Intelligent Knowledge Management and Application in Art Design Experimental Teaching of Colleges and Universities

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Abstract. This paper explores the application of knowledge graphs and artificial intelligence technology in the experimental teaching of art design in colleges and universities, as well as how these technologies can promote educational reform and enhance the quality of education. It points out that knowledge graphs, as a new way of representing and organizing knowledge, make personalized learning and intelligent recommendation of teaching resources possible. A reform plan for art design experimental teaching based on AI technology and knowledge graphs is proposed, further elaborating on the construction goals of the art design experimental teaching platform. Through the approach of "deconstruction—embedding—integration," the teaching objectives and content are deconstructed and embedded with knowledge graphs and AI technology to improve teaching efficiency and effectiveness. Taking the experimental projects of the Experimental Teaching Center of the School of Art at Sichuan University as an example, it demonstrates how to incorporate experimental projects into the teaching platform and use knowledge graphs to perfect the knowledge elements of experimental projects, thereby achieving a three-dimensional and personalized teaching content.

Keywords: Higher Education; Experimental Teaching; Art Design; Knowledge Graph

1 Introduction

In the current field of education, the major of art and design is facing an unprecedented transformation. With the rapid development of technology and the explosive expansion of knowledge, art and design have evolved from traditional manual skills and apprenticeship to a comprehensive discipline that emphasizes the integration of innovation, practice, and theory [1]. Experimental teaching, as an important means of cultivating students' practical abilities and innovative spirit, has always been a vital part of art and design education [2]. However, traditional experimental teaching in art and

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design is often limited by factors such as resources, time, and space, making it difficult to meet the personalized learning needs of students [3].

In recent years, knowledge graphs, as a new form of knowledge representation and organization, have shown their strong potential for application in various fields. Knowledge graphs structure complex information and knowledge in the form of a graph, making the retrieval, analysis, and utilization of information more efficient and intuitive. The application of knowledge graph technology provides a new solution for experimental teaching in art and design, offering the possibility for personalized learning and intelligent recommendation of teaching resources [4].

Exploring the application schemes and scenarios of knowledge graphs in the experimental teaching of art and design in higher education, and analyzing their potential impact on improving teaching quality and promoting the development of students' innovative abilities and critical thinking skills, can provide new teaching strategies and tools for art and design educators to adapt to the trends of modernization and internationalization in education [5].

2 Reform of Art and Design Experimental Teaching in Colleges and Universities Based on AI Technology and Knowledge Graphs

Due to the comprehensive and innovative nature of art and design experimental teaching, it is necessary to integrate the fragmented content of previous art and design experimental teaching [6]. Establishing an intelligent knowledge management and application learning platform can integrate experimental teaching resources and organically link experimental teaching content, so we will establish an intelligent knowledge management and application platform for art and design experimental teaching as the path and direction for teaching reform.

According to the needs of teachers, students, society, and other aspects, this art and design experimental teaching platform needs to support the expansion and replacement of knowledge content within the platform, enable the automatic generation and updating of teaching materials, remember and assess the learning progress and knowledge reserves of individual students, and achieve personalized teaching for individual students. The platform should combine the hardware conditions of the teaching unit and the specific teaching requirements of the course to provide students with various learning functions such as previewing, reviewing, and practicing. At the same time, the platform can achieve AI autonomous integration of content and automatic updating of teaching frameworks and teaching resources. Teachers can provide knowledge elements, knowledge support, and related learning materials to the system at any time. The AI system constructs knowledge chains based on the knowledge support relationships of knowledge elements and maps the knowledge elements into the system's knowledge graph. Based on the knowledge graph, the AI system matches learning materials with related knowledge elements and knowledge chains. The platform framework is shown in Figure 1.

