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Design and Application of Knowledge Graphs and Evaluation System Reconstruction: A Case Study of "Display Technology and Devices"

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Abstract: With the advancement of applied undergraduate education, optimizing curriculum systems and innovating assessment methods have become crucial. Taking the course "Display Technology and Devices" as an example, the construction of a knowledge graph and the reconstruction of the assessment system hold significant practical value. This paper elucidates the concept and application of knowledge graphs and the theoretical foundation of assessment systems, analyzes the current state of the course and the issues within the existing assessment framework, and elaborates on the design methodologies and application outcomes of knowledge graphs. It further discusses the principles, objectives, specific contents, implementation strategies, and safeguard measures for reconstructing the assessment system. Finally, the research findings are summarized, and prospective research directions are outlined.

Keywords: Applied undergraduate; Display Technology and Devices; Knowledge graph; Assessment system

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1. Introduction

With the continuous development of applied undergraduate education, optimizing curriculum systems and innovating evaluation methods have become pivotal in improving teaching quality and cultivating professional talents aligned with industry requirements. Display technology, as a vital component of contemporary technological advancements, spans a range of innovations, from traditional 2-dimensional (2D) displays to cutting-edge 3-dimensional (3D) displays. Between July 2023 and January 2024, the National Development and Reform Commission, the Ministry of Industry and Information Technology, the Ministry of Finance, and the Ministry of Education issued several policies [1-5] aimed at fostering research on quantum dot displays, holographic displays, and achieving breakthroughs in micro light-emitting diode (LED), laser, and printed display technologies. These policies emphasize achieving large-scale applications with barrier-free, fully flexible, and 3D stereoscopic display effects while accelerating their deployment in scenarios such as intelligent terminals, connected vehicles, remote communication, and cultural content presentation.

In response to the rapid growth of the display industry, applied undergraduate institutions must emphasize industry-oriented talent training to meet the workforce demands during this "high-speed development period" of the display sector.

The construction of a knowledge graph provides a systematic integration of course content, presenting complex concepts in display technology within a clear and structured framework [6]. It facilitates an in-depth exploration of the knowledge system in display technology, encompassing the structures, principles, and related technologies of various 3D displays, including assistive 3D displays, raster 3D displays, integrated imaging 3D displays, volumetric 3D displays, and holographic 3D displays [7].

Reconstructing the assessment system enables the evaluation of students' learning outcomes and skill levels in a more scientific manner. Diversified assessment methods, including evaluations of experimental skills, project design, problem analysis, and engineering problem-solving abilities, can stimulate students' enthusiasm and initiative while enhancing their comprehensive competencies.

Using the course "Display Technology and Devices" as a case study, this article demonstrates the construction of a knowledge graph and the reconstruction of the evaluation system. These approaches not only enhance the teaching quality of the course but also provide valuable insights and guidance for reforming other applied undergraduate courses. This work significantly contributes to cultivating industry-ready professionals and advancing applied undergraduate education.

2. Analysis of the current situation of the course "Display Technology and Devices"

2.1. Course content updates and iterations

The course "Display Technology and Devices" is characterized by strong professionalism, high practicality, and rapid knowledge updates. The aspect of strong professionalism is reflected in the course's integration of knowledge from multiple disciplines, including optics, electronics, and information science, requiring students to possess a solid theoretical foundation and advanced professional skills. The high practicality of the course arises from the extensive application of display technology and devices in the design, manufacturing, program development, testing, debugging, and technical management of optoelectronic devices and systems. During the teaching process, students are expected to acquire practical operational skills for product development through hands-on activities such as experiments and project design [8].

The rapid pace of knowledge updates stems from the continuous advancements in the display technology industry. As a critical component of modern technological development, the industry evolves quickly with the emergence of new display technologies and devices. Consequently, the course content must be frequently revised to align with industry developments [9]. In summary, the knowledge content of the course requires timely adjustments to accommodate both its intrinsic characteristics and the industry's progress. The construction of a knowledge graph offers an effective solution to meet the course's teaching needs, underscoring the urgency of creating a visual knowledge graph tailored to industry requirements.

