Application and Practice of Knowledge Graph in Experimental Teaching in Colleges and Universities

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Abstract With the reform of experimental teaching in colleges and universities, the teaching mode of "experimental students as the main body, experimental teachers as the guide" needs to constantly explore new experimental teaching methods. In this paper, knowledge graph is integrated into the experiment of mechanical principle to guide undergraduates to use knowledge graph to analyze and summarize independently in experimental teaching activities, aiming at cultivating undergraduates' interest in learning and innovative thinking, so as to improve the quality of experimental teaching. This study has a certain reference significance for experimental teaching in colleges and universities.

Key words Experimental students as the main body and experimental teachers as the guide, Knowledge graph, Mechanical principle experiment

1 Introduction

As a key component of higher education system, experimental teaching plays an irreplaceable role in cultivating students' practical ability, innovative thinking and ability to solve complex engineering problems[1]. In recent years, with the in-depth implementation of the "Double First-Class" initiative of the Ministry of Education of China[2-4], the experimental teaching work in colleges and universities is facing new challenges and opportunities, and its focus has gradually shifted to stimulating students' interest in active learning and strengthening the training of innovative thinking, in order to cultivate more compound talents with excellent engineering literacy. The traditional experimental teaching mode in colleges and universities is often dominated by experimental teachers, in which students participate passively and lack opportunities for active exploration and deep thinking, so it is difficult to effectively cultivate their ability to observe, analyze and solve problems, thus limiting the improvement of experimental teaching effect[5]. In response to this challenge, scholars have actively explored the innovative path of experimental teaching mode. The reflective experimental teaching mode proposed by Yang Yongming *et al.* [5] significantly improves students' practical ability and learning initiative by strengthening their reflective and autonomous learning ability, and provides valuable ideas for experimental teaching reform. Wang Li *et al.* [6-7] further discussed the possibility of integrating scientific research projects into undergraduate experimental teaching, pointing out that this measure can stimulate students' interest in experiments, and has a far-reaching impact on the cultivation of outstanding engineering talents and the innovation of experimental teaching mode. As the cornerstone of experimental teaching, laboratory safety management also needs to be optimized and strengthened. From the student-centered perspective, Yang Yongming *et al.* [8] put forward a series of strategies to strengthen laboratory safety management, such as improving safety management system, strengthening civilized behavior education, and introducing safety psychology training, aiming at comprehensively improving the safety literacy and self-protection ability of teachers and students, and providing a solid guarantee for the safe and orderly development of experimental teaching. Especially in the context of "Double First-Class" initiative, the systematization and modularization of laboratory safety and management and the professional construction of teachers have been endowed with new epochal significance[9], which has become an important driving force to promote the scientific development of laboratories in colleges and universities.

In this study, we focused on the introduction of knowledge graph technology into the field of experimental teaching of mechanical principles, and carried out its application and practical research. Through the construction and application of knowledge graph, the undergraduates' interest in learning can be stimulated, their innovative thinking and problem-solving ability are cultivated, and the quality of experimental teaching is improved. This study not only enriches the methods of experimental teaching in colleges and universities, but also provides a useful exploration and reference for the construction of a new experimental teaching mode with students as the main body and teachers as the guide.

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2 Knowledge graph

2.1 Definition The knowledge graph is a theory that combines information visualization technology, graphics and other technologies with theory, and uses visual elements to vividly display the relevant core structure and knowledge architecture to achieve multi-disciplinary integration. Figure 1 shows a typical example of knowledge graph, in which nodes represent entities or concepts.

2.2 Strengths

2.2.1 Integration of cognitive science and improvement of memory efficiency. As a systematic and divergent thinking tool, knowledge graph is unique in that it can effectively integrate the functions of the left and right brain and promote the overall optimization of cognitive processes. Specifically, it can not only activate the left brain's logical analysis ability of abstract elements such as words and symbols, but also synchronously mobilize the right brain's image processing ability of intuitive elements such as images and colors. In this process, the left and right brain work together to construct a systematic and divergent knowledge structure with multi-dimensional elements such as graphics, text and color, which simulates the natural divergent thinking mode of the brain, significantly enhances the depth and breadth of information processing, and then helps to improve the efficiency and effect of students' memory.

