

Construction and Implementation of Knowledge Graph-Based Blended Learning Model

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Abstract: This study investigates the use of knowledge graphs in blended learning, aiming to address the challenges such as fragmented self-study and lack of comprehensive understanding. Knowledge graphs help by visually representing complex knowledge structures and providing personalized learning paths tailored to individual student needs. The implementation of this approach includes several key steps: preparing multimedia resources to support diverse learning styles, guiding students in their pre-class preparation to ensure they are well-equipped for in-class activities, enhancing the in-class learning experience through interactive and engaging activities, and supporting post-class consolidation to reinforce and deepen the knowledge acquired. By integrating knowledge graphs throughout these stages, the study aims to create a more structured and coherent learning environment that can significantly improve overall learning outcomes and student engagement. The expected benefits include better organization of study materials, increased student motivation, and a more personalized and adaptive learning experience. This approach not only facilitates a deeper understanding of the subject matter but also encourages active participation and continuous learning, ultimately leading to enhanced academic performance and satisfaction.

1. Introduction to Blended Learning

Blended learning, also known as hybrid learning, is an educational approach that combines traditional face-to-face classroom methods with online educational materials and interactive online activities. This method aims to leverage the advantages of both in person and online learning environments to enhance the overall educational experience [8]. Castro [4] emphasized that it is not merely a combination of traditional and online learning resources but an integrated approach designed to maximize educational outcomes. Blended learning has gained significant traction in educational research and practice globally [3].

The implementation of blended learning has seen substantial growth, especially in higher education. Institutions worldwide, including top universities, have adopted blended learning models to improve teaching and learning processes. For instance, studies have shown that blended learning can lead to higher student engagement and improved learning outcomes compared to traditional methods [7]. Many universities have integrated blended learning into their curricula, utilizing online

platforms and digital resources to enhance classroom teaching [17]. Despite these advancements, there are still several challenges in the effective implementation of blended learning.

2. Challenges with Blended Learning

Several issues persist in the adoption of blended learning. One major challenge is that students often focus on individual knowledge units during self-study, lacking a comprehensive understanding of the overall knowledge structure and internal logical relationships, which hinders the formation of a systematic knowledge framework [18]. Additionally, individual differences among students make it difficult to control the quality of self-directed learning, negatively impacting overall teaching effectiveness [8].

Furthermore, the vast amount of online learning resources can be overwhelming, and there is a lack of effective, guided learning paths to meet the personalized needs of students [13]. Students may struggle to identify the most relevant and high-quality resources, leading to inefficiencies in their learning process. This issue is exacerbated by the diverse technological proficiency levels among students, which can affect their ability to effectively navigate and utilize online resources [2].

Addressing these challenges requires innovative teaching models and technological integration. One promising approach is the use of knowledge graphs, which can help students build a clear and comprehensive map of disciplinary knowledge. Knowledge graphs provide a visual and interactive representation of knowledge domains, showing the relationships between different concepts and how they fit into a broader context [6]. By integrating knowledge graphs into blended learning environments, educators can offer students a more structured and guided learning experience.

3. Introduction to knowledge Graphs and Unique Advantages

3.1. Definition and Concept of Knowledge Graphs

Knowledge graphs are structured representations of knowledge that use nodes to represent entities and edges to represent relationships between them. They offer a way to visualize and organize complex information, making it more accessible and understandable [10]. Initially developed by Google to enhance search engine capabilities, knowledge graphs are now applied across various domains, including education [6].

Knowledge extraction, knowledge fusion, and knowledge representation are key elements of knowledge graph. Knowledge extraction entails gathering useful information from texts and other data sources; knowledge fusion integrates knowledge from different sources; and knowledge representation displays the knowledge in a graphical format [14].

Constructing the knowledge graph involves defining and categorizing knowledge points, determining and representing relationships between these points, and drawing and optimizing the knowledge graph [16]. The construction of the knowledge graph should adhere to several principles. First, the design should align with the course objectives, ensuring that the included knowledge points support students in achieving the expected learning outcomes [11], and core knowledge points in the course need to be identified and categorized. Second, the knowledge graph should encompass all significant knowledge points within the course and illustrate the logical relationships among these points, aiding students in forming a systematic knowledge structure [6]. The relationships among these knowledge points should be established and graphically represented. Finally, the knowledge graph should be optimized to ensure it clearly displays the course content [15].