2.2. Problems with the existing evaluation system

The current evaluation system exhibits issues such as reliance on a single assessment method, limited involvement of diverse evaluation subjects, and the absence of process-oriented assessments. In the evaluation system for the course "Display Technology and Devices," assessments are predominantly based on final examination scores, which fail to adequately measure students' practical abilities and innovative thinking. Sole reliance on theoretical exams makes it challenging to comprehensively evaluate students' mastery of knowledge and their capacity for practical application.

Moreover, the evaluation system lacks a process-oriented approach, providing insufficient feedback during the learning process. This absence of ongoing assessment can lead to a lack of engagement and clear objectives in the learning experience. Students often resort to short-term, intensive review sessions before exams, which impede a deep understanding of knowledge and its transformation into practical skills. As a result, students may feel uncertain about their learning progress, making it difficult to undertake targeted adjustments to their study strategies.

In summary, the shortcomings of the existing evaluation system hinder the teaching quality of the "Display Technology and Devices" course and the comprehensive development of students. This situation necessitates immediate reforms to improve the system.

3. Construction of knowledge graph for the course "Display Technology and Devices"

A knowledge graph is a semantic network with robust expressive capabilities and modeling flexibility, capable of representing entities, concepts, and their interrelationships in the real world [10]. Its attributes include structural organization, visualization, semantic clarity, scalability, and efficiency. In the educational domain, a knowledge graph serves as a structured and standardized technical tool for expressing and encapsulating teacher expertise or subject knowledge. By linking fragmented teaching resources, establishing associations between disparate educational data, and creating technological value, it provides essential knowledge support for intelligent educational services. These services include semantic search, personalized recommendations, user profiling, intelligent questions and answers (Q&A), behavior prediction, precise analysis, and decision-making support.

During the process of constructing a course knowledge graph, a blended learning approach is applied. This approach organizes course knowledge points and integrates them with industry-driven issues or technological paths within the knowledge graph system [11]. This methodology assists students in developing a comprehensive knowledge framework, enhances their analytical capabilities in solving practical problems during the production of display devices, fosters collaborative learning, and cultivates teamwork skills [12].

3.1. Construction of knowledge graph

The knowledge graph is constructed by identifying key knowledge points, analyzing their logical relationships, establishing interconnections between them, and using specialized drawing software to visualize the resulting knowledge system. This visualization simplifies the learning process for students and supports teaching efforts. For instance, light-emitting diode technologies such as LED and organic light-emitting diode (OLED) are interconnected with the display principles of liquid crystal displays (LCDs), while the three primary color principles interact with various display technologies to achieve color rendering. Structuring these logical relationships enables students to develop a deeper understanding of the course content.