2.2.2 Technology-assisted efficient learning and knowledge management. In the drawing and application of knowledge graph, the application of modern information technology has greatly enriched its form of expression and practicality, in addition to the traditional paper-pen hand-drawing. Using professional software such as XMind, MindManager, Microsoft Office Word and Microsoft Office PowerPoint, students and educators can more easily create knowledge networks with themes as the core and keywords as the nodes. By providing rich graphics, color and text editing functions, such software supports users to construct tree or mesh maps with clear hierarchy and rich content, and realize the intuitive display and efficient management of knowledge. Such digital knowledge graph not only facilitates the instant access and update of information, but also significantly improves the orderliness and efficiency of the learning process, providing a powerful cognitive tool and knowledge management platform for learners.

2.2.3 Theoretical basis and practical value of multidisciplinary integration. The construction and application of knowledge graph deeply reflects the comprehensive application of information visualization technology, graphics and other multi-disciplinary theories. By presenting complex information relationships in an intuitive and vivid way, knowledge graph not only promotes the visual understanding of knowledge, but also provides a strong support for the integration and integration of interdisciplinary knowledge. As shown in Fig. 1, the node of the typical knowledge graph is a concrete representation of an entity or concept, which clearly shows the internal relationship and hierarchical structure between knowledge elements, and constructs a dynamic and open knowledge ecosystem for the cognitive process of learners. This theoretical framework not only enriches the connotation of cognitive science, but also provides new ideas and ways for knowledge imparting and skill training in educational practice.

3 Application and practice of knowledge graph in experimental teaching of mechanical principle

3.1 Using knowledge graph to optimize the teaching design of mechanical principle experiment Under the concept of modern education, the construction of "student-centered and teacher-guided" teaching mode has become the key to improve the quality of teaching. Under this mode, while ensuring the dominant position of students, teachers need to give full play to their role of guidance and assistance, through precise teaching design and effective organization of teaching activities, in order to achieve the best experimental teaching effect. As a powerful knowledge organization and representation tool, knowledge graph provides strong support for the design of mechanical principle experiment teaching. Taking University of Shanghai for Science and Technology as an example, knowledge graph is successfully used to assist the teaching design of mechanism motion diagram drawing experiment in the mechanical principle experiment course of the first-class undergraduate course construction project in 2024. As shown in Fig. 2, the graph systematically shows the core knowledge points involved in the experiment and their interrelationships, providing a clear teaching framework for experimental teachers. On this basis, the teaching design shown in Fig. 3 not only closely revolves around the knowledge graph, but also fully considers the cognitive characteristics of students and the experimental environment, ensuring the scientificity of the teaching content and the logicality of the teaching process. Through the use of knowledge graph, teaching designers can grasp the teaching content more comprehensively, and precisely connect with the experimental teaching objectives, so as to design experimental tasks that are not only in line with the actual level of students, but also full of challenges, which effectively improves the pertinence and effectiveness of experimental teaching.

3.2 Relying on knowledge graph to promote the implementation of experimental teaching activities In the "student-centered, teacher-guided" experimental teaching activities, how to stimulate students' interest in learning, promote their autonomous learning and actively participate in the experimental process, is an important issue that teachers need to face. As an intuitive and efficient way of knowledge presentation, knowledge graph provides a strong support for the realization of this goal. Specifically, knowledge graph can help students quickly build a knowledge network and understand the internal relationship between knowledge points, thus reducing the difficulty of learning and improving learning efficiency. Besides, teachers can also guide students to

explore the unknown areas in the knowledge graph, stimulate their curiosity and thirst for knowledge, and promote the development of their autonomous learning ability. In addition, knowledge graph also provides a convenient platform for communication and discussion between teachers and students. In the process of experiment, teachers can organize students to carry out group discussion, cooperative learning and other activities according to the guidance of knowledge graph, promote the collision and integration of different ways of thinking, and further enhance students' innovative thinking ability and team cooperation ability.