3.2. Unique Advantages of Knowledge Graphs in Education

Knowledge graphs offer unique advantages in education by providing a structured and visual representation of complex knowledge domains. They facilitate better understanding and retention of information by clearly illustrating relationships between different concepts. This visualization aids in constructing a comprehensive knowledge framework, enabling students to see the big picture and understand how individual pieces of information interconnect [6]. Additionally, knowledge graphs support personalized learning by dynamically adjusting learning paths based on individual student needs and progress. This personalized approach enhances learning efficiency and effectiveness, catering to diverse learning styles and improving overall educational outcomes [5].

4. Implementing Knowledge Graph-Based Blended Teaching Model

The design of knowledge graph-based blended learning lessons requires careful consideration of both teaching tasks and the target students. Blended learning transcends the mere transfer of knowledge, aiming instead to foster logical thinking and spiritual development. This shift in focus means that educators must prioritize how to effectively engage students in acquiring subject knowledge, enhancing logical reasoning, and ultimately awakening their inner potential. Traditional concerns about what and how to teach must give way to innovative approaches that integrate online and offline methods to achieve these higher objectives.

Teaching content, as the primary vehicle for achieving educational goals, must be selected and designed to align with these broader aims. Using knowledge graphs, educators can uncover both explicit and implicit logical connections within the subject matter. This approach facilitates the cultivation of critical and independent thinking skills, essential for students navigating an information-rich world.

Moreover, understanding the target students through data analysis within knowledge graphs is paramount. Teachers can analyze students' cognitive, emotional, and attitudinal levels, both collectively and individually, to tailor their instructional strategies. This comprehensive analysis should not only assess students' current knowledge base but also their thinking and cognitive abilities, which are critical for determining their readiness for new learning tasks. Accurate assessment of these factors allows for effective planning and prediction of learning outcomes, ensuring that educational activities meet the desired cognitive, emotional, and attitudinal benchmarks. This holistic approach ensures that blended learning programs are well-suited to foster deep learning and personal development in students.

Teachers need to begin by constructing and integrating knowledge graphs that encompass all core concepts and themes of the course. These knowledge graphs should include the logical relationships and interactive links between various knowledge points, helping students to understand and connect different knowledge units [6]. Additionally, teachers should prepare multimedia teaching resources, such as micro-lesson videos and MOOC platform materials, and link these resources to the knowledge graphs. This enables students to directly access and learn the relevant content through the knowledge graphs [16]. Furthermore, it is crucial to develop a detailed teaching plan that outlines the objectives and tasks for each teaching stage, ensuring the effective integration and application of knowledge graphs in the instructional process. This comprehensive preparation supports a seamless and efficient blended learning experience.

4.1. Pre-Class Learning Arrangement and Guidance

Teachers should guide students to use the knowledge graph for pre-class learning, clarifying the key points for preparation. Through online discussions or forums, teachers can answer students'

questions, ensuring they fully understand the pre-class content [11]. Additionally, designing interactive pre-class learning activities such as online quizzes and discussions can help students deepen their understanding of the content within the knowledge graph and better prepare for classroom instruction.

To facilitate this process, teachers can create comprehensive pre-class study guides that highlight essential nodes and relationships within the knowledge graph. These guides can serve as a starting point for students' independent exploration, encouraging them to delve deeper into each topic. Providing these structured resources helps students navigate complex information more efficiently and fosters a more organized approach to their studies.

Through online discussions or forums, teachers can answer students' questions, ensuring they fully understand the pre-class content. These digital platforms offer an interactive space where students can seek clarification on difficult concepts, share insights, and engage in collaborative learning. This ongoing interaction not only resolves immediate queries but also builds a supportive learning community where students feel comfortable voicing their uncertainties and learning from their peers [11].

4.2. Organization and Interaction in Classroom Teaching

In the classroom, teachers can utilize the knowledge graph to visually present course content, explaining the relationships between knowledge points. This helps students construct a systematic knowledge framework. The knowledge graph allows teachers to clearly explain complex concepts, thereby enhancing the overall effectiveness of instruction [5]. Furthermore, knowledge graphs can be used to design interactive classroom activities, such as group discussions, case analyses, and problem-solving sessions. These activities encourage active participation and interaction among students, increasing their engagement and motivation in the learning process [7].

The knowledge graph allows teachers to clearly explain complex concepts, breaking them down into more manageable parts that are visually linked. Additionally, knowledge graphs can be integrated into various teaching strategies to enrich the learning experience. Teachers can use the knowledge graph to create "concept journeys," where students follow a path through different nodes to explore how foundational principles lead to advanced applications. This approach helps in scaffolding learning, ensuring that students build their understanding step-by-step.