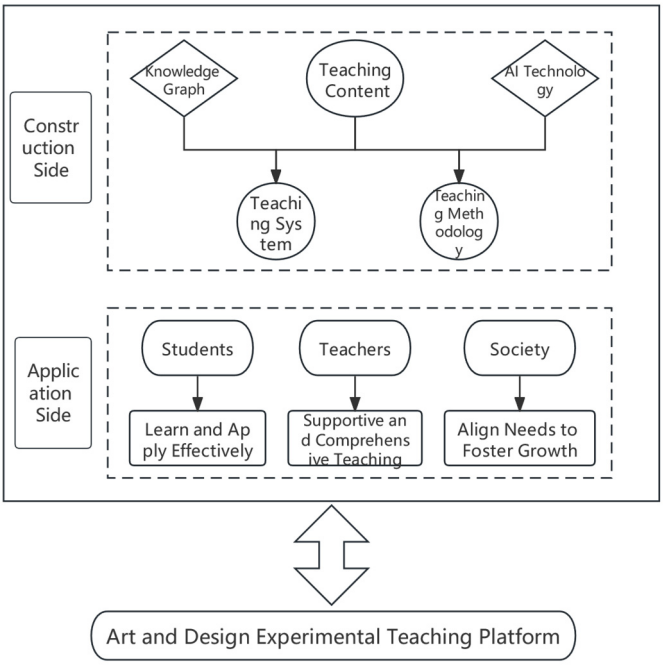

Fig. 1. Art and Design Experimental Teaching Platform Framework

2.1 Construction Goals of the Art and Design Experimental Teaching Platform

2.1.1 Integration of Course Content and Practice to Enable Students to Apply and Utilize Their Knowledge.

In the teaching process, combine theoretical knowledge teaching with practical operations. By lecturing on the relevant concepts and technical principles in the knowledge graph, guide students to understand the principles and applications behind artistic techniques. At the same time, arrange practical activities for students to personally operate and apply the technology they have learned in the laboratory. Through AI-empowered teaching processes, students gain skills and talents that can be applied to society, serve society, and promote social development during their learning process.

2.1.2 Project-Driven Learning to Achieve a Three-Dimensional Approach to Artistic Experimental Teaching, Providing a Solid Foundation for Teachers.

Design project tasks that allow students to apply the technology and knowledge they have learned in practice. Projects can be designed according to the course content and students' interests, encouraging students to explore innovation and practical abilities [7]. For example, designing a screen printing portfolio requires students to

create a series of works using screen printing techniques and to showcase their creativity and technical implementation. Through the digital twinning of the knowledge graph and teaching content, achieve a three-dimensional teaching process, providing teachers with a scientific basis and reasonable arrangement when selecting teaching content. This expands the breadth of teaching content, improves the height of students' learning efficiency, and enhances the matching degree of social needs, thereby comprehensively improving teaching effectiveness in a multi-dimensional and three-dimensional manner.

2.1.3 Establishing a Systematic Assessment and Feedback Mechanism.

Design assessment methods to evaluate students' learning outcomes and provide timely feedback. Assessments include various forms such as homework, project results, and classroom participation to comprehensively understand students' learning situations and the development of their abilities.

2.2 Content of the Art and Design Experimental Teaching Platform Construction

The main content of the construction is to complete the application of knowledge graphs and AI technology in the experimental courses of plastic arts to improve teaching efficiency and enhance teaching effectiveness. By adopting the approach of "deconstruction—embedding—integration," deconstruct the teaching objectives and content, and embed techniques related to knowledge graphs and AI technology to achieve the integration of high-tech in the experimental teaching of plastic arts. As shown in Figure 2:

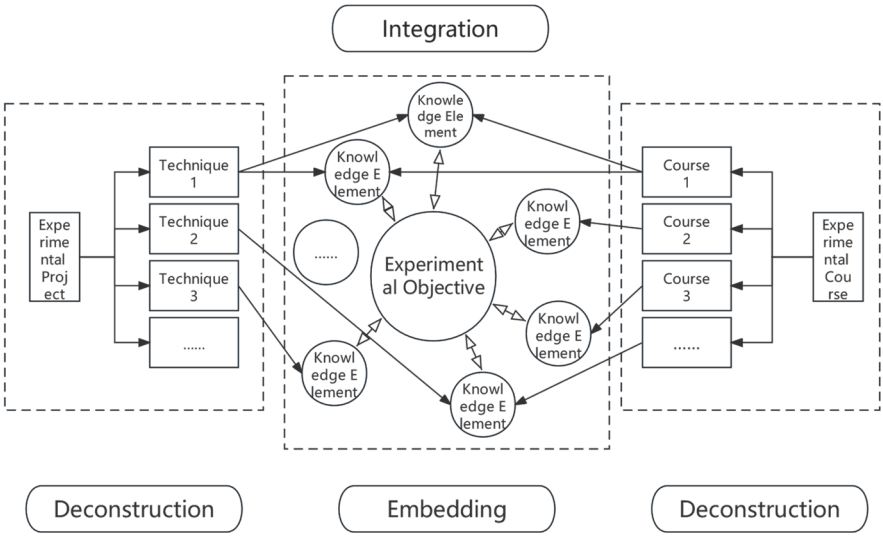

Fig. 2. Construction Approach: Deconstruction—Embedding—Integration

2.2.1 Deconstruction of Cultivation Content.

In the construction of the art and design experimental teaching platform, the deconstruction of cultivation content covers three aspects: quality cultivation, ability cultivation, and knowledge cultivation.

Quality Cultivation focuses on three main areas: the development of aesthetic emotions to enhance students' appreciation and aesthetic ability for art works, shaping their artistic taste; the cultivation of creativity to stimulate students' creative potential and foster the independence and innovation in their artistic creation; and the cultivation of team spirit to strengthen students' ability to collaborate with others in completing art projects.

Ability Cultivation encompasses artistic skills, creative thinking, and digital literacy. Artistic skills involve the mastery and application of various artistic techniques such as printmaking, ceramics, 3D printing, laser processing, and woodworking. The cultivation of creative thinking aims to improve students' ability to propose and realize unique artistic ideas. The cultivation of digital literacy focuses on students' skills in digital design, image processing, and model making.

Knowledge Cultivation includes the study of art theory, tool application, and practical experience. The study of art theory assists students in understanding the context and principles of artistic creation, covering areas such as art history, aesthetic theory, and art education theory. Tool application teaches students how to use various artistic tools like printmaking tools, ceramic equipment, and 3D printers. The accumulation of practical experience is achieved through practical activities, enhancing students' artistic skills and creative levels.

2.2.2 Knowledge Deconstruction Supported by Experimental Projects.

Taking Sichuan University as an example, in conjunction with the existing hardware conditions of the Experimental Teaching Center of the School of Art at Sichuan University, the experimental teaching content is divided into five modules: screen printing, ceramics, 3D printing, woodworking, and laser processing. The technical characteristics and application fields of the five modules are extracted as follows:

Screen Printing: Characteristics: Screen printing is a printing method that uses a template to print pigments through mesh holes onto the surface of an object. It features a wide range of applicability, bright colors, low cost, and is suitable for various materials. Application Fields: Widely used in the production of T-shirts, posters, albums, packaging boxes, and other paper or fabric printed products, and also commonly used for printing on circuit boards, glass, ceramics, and other materials.

Ceramics: Characteristics: Ceramics is an art form that uses clay as the main raw material and is made into artworks through processes such as shaping, drying, and firing. It is characterized by diverse shapes, rich materials, and complex production techniques. Application Fields: Mainly used for making vases, bowls and plates, sculptures, and other decorative and practical items, and also commonly used for decoration and sculpture in architecture and landscape fields.

3D Printing: Characteristics: 3D printing is a manufacturing technology that constructs objects by layering materials. It features rapid manufacturing, personalized customization, and high geometric complexity. Application Fields: Widely used in

rapid prototyping, medical devices, aerospace, automotive manufacturing, construction, and other fields.

Woodworking: Characteristics: Woodworking is a manual art that processes and assembles wood into various items using tools such as saws, planes, and sanders. It is characterized by a wide range of raw materials, diverse production techniques, and sturdy and durable finished products. Application Fields: Mainly used for making furniture, building components, crafts, ships, and other wood products.