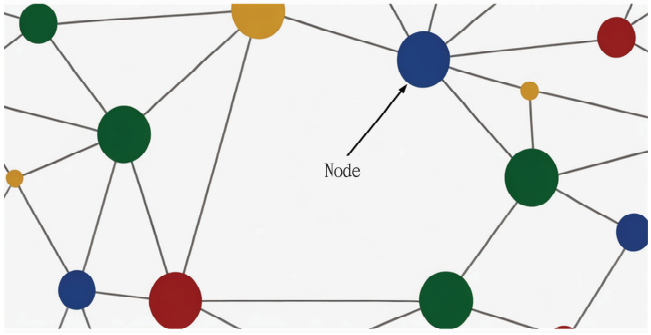

Fig. 1 Knowledge graph

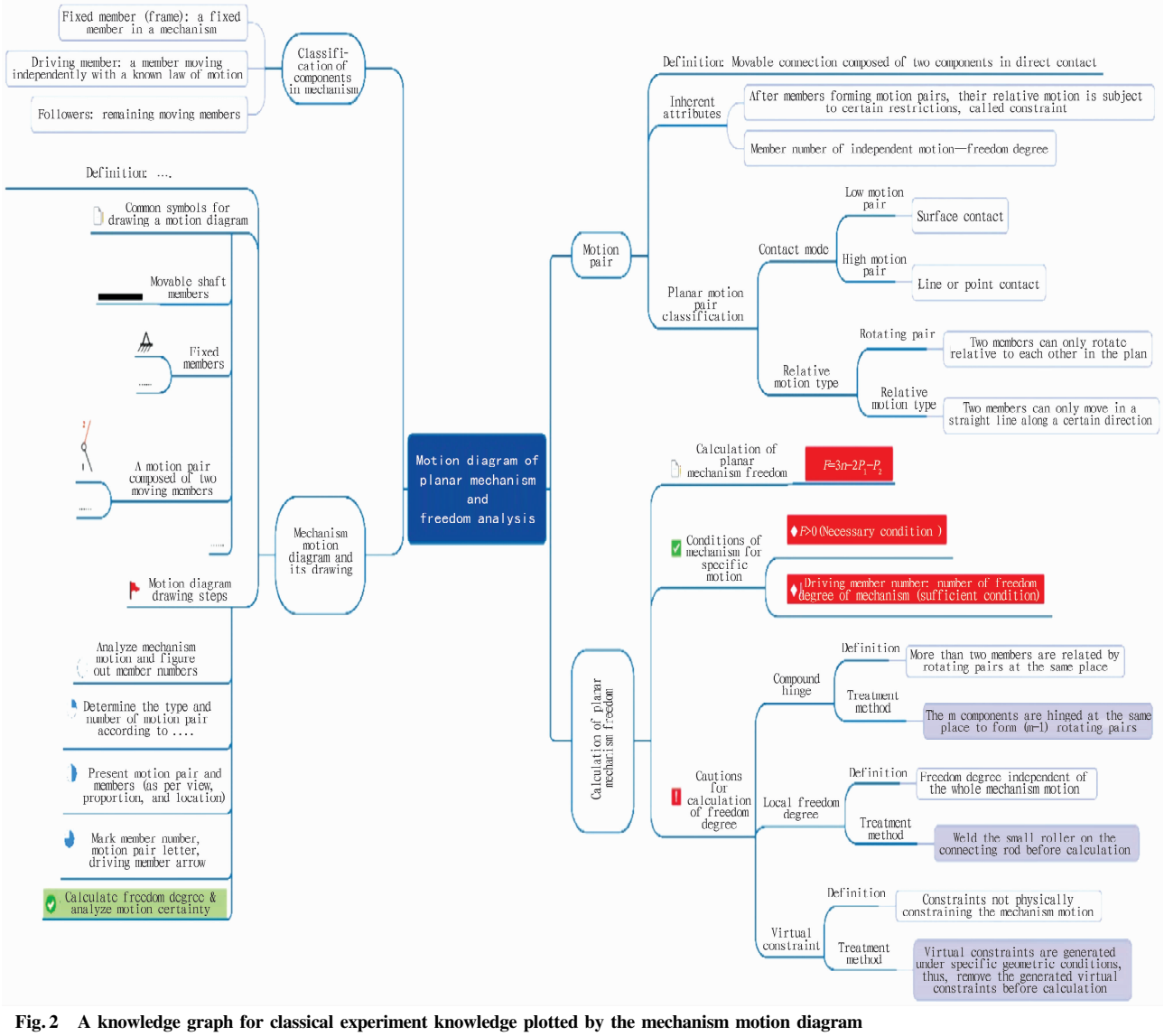

Fig. 2 A knowledge graph for classical experiment knowledge plotted by the mechanism motion diagram

3.3 Experimental operation with the help of knowledge graph Taking the mechanism motion diagram drawing experiment in the mechanical principle experiment course as an example, in the existing experimental teaching activities, experimental teachers often use multimedia technology such as experimental video and simulation animation to play experimental video and simulation animation to students while explaining the experiment and demonstrating the operation. Because the experimental teachers do not fully consider the students' dominant position in the experimental learning process, the experimental students have to accept the knowledge mechanically. The experimental students memorize some knowledge points sporadically, which can not be associated sys-

tematically and completely, and the arrangement of less experimental teaching hours makes the experimental teaching process have a certain interval, which leads to a great discount in the result of drawing the kinematic diagram of the mechanism. According to this situation, the use of knowledge graph is helpful to improve students' memory efficiency and learning efficiency. The experimental teacher guides the experimental teaching, gives full play to the students' learning initiative, lets the students record many details of the drawing of the mechanism motion diagram in the form of knowledge graph, and requires the experimental students to write the relevant knowledge graph in the experimental report, so as to help the students to carry out the experimental operation, to achieve the effect of deepening memory and consolidating knowledge. This not only helps students develop the habit of analyzing and summarizing independently, but also helps to cultivate students' ability of autonomous learning and knowledge construction, synchronously exercises students' logical thinking and divergent thinking, and promotes students to effectively cultivate their interest in autonomous learning and independent innovative thinking.