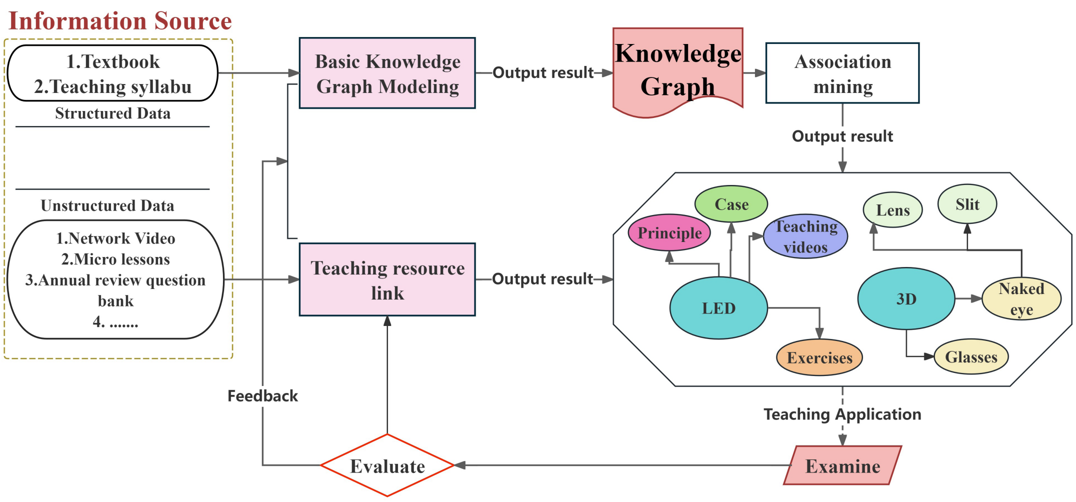

Figure 1. Construction of knowledge graph and teaching process for the course "Display Technology and Devices"

To construct the knowledge graph, various layout methods such as force-directed, circular, grid, tree, radial, and cluster layouts are utilized, with the selection of a specific layout based on the graph's characteristics and the teaching objectives [13]. For hierarchical relationships between knowledge points, a tree layout can clearly display the hierarchical structure, as illustrated in **Figure 1**. Furthermore, the visualization technique enables the division of the knowledge graph's plane into multiple regions. Using the information on these divisions and corresponding layout requirements, the positioning of nodes and relationship edges can be effectively arranged and displayed.

Additionally, the visualization implementation leverages force-directed layout methods based on physical simulations. By balancing forces within the graph data and rendering the final visualization, the method enhances the graphical representation and clarity of the knowledge graph. This approach not only improves the teaching experience but also aids in the effective comprehension of complex relationships within the course content.

3.2. Application effect of the knowledge graph

The application of the learning navigation function provided by a knowledge graph enables students to better comprehend course content and enhances their learning efficiency. In the course "Display Technology and Devices," the knowledge graph interconnects numerous knowledge points, such as diodes, LEDs, OLEDs, and LCDs, to establish a comprehensive and coherent knowledge framework. By organizing logical relationships, the knowledge graph helps students systematically master course concepts, avoiding the pitfall of studying knowledge points in isolation.

Furthermore, based on the characteristics of the knowledge graph and specific teaching requirements, visual presentation methods are utilized to deliver an intuitive and engaging learning experience. These visual aids provide clarity, allowing students to better grasp complex relationships and technologies.

During the instructional design phase, teachers can utilize the relationships between knowledge points within the knowledge graph to organize and sequence teaching content effectively. For instance, when introducing 3D display technology, teachers can reference the structure, principles, and associated technologies of various 3D display systems, such as assistive 3D displays, raster 3D displays, and integrated imaging 3D displays, as mapped within the knowledge graph. This targeted approach facilitates focused instruction and promotes a deeper understanding of advanced topics in display technology.

4. Reconstruction of the evaluation system for the course "Display Technology and Devices"

Course assessment and evaluation play a pivotal role in enhancing teaching quality. A well-designed assessment system facilitates a comprehensive understanding of students' learning outcomes and skill levels, providing a foundation for continuous improvement in teaching practices [14,15]. The current reliance on single-process assessment standards often results in "equalization," with insufficient feedback preventing students from gauging the quality of their learning and making necessary adjustments. This situation can foster a mindset focused on merely earning credits rather than achieving meaningful learning outcomes.

The principles guiding the reconstruction of the evaluation system emphasize objectivity and comprehensiveness. By fully accounting for the professional, practical, and rapidly evolving nature of the course, the evaluation system should adopt diverse assessment methods to ensure objectivity in both content and criteria. The evaluation process must minimize subjective influence and rely on objective evidence. For instance, when assessing experimental skills, clear criteria and standardized procedures should be established to reduce variability caused by human factors, ensuring consistent and unbiased outcomes.

The primary objective of restructuring the evaluation system is to enhance students' practical skills, innovative thinking, and overall competencies. Given the high practicality of the "Display Technology and Devices" course, the restructured system must prioritize hands-on activities such as experiments and project design, thereby encouraging students to actively engage in these activities and elevate their proficiency in practical applications.