Laser Processing: Characteristics: Laser processing is a processing technology that uses a laser beam for high-precision cutting of materials. It features high cutting precision, fast processing speed, and a wide range of applicability. Application Fields: Mainly used for cutting and processing of metals, wood, plastics, glass, and other materials, and commonly used for part processing, craft carving, architectural decoration, and other fields.

Further, based on specific task objectives, the above five modules are deconstructed and decomposed at a more fundamental knowledge level, until all knowledge support is traced back to the knowledge element level through the theory of knowledge chains.

2.2.3 Construction of Knowledge Graphs.

Establish a knowledge graph for each technical module, including related concepts, technical principles, and practical methods, and map each knowledge element within the knowledge graph. The content of the knowledge graph covers: artistic techniques and tools, artistic concepts and theories, and artistic practice and creation. The organizational structure of the knowledge graph includes: topics and subtopics, concept associations, and links. Design the hierarchical structure of the knowledge graph, gradually unfolding from basic knowledge to advanced applications, deeply exploring the connotation and extension of each topic. Continuously update the content and structure of the knowledge graph to keep pace with the times and reflect the latest developments in art education. Involve multiple parties and feedback: absorb the opinions and feedback of teachers, students, and professionals in the art field to ensure the comprehensiveness and accuracy of the knowledge graph.

2.3 Embedding of Teaching Resources and AI Technology

Collect and organize teaching resources related to the knowledge graph, including textbooks, reference books, academic papers, video tutorials, and practical cases. Categorize and annotate the teaching resources according to the structure of the knowledge graph for teachers and students to search and obtain as needed.

Associate the teaching resources with the relevant concepts and knowledge points in the knowledge graph to form a match between resources and knowledge. Mark the links or references of teaching resources in the knowledge graph so that students can intuitively understand the relationship between resources and knowledge.

In teaching activities, introduce corresponding teaching resources according to the teaching content and student needs. For example, when explaining screen printing

technology, you can refer to relevant textbooks, video tutorials, or practical cases. Teachers can use teaching resources for case analysis, demonstration operations, group discussions, and other teaching activities to deepen students' understanding and application of knowledge.

Use AI technology to provide personalized teaching resource recommendations and learning path guidance based on students' learning interests and levels, to meet the learning needs of different students. Students can improve their autonomy and effectiveness in learning by embedding knowledge graphs and teaching resources, and independently choosing and exploring knowledge points and learning resources of interest [8].

3 Teaching Practice: A Case Study of Sichuan University

Take the "Design and Manufacture of Artistic Home Decor" experimental project at the Experimental Teaching Center of the School of Art at Sichuan University as an example. This experimental project requires students to design and produce artistic home decorations that integrate technology with nature, exploring the beauty of the fusion between technology and nature. By combining modern technology with natural elements, students are tasked with creating home decorations that possess both artistic sensibility and practicality.

3.1 Incorporation of New Experimental Projects into the Teaching Platform

Faculty members of the course cluster need to map the experimental project within the knowledge graph to associate it with related courses, establishing a relationship between the experimental project and the experimental curriculum. Subsequently, they should further break down the process route of the experimental project, in line with the actual experimental teaching environment, to deconstruct the process route and the effects of the craftsmanship within this experimental project. After completing the deconstruction of the process route, map the process route of the experimental project to the craftsmanship within the knowledge graph.

During the teaching process, teachers can view and select the experimental project within the appropriate experimental courses by utilizing the mapping relationships in the knowledge graph. Students, after proposing their creative plans for their works, can receive recommendations for the process route from the AI system based on existing experimental conditions. After inspecting and refining the process route, students proceed to the laboratory to complete the creation of their works. The specific process is depicted in Figure 3.

