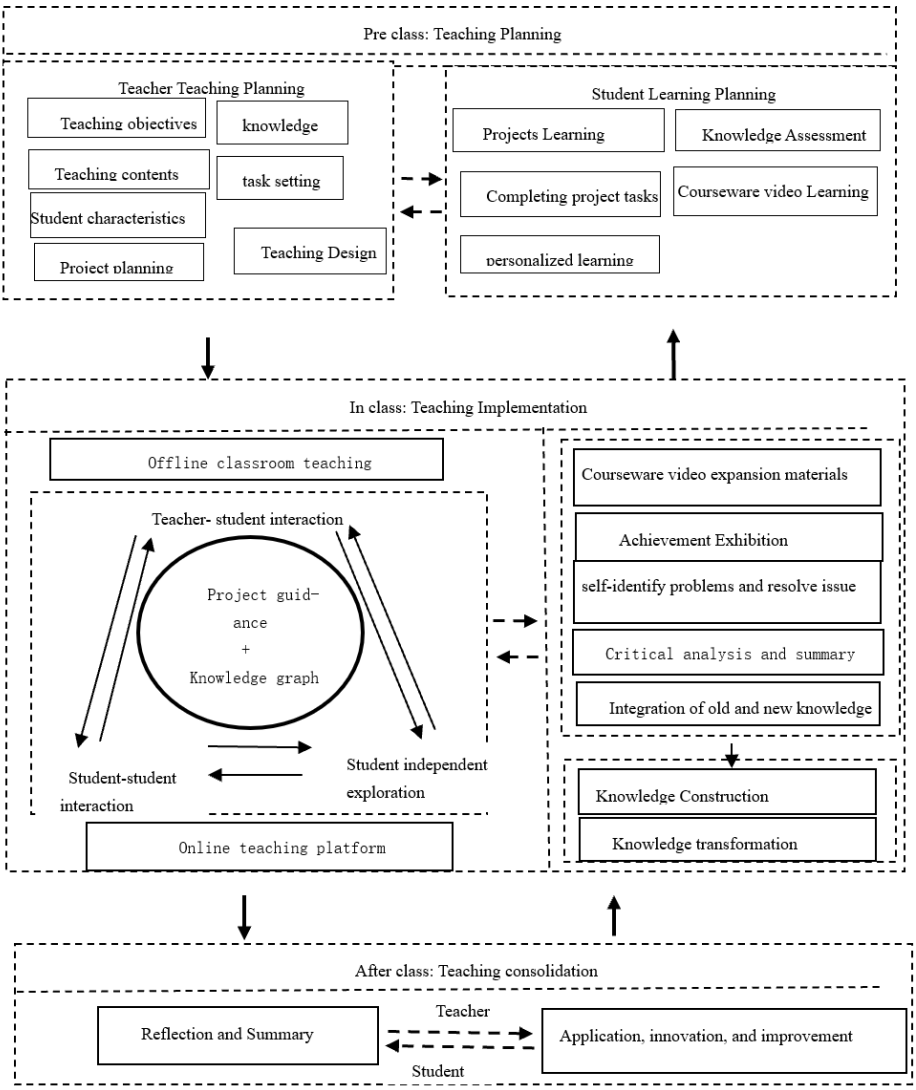

Fig. 1. Project and Knowledge Graph Guided Online and Offline Hybrid Enhanced Deep Teaching Model

2.1 Project-Driven Pre-Class Teaching Planning Based on Core Knowledge

By integrating student characteristics and introducing real-world engineering database system projects, this paper constructs a curriculum content framework in the sequence of prior knowledge, new knowledge, and transformative application. The overall teaching model employs project guidance, while core knowledge points are embedded with knowledge graphs to conduct scenario-based explanations and implement step-

by-step spiral teaching activities, reflecting the educational philosophy of "learn-think-act-create."