4.1. Reconstruction ideas for the evaluation system

Based on the unique characteristics of the course and the limitations of traditional evaluation methods, such as reliance on "homework, attendance, and closed-book exams," the evaluation system should evolve to align more closely with talent development goals and industry requirements. Key aspects of this reconstruction include:

(1) Process assessment: Increasing the proportion of continuous assessment components, such as classroom performance, homework completion, and project participation, is crucial for promoting active engagement. Regular assessments ensure that students remain motivated and focused on their learning. For instance, teachers can assign grades based on student's participation in class activities, such as discussions and presentations, to foster critical thinking and encourage active contribution.

(2) Diversified evaluation subjects: Introducing multiple evaluators, including peer and industry assessments, can improve the objectivity and comprehensiveness of the evaluation process. Peer evaluation enables students to reflect on their own and their peers' learning outcomes, promoting critical thinking and collaboration. For example, students can evaluate each other's projects based on innovation and practicality after completion. Industry evaluations provide real-world insights, offering valuable feedback that bridges the gap between academic learning and professional expectations.

(3) Practical ability assessment: Emphasizing the assessment of practical skills, such as experimental

reports, project designs, and internship performance, is essential for a course characterized by high practicality. Experimental reports offer insights into students' understanding of experimental procedures, operational skills, and data analysis capabilities. Similarly, project design assessments evaluate students' innovative thinking and ability to apply interdisciplinary knowledge comprehensively. Strengthening these assessments ensures that students acquire the hands-on experience needed for their professional growth.

4.2. Implementation of the evaluation system

To ensure the effective implementation of the evaluation system for the "Display Technology and Devices" course, comprehensive evaluation standards and detailed implementation rules must be established. The evaluation criteria should clearly define specific requirements and scoring metrics for each assessment component. For instance, criteria should outline the scoring standards for classroom performance, homework completion, and project participation as part of the process assessment. Similarly, the weight allocation for each evaluation subject in the diversified assessment framework should be specified.

The implementation rules must include a timeline for assessments, detailed procedures for executing various assessment methods, and feedback mechanisms for communicating assessment results. By developing scientific and reasonable evaluation standards and implementation guidelines, the process can be standardized, ensuring fairness, transparency, and smooth operation of the evaluation system.

The integration of assessment and evaluation throughout the teaching process allows for a more comprehensive review of students' learning attitudes and innovative ideas. Establishing a robust feedback mechanism enables the collection of information regarding students' engagement and creativity, facilitating timely adjustments to assessment content and methods. This approach enhances the comprehensiveness and effectiveness of the evaluation system. Additionally, teachers can provide feedback and recommendations through this mechanism, promoting the continuous refinement of the evaluation system.

5. Conclusion

In the "Display Technology and Devices" course, the construction of a knowledge graph offers a systematic integration of complex knowledge points, encompassing topics such as display device technology and 3D display systems. By leveraging knowledge graphs, students gain a better understanding of course content, improve their learning efficiency, and enhance their self-learning capabilities.

The reconstruction of the evaluation system has further motivated students, encouraging active participation in the learning process and fostering comprehensive skill development, which enhances their employability. Process assessment, with its emphasis on classroom performance, homework completion, and project involvement, increases the proportion of continuous evaluation, driving student engagement. The introduction of diversified evaluation subjects, such as peer evaluations and feedback from industry professionals, improves both the objectivity and thoroughness of assessments.

With advancements in artificial intelligence and big data technology, more precise analysis and evaluation of students' learning processes can be achieved. For instance, behavioral data from online learning platforms can be analyzed to understand students' habits and progress, offering personalized teaching recommendations and tailored assessment plans for educators.

Furthermore, ongoing refinement of assessment standards and implementation rules, along with the establishment of a more efficient feedback mechanism, is essential to ensure the system's continued effectiveness. These efforts collectively enhance the teaching quality of the course and contribute to the cultivation of skilled, innovative professionals.

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Disclosure statement

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