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Research on Adaptive Teaching Mode of Basic Mechanics Course based on Knowledge Graph

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Abstract: This research project is committed to exploring and practicing the deep integration of knowledge graph-based teaching model and adaptive teaching strategy in the course of basic mechanics. Through the construction of mechanical knowledge graph, the visualization and structured expression of abstract concepts can be realized, which effectively breaks through the traditional teaching content organization mode, and significantly improves the accuracy and efficiency of teaching resource retrieval, recommendation and personalized learning path planning. At the same time, the project designed and implemented an adaptive teaching model, using students' learning behavior data and learning results to dynamically optimize teaching content and strategies, providing personalized learning support and feedback for each student, meeting their differentiated needs, and effectively improving learning results. In addition, this project pays particular attention to the deep integration of information technology and education and teaching concepts. On the premise of maintaining the rigor of mechanics discipline, knowledge graph technology is used to strengthen classroom interaction, stimulate students' enthusiasm for independent learning, and cultivate their problem-solving and innovation abilities. This series of measures aims to promote the deep transformation of higher education teaching mode from teacher-centered to student-centered, and improve teaching quality and educational effectiveness.

Keywords: knowledge graph, basic mechanics, teaching model research

1. Introduction

With the rapid advancement of information technology, the higher education system is undergoing a profound transformation of teaching paradigm, and the traditional one-size-fits-all teaching model is unable to cope with the increasing personalized and diversified learning demands of current students. Therefore, in the context of education in the new era, exploring and practicing a new teaching model with greater adaptability has become the core issue of higher education teaching reform[1].

As a cornerstone course in the knowledge system of engineering disciplines, basic mechanics has a core value in tempering students' logical reasoning ability and complex problem solving skills[2,3]. However, due to the abstract and theoretical content of this course, many students encounter great challenges in the learning process, which not only affects their academic performance, but also may inhibit the development of their learning enthusiasm and lasting interest[4].

As an innovative means of knowledge organization and representation, knowledge graph technology structurally presents the complex knowledge system of the real world through the entity-attribute-relationship model, providing new possibilities for the realization of refined teaching[5,6]. Adaptive teaching takes individual differences as the core, and dynamically optimizes teaching content and strategies according to their learning progress, understanding level and needs, aiming at creating a highly personalized learning environment.

This research project is committed to building a knowledge graph covering the whole course of basic mechanics knowledge points and their correlation, and combining advanced adaptive teaching concepts and technical means, to design flexible and diverse learning paths and guidance programs. It is expected that this teaching mode will significantly improve students' learning efficiency, reduce the cognitive difficulty barrier, and effectively stimulate their internal learning motivation, so as to cultivate students' independent learning ability and lifelong learning accomplishment.

2. Basic mechanics teaching reform: adaptive model of knowledge graph

(1) Teaching status and challenges of basic mechanics course

As a compulsory basic course for engineering students, the course of basic mechanics plays a vital role in teaching. However, the current teaching situation reflects a series of problems and challenges:

1) Contradiction between content and class hours: With the continuous expansion and deepening of the knowledge system, the basic mechanics course contains increasingly rich content, but the actual teaching hours are relatively limited, which makes it difficult for teachers to fully explain all

knowledge points in a limited time, and the pressure of students' absorption and understanding increases.

2) Disconnection between theory and practice: Traditional teaching mode tends to emphasize theory teaching, but ignores the combination with practical engineering application, making students' understanding of mechanics concepts remain at the abstract level, and it is difficult to effectively apply to solve practical problems.
3) Lack of individual needs: different students have different learning abilities, interests and backgrounds, and the traditional "one-size-fits-all" teaching method cannot meet the learning needs of each student, which is not conducive to stimulating learning enthusiasm and innovation ability.
4) Lack of connection: the transition between basic mechanics and subsequent professional courses is not smooth enough. For example, the correlation between mechanics courses of mining engineering and specific engineering practice cases is not high enough, so it is necessary to build a teaching case base with professional characteristics to strengthen the connection between courses.
5) Lagging technical means: Although the development of information technology has brought new opportunities for education, modern information technology (such as knowledge graph and online adaptive teaching system) has not been fully utilized in the teaching of basic mechanics in some colleges and universities to improve teaching efficiency and quality.

(2) Adaptive teaching model and its application in the field of education

Adaptive teaching mode is a modern teaching method combining educational technology and learning theory, which emphasizes the dynamic adjustment of teaching content, process and strategy according to students' learning style, ability level, interest preference and real-time learning performance. This model aims to personalize education, ensuring that each student can learn effectively at a pace and in a manner that suits them.

In the field of education, adaptive teaching mainly includes the following aspects:

1) Personalized learning path design: By establishing student models, analyzing students' learning ability and knowledge mastery, recommending the most suitable learning resources and course order for each student, and forming a personalized learning path.
2) Intelligent assessment and feedback: Using big data technology and artificial intelligence algorithms to conduct real-time analysis of students' learning data, accurately assess students' understanding of various knowledge points, and provide timely and targeted feedback to help students identify their learning weaknesses and make improvements.
3) Adaptive content presentation: Based on knowledge graph or other knowledge representation forms, the system can identify students' knowledge gaps and automatically adjust the difficulty and depth of teaching content to ensure that the content can challenge students and avoid excessive pressure.
4) Cultivation of independent learning ability: adaptive teaching not only focuses on knowledge transfer, but also focuses on cultivating students' self-regulated learning ability and lifelong learning habits, encouraging students to actively explore knowledge and solve problems.
5) Classroom practice cases: In courses such as basic mechanics, teachers can dynamically organize experimental activities, discussion sessions and case studies according to students' understanding, so that teaching can be closer to students' actual needs.