(1)Knowledge Point Organization. The database system course features abstract concepts, strong theoretical and practical components, and fragmented knowledge points that make it difficult for students to grasp key concepts and build their own "knowledge graphs." To address this, this paper links related core knowledge points by integrating fundamental disciplinary knowledge with application scenarios, interspersed with core theories and technical points from real database systems. To leverage project-driven deep learning, pre-class project tasks are designed to introduce 1-2 challenging/hot topic questions through online platforms. Students complete database operations, designs, and applications under project guidance using foundational principles and practical skills.

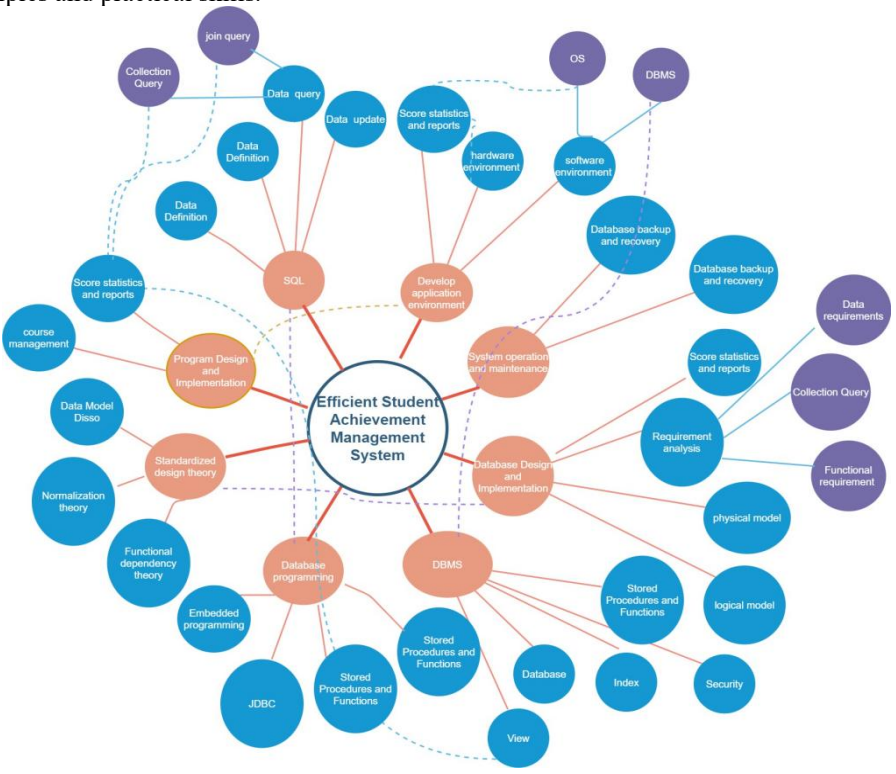

Fig. 2. Knowledge Graph of Course Knowledge Points Related to the "Student Achievement Management System" Project and Database System

(2)Teaching Project Design. As facilitators of deep learning, instructors develop an actual database system project that runs through the entire teaching process and multiple projects for students to practice hands-on based on teaching objectives, student abilitie.For each subtask, teaching cases are designed with knowledge graphs to guide students in constructing knowledge chains. For example,the "Student course selection management system" serves as the core project for deep teaching, while

"University Library Management System" and "Dormitory Management System" provide practical projects that students can easily relate to, enhancing engagement and interest.

(3) Structuring & Visualizing Core Knowledge.Knowledge graphs offer intuitive visualization of explicit and implicit knowledge in structured formats. This paper integrates curriculum knowledge points with project knowledge through knowledge graphs, demonstrating connections between teaching projects and course content to guide instructional design. As shown in Fig.2, the "Student Performance Management System" decomposes theoretical knowledge into core modules, each supported by micro-lectures that maintain course integrity while providing focused explanations, resulting in a structured curriculum knowledge system.

