A New Digital Teaching Ecosystem Empowered by Knowledge Graphs for "Multimedia Technology and Application"

Jing Wang[1] Yun Zhu[2] Zexi Li[3]

[1,2,3] *School of Computer Science, Zhuhai University of Science and Technology, Zhuhai, Guangdong, China*

ABSTRACT

Knowledge graph, an emerging teaching aid, offers enormous benefits in delivering digital instructions for fundamental computer courses. This study will elaborate on how knowledge graph can enhance the "Multimedia Technology and Application", known as the first-rate web-based course in Guangdong Province in respect of application of graphs, development of graphs, strategies, and analysis of effectiveness, in order to create an efficient, interactive, and personalized teaching setting. This study is taken as a reference for digital teaching methods in undergraduate computer courses at higher education institutions.

Keywords: *Knowledge graph, Digitalized teaching, Teaching ecosystem.*

1. INTRODUCTION

Director Wu Yan, Vice Minister of Education, underlined the importance of exploring new lanes and making innovative breakthroughs during the Global MOOC and Online Education Conference. The critical point lies in the digital transformation of education, which in turn paves the way for advancements in higher education and the use of digital tools to revolutionize the way how students learn. The rapid evolution of education digitization, artificial intelligence, and knowledge graphs has captured an extensive attention and research interest from scholars domestically and internationally. [1] The shift from traditional educational models towards digitalization and intelligence is becoming increasingly evident.

In the field of multimedia technology and application, the fast pace of information updates and technological advancements call on educators and learners to adapt to new technologies and knowledge. Knowledge graph bridges information with knowledge, inspiring a new perspective and motive for digital teaching and learning in the course "Multimedia Technology and Application".

2. CONCEPT AND APPLICATION OF KNOWLEDGE GRAPH

2.1 Basic Concept

In 2012, Google introduced the concept of knowledge graph connecting knowledge through relationships to form a mesh-bonding knowledge structure [2-3]. The knowledge graph in structured form describes concepts, entities, and their relationships in a readily recognizable and understandable manner, suitable for computer management. It utilizes an "entity-relationship-entity" form for resource description and storage [4]. In a word, the knowledge graph is a structured semantic knowledge base that graphically represents knowledge entities and their relationships.

2.2 Education Applications

When applied in the field of education, knowledge graph is an efficient tool that aids both teachers and students in structuring and comprehending course material, facilitating a deep linking of knowledge and the integration across various disciplines. By visually illustrating the relationships among different units of knowledge,

this approach enables students to realize the connections between theoretical concepts and real applications. Through the creation of subject-specific knowledge graphs, teachers can clearly present fundamental principles and methodologies of the course, empowering students to enhance their comprehension and application of knowledge points through interactive knowledge graphs.

3. DEVELOPING A KNOWLEDGE GRAPH CENTERED ON THE "MULTIMEDIA TECHNOLOGY AND APPLICATIONS" COURSE

Multimedia technology is defined as a computer-empowered approach that combines texts, images, sounds, videos, and other forms of media. The course "Multimedia Technology and Application" can be delivered in a range of forms to arouse learning interests and engagement of students. Certain theoretical concepts can be illustrated through animations, simulation experiments, and other alternatives; abstract concepts can be