Furthermore, knowledge graphs can be used to design interactive classroom activities that foster deeper engagement. For instance, teachers can organize group discussions centered around specific nodes or relationships within the graph. Students can be assigned different nodes to research and then present their findings to the class, facilitating peer learning and collaboration. This not only reinforces their understanding but also develops their presentation and communication skills.

Furthermore, knowledge graphs can facilitate personalized learning experiences by allowing teachers to track student progress and provide tailored feedback. Through data collected from students' interactions with the knowledge graph, educators can identify areas where individual students may need additional support or challenge. This personalized approach ensures that each student receives the appropriate level of guidance and resources to enhance their learning journey.

4.3. Post-Class Consolidation and Extended Learning Design

After class, teachers can assign consolidation tasks based on the knowledge graph. Students can use the knowledge graph to review the content covered in class and complete related exercises and assignments, reinforcing their grasp of key concepts [11]. Additionally, teachers can use the knowledge graph to recommend extended learning resources, encouraging students to engage in deeper study and exploration. This approach helps students broaden their knowledge base and

improve their comprehensive abilities [16].

In addition to reinforcing content knowledge, post-class activities should also focus on developing critical thinking and problem-solving skills. By leveraging the interconnected nature of knowledge graphs, teachers can design tasks that require students to apply their learning to new and diverse contexts, thus promoting higher-order cognitive skills. For example, students might be asked to identify and analyze relationships between different knowledge nodes, which encourages them to think beyond rote memorization and engage in deeper analytical thinking.

5. Evaluation Principles for Knowledge Graph-Based Blended Teaching Model

5.1. Comprehensive Assessment of Learning Outcomes

Knowledge graphs play a crucial role in evaluating learning outcomes by visually representing the relationships between different knowledge points. This helps students better understand and retain complex information, facilitating a more effective measurement of knowledge mastery [6]. By integrating knowledge graphs into assignments and projects, teachers can assess students' critical thinking, problem-solving skills, and application of knowledge in practical contexts. Furthermore, knowledge graphs support the evaluation of quality cultivation, such as self-discipline, motivation, and adaptability, by tracking students' interactions and engagement in self-directed learning tasks [5].

5.2. Evaluation Index System

The evaluation index system should combine both qualitative and quantitative indicators. For instance, student performance can be assessed through multiple dimensions such as self-directed learning, collaborative learning, and innovative thinking [1]. Additionally, teacher effectiveness can be evaluated by examining detailed instructional designs, the effectiveness of implementation, and the improvement based on feedback [12]. This comprehensive approach ensures a thorough assessment of both student learning outcomes and instructional quality, providing valuable insights for continuous improvement.

5.3. Evaluation Methods and Tools

Appropriate evaluation tools should be selected and applied, such as knowledge graph learning analytics platforms and teaching evaluation systems. The results of these evaluations should be systematically analyzed and utilized to improve teaching methods, enhance the quality of education, and ensure that instructional strategies are effectively meeting the learning needs of students [9]. This approach promotes continuous improvement and excellence in educational practices.

5.4. Continuous Feedback and Improvement

Providing continuous feedback is essential for enhancing the quality of blended learning. Knowledge graphs enable real-time tracking of student progress, allowing teachers to offer timely and constructive feedback. This iterative process helps students understand their strengths and areas for improvement, promoting self-regulated learning and continuous growth [16]. Regular feedback based on knowledge graph analytics supports the refinement of teaching strategies, ensuring that instructional practices are continuously adapted to meet the evolving needs of students.

6. Conclusions

This study has explored the significant potential of knowledge graphs in enhancing blended learning environments. The integration of knowledge graphs into blended learning not only helps in organizing and presenting complex information but also facilitates the development of a systematic knowledge structure among students. By leveraging knowledge graphs, educators can provide a more structured and guided learning experience that addresses the common challenges associated with blended learning, such as fragmented self-study and lack of comprehensive understanding. Furthermore, the use of knowledge graphs supports personalized learning paths, real-time feedback, and continuous improvement in teaching methods, thereby enhancing overall teaching effectiveness and learning outcomes. This approach aligns with modern educational goals of fostering critical thinking, problem-solving skills, and adaptive learning capabilities, making it a valuable tool for contemporary education.

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