2.2 Online-Offline and In-Class Teaching Implementation Guided by Projects & Knowledge Graphs

Drawing on software lifecycle principles, this paper emphasizes the transition from static to dynamic teaching spaces through the full lifecycle perspective of database systems. A blended enhanced deep teaching model is implemented, it carries out online and offline hybrid enhanced deep teaching through teacher-student interaction, student student interaction, and independent exploration. Online content integrates project-guided teaching resources and media, where instructors use video lectures, knowledge graphs, and task assignments to facilitate pre-class preview, application, and independent completion of learning tasks. Offline sessions adopt a dual-centered teaching model with instructor guidance and student-centered activities, focusing on addressing pre-class questions, knowledge gaps, and task challenges through interactive discussions and project demonstrations. Knowledge internalization and construction are achieved through collaborative exploration and analytical summarization, enhancing students' ability to apply theoretical knowledge to real-world problems.

(1) Guiding Problem Identification & Resolution

To cultivate students' complex problem-solving, higher-order thinking, and innovative capabilities, the Student course selection management system" project is decomposed into six sub-projects aligned with course objectives: Database Integrity, Database Security, Database Programming, Conceptual Design, Logical & Physical Design, and Concurrency Control. Each sub-project is further broken into tasks. For example, the "Database Integrity" module integrates "Query & Update" operations in the student system, where students observe data manipulation processes and analyze questions like "Why ensure integrity?" and "What factors compromise integrity?" Interactive classroom discussions deepen understanding of integrity types and constraint violation handling.

(2) Driving Knowledge Construction & Transformation

By immersing students in authentic project scenarios, structured tasks are designed to promote knowledge integration. Students work in collaborative teams to complete incremental agile tasks, reinforcing existing knowledge while acquiring new concepts and establishing cross-domain connections. For instance, operations like adding/modifying/deleting course selection data involve core concepts such as "correlat-

ed queries," "cascading updates," "transactions," and "concurrency control." The multi-faceted nature of these problems requires students to analyze from multiple perspectives, engage in self-directed inquiry, and practice reflective criticism. Through peer-instructor interactions and independent exploration, students construct new knowledge while enhancing practical skills. Post-class reflections and knowledge transfer exercises encourage application of newly acquired frameworks to novel scenarios. Concurrently, instructors evaluate teaching effectiveness and student performance, adjusting strategies and implementations based on real-time feedback.

2.3 Construction of Project-Driven Knowledge Graph for Database Systems Course

Traditional offline teaching and online platforms often suffer from fragmented knowledge presentation, failing to build systematic knowledge frameworks for students. Moreover, the lack of complementary integration between online and offline learning leads to perceptions of abstract and complex content. The root cause lies in weak curriculum goal orientation. This paper introduces a closed-loop "Course-Project-Course" knowledge graph design that breaks traditional linear knowledge structures, transforming fragmented points into interconnected networks through horizontal and vertical knowledge associations. This seamless integration supports systematic and project-based learning. This paper extracts knowledge points from real database projects and constructs integrated knowledge graphs (Fig.2.). Each knowledge graph consists of global frameworks and detailed local modules.

3 Evaluation of Blended Enhanced Deep Teaching Guided by Projects & Knowledge Graphs

Implementation of the proposed model has significantly transformed classroom dynamics, replacing passive listening with active engagement. Assessment now centers on project-based assignments, encouraging innovative problem-solving and personalized knowledge graph construction. Random in-class evaluations using real projects stimulate interactive discussions, enhancing student motivation, inquiry skills, and teamwork. Students take the initiative to make videos or PPTs of the phased "achievements" during the project completion process and share them in learning groups, platforms, or in the classroom for display. These not only enliven the atmosphere of classroom teaching exploration, but also enable teachers to analyze whether the teaching content is appropriate and meets teaching expectations through this evaluation method, thereby achieving continuous improvement of course teaching in the closed loop of teaching and learning.

4 Conclusion

The blended enhanced deep teaching model guided by projects and knowledge graphs can enable students to achieve the teaching effect of deep learning within limited teaching hours while meeting the "Three-Quality" gold standard (high-order thinking, innovation, challenge). The interactive project-driven approach cultivates complex problem-solving and advanced cognitive skills, enabling students to master theories and skills naturally. Personalized knowledge graph construction during knowledge integration and transformation enhances systematic thinking, reinforces competency development, and ignites curiosity and innovation.

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Disclosure of Interests

The authors have no competing interests to declare that are relevant to the content of this article.

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