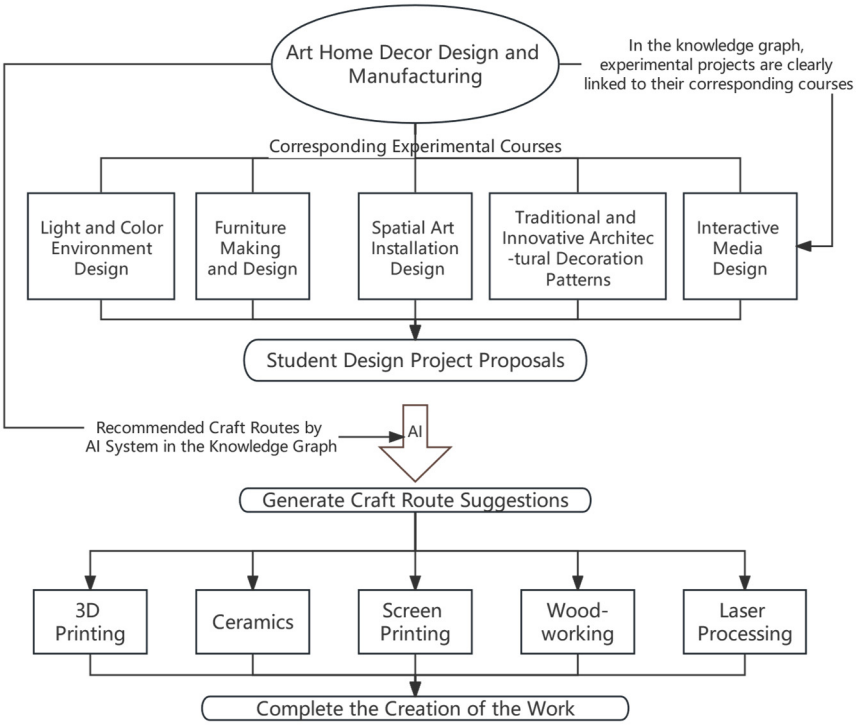

Fig. 3. AI Course New Experimental Project Process

3.2 Enriching the Experimental Project Knowledge Elements Based on the Knowledge Graph Structure

The existing craftsmanship within the knowledge graph includes screen printing, laser processing, 3D printing, ceramics, and woodworking. The application of the above craftsmanship in the experimental project "Design and Manufacture of Artistic Home Decor" is analyzed as follows:

Screen Printing: Utilizing screen printing technology to print patterns of natural elements, such as leaves, flowers, landscapes, etc., on fabric or paper materials to create a natural atmosphere.

Laser Processing: Employing laser processing technology to cut metal or wood into carving patterns with a sense of technology, such as geometric shapes, abstract forms composed of lines, etc., reflecting the characteristics of modern technology.

3D Printing: Using 3D printing technology to create decorative items with a futuristic and sci-fi style, such as abstract-shaped vases, lamps, etc., showcasing the innovation and imagination of technology.

Ceramics: Applying ceramic techniques to produce ceramic decorative items with natural textures and tactile qualities, such as flower pots, fruit plates, etc., displaying the charm and vitality of nature.

Woodworking: Leveraging woodworking techniques to craft sturdy and simply styled wooden home decorative items, such as bookshelves, flower stands, etc., adding warmth and practicality to the overall decorations.

The relevant content of the above analysis should be supplemented into the knowledge graph. Before the official class, teachers, posing as students, ask questions to the AI system to elicit the process route, continuously checking and correcting the AI's feedback. Prior to formal instruction, ensure that the AI system's selection accuracy for the process route exceeds 95%.

4 Conclusion

The application of intelligent knowledge management and application in the field of art and design education will continue to deepen. With the continuous advancement of AI technology, personalized learning experiences will be further optimized. More precise data analysis will provide students with customized learning paths and resources. The enrichment and refinement of knowledge graphs will integrate more teaching resources, including multimedia materials and interactive tools, to provide a more comprehensive learning experience. The promotion of interdisciplinary teaching will help break down disciplinary barriers and cultivate students' interdisciplinary thinking abilities. Additionally, educational equity is expected to be enhanced through the application of intelligent technology, providing students from different regions and backgrounds with equally high-quality educational resources, thereby narrowing the educational gap. Teaching assessment and feedback mechanisms will also become more scientific and timely due to technological innovation, helping teachers to adjust their teaching strategies promptly. Ultimately, intelligent knowledge management and application will drive innovation in educational models, possibly leading to more student-centered, project-based teaching models, promoting the modernization and internationalization of art and design education.

Acknowledgement

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