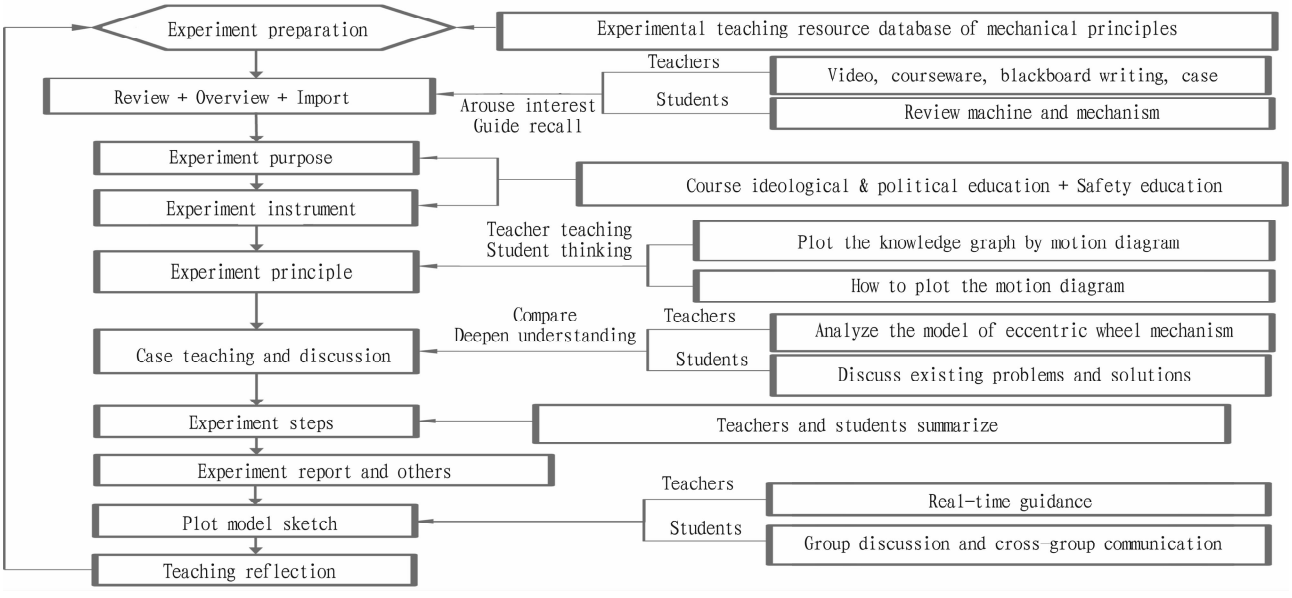

Fig. 3 Teaching design of experimental course

4 Conclusions

The practice shows that the practical effect and value of integrating knowledge graph, an advanced information technology, into the experimental teaching of mechanical principles are remarkable, which has a far-reaching impact on the field of education. With its unique structural knowledge representation form, knowledge graph can intuitively show the concepts, principles, methods and their internal relations in the knowledge system of mechanical principles, which provides a new perspective and tool for experimental teaching.

In the implementation of specific experimental courses, through the use of knowledge graph, teachers can deeply interpret and systematically sort out the experimental contents related to mechanical principles, and help students establish a comprehensive and coherent knowledge network structure. This not only helps students to deeply understand the internal logic of a single experimental project, but also improves their cognitive level of the whole subject area, thus greatly improving the quality and effect of experimental teaching. The application of knowledge graph ensures that students can master the basic theoretical knowledge of mechanical specialty and effectively transform it into practical operation skills. It guides students to learn how to use knowledge graph to analyze problems and sum up experience, and forms an active exploratory learning mode, which plays an important role in cultivating students' interest in autonomous learning and innovative thinking mode. This model encourages students to think independently, stimulates their innovative spirit, and promotes them to find and solve problems, so as to continuously improve their overall quality. For the experimental teaching in colleges and universities, the introduction of knowledge graph provides a new thinking direction and practice path for educators. Through the analysis of knowledge graph, teachers can better grasp the development trend and direction of experimental teaching, update and improve the teaching content and methods in time. It can also optimize the allocation of experimental teaching resources with the help of knowledge graph technology, so as to maximize the use of educational resources and continuously improve the teaching effect.

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(To page 57)

comprehensive advancement and development of landscape architecture in the modern context. The integration of educational resources encompasses not only physical facilities, such as library materials and laboratories located on campus, but also collaboration with external organizations, including enterprises and research institutes. This collaboration aims to offer students a more extensive practical platform through the sharing of resources. Furthermore, it is essential to update educational content. The curriculum of landscape architecture must remain current and incorporate contemporary concepts related to ecological conservation and sustainable development. This approach will better equip students to address the diverse challenges they may encounter in their future careers. In conclusion, in response to the challenges and opportunities presented by the new media era, it is imperative for China's landscape architecture education to proactively adapt to contemporary changes. This necessitates continuous innovation and enhancement of educational practices, aiming at cultivating a greater number of landscape architecture professionals equipped with an international perspective, innovative capabilities, and practical skills. Such efforts are essential for contributing to the advancement of China's ecological civilization and promoting sustainable development.

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(From page 53)

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