(3) Knowledge graph technology and its application in teaching

Knowledge graph technology is an advanced method of data structure and knowledge organization, which represents entities (such as people, places, events, etc.) and their relationships through graphical forms. In the knowledge graph, entities are seen as nodes, and relationships are represented as edges that connect these nodes. Such structured representations enable machines to understand and process complex information networks, and achieve semantic level search, reasoning, and recommendation. In terms of application in the field of education, knowledge graph technology has significant advantages:

1) Structure of course content: Knowledge graph can organize knowledge points, concepts, principles and cases of the course in a structured way to form a visual knowledge network, which helps teachers systematically plan teaching content and clearly show the logical correlation between knowledge points.
2) Personalized learning path design: Based on knowledge graph, personalized learning routes can be constructed according to students' learning situation, ability level and interest preference, and teaching resources and learning tasks suitable for individuals can be intelligently recommended to support adaptive learning.

3) Real-time assessment and feedback: Through the analysis of students' behavior data in the learning process, knowledge graph can immediately reflect students' understanding of various knowledge points, provide teachers with accurate teaching evaluation basis, adjust teaching strategies accordingly, and give students targeted feedback and guidance.
4) Interdisciplinary knowledge integration: In the interdisciplinary teaching scenario, knowledge graph can effectively reveal the links between different fields of knowledge, and promote interdisciplinary learning and comprehensive literacy training.

3. Design and implementation of adaptive teaching mode based on knowledge graph

With the help of knowledge graph, implement accurate personalized teaching content push. Through real-time analysis of students' learning path and mastery level, the best learning resources and optimal learning path are tailored for each student. Explore the establishment of a dynamic self-adaptive teaching mechanism, timely adjust teaching strategies based on the feedback of students' learning data, guide students from shallow learning to deep understanding and flexible application, and improve teaching quality and efficiency.

(1) Construction of knowledge map of basic mechanics course

Based on the systematic analysis and arrangement of the content of the basic mechanics course, a complete, accurate and structured knowledge graph is constructed by using artificial intelligence technology according to the logical relations and attributes of knowledge points. In the construction process, concepts, formulas, theorems and other knowledge points in the mechanics course will be extracted to clarify their mutual relations, and natural language processing technology will be used to carry out entity extraction, relationship extraction and entity disambiguation operations, so as to build the ontology hierarchy of the knowledge graph of the mechanics course.

(2) Collection and analysis of students' learning behavior data

Through the learning management system and other data collection means, the behavioral data of students in the learning process of basic mechanics course is collected, including learning time, learning track, knowledge point mastery, etc. In-depth analysis of students' learning behavior data is carried out to dig out students' learning characteristics and rules, and provide data support for the subsequent design of adaptive teaching mode.

(3) Design of adaptive teaching mode

According to students' learning history, ability level, learning preference and other personal characteristics, intelligent dynamic adjustment of learning resources, learning tasks and learning progress, to generate personalized learning paths, resource recommendations and learning support for students. The adaptive teaching mode includes learning behavior module, ability level assessment module, learning interest mining module and personalized learning resource recommendation module. The hierarchical structure of knowledge graph is used to dynamically generate questions and exercises suitable for students' needs, so as to provide students with more accurate learning services.

(4) Development of practical teaching platform

The adaptive practical teaching platform of basic mechanics course based on knowledge graph is developed. The platform includes online courses, online tests, online Q&A and other functional modules to provide students with a full range of learning support. In the online course module, students can systematically learn the basic mechanics course knowledge according to the guidance of knowledge graph. In the online test module, students can complete personalized exercises and tests; In the online Q&A module, students can ask questions at any time and get help from teachers or other students.

(5) Analysis and application of teaching effect

The teaching effect of adaptive teaching mode is studied deeply, including the improvement of students' learning interest, learning motivation, learning effect and ability. Evaluate students' acceptance of the new teaching mode, learning effect, learning experience and its impact on teaching quality. According to the evaluation results, the teaching mode and method should be optimized continuously to improve the teaching effect. The research results will be applied to the teaching reform of other subjects to improve the teaching quality and effect.

4. Conclusion

(1) Teaching mode based on knowledge graph

By constructing, organizing and representing knowledge graph, this study visualizes and structures abstract mechanics concepts and principles, so that students can understand and master knowledge more intuitively. This is not only a major breakthrough to the traditional teaching content organization, but also makes the retrieval of teaching resources, recommendation and learning path planning more accurate and efficient.

(2) Personalized exploration of adaptive teaching model

This study designed adaptive teaching strategies to dynamically adjust teaching content and strategies according to students' learning situation and needs. By analyzing students' learning behavior data and academic performance, we can provide personalized learning support and feedback for each student, so as to better meet students' differentiated learning needs and improve learning results.

(3) Deep integration of information technology and education and teaching concepts

This study not only focuses on technological innovation, but also emphasizes the deep integration of modern information technology and educational teaching concepts. Actively explore how to enhance classroom interaction with knowledge graph technology while maintaining the rigor of mechanics discipline, stimulate students' interest in independent learning, and cultivate their problem-solving ability and innovation ability, so as to promote the transformation of higher education from traditional teacher-centered to student-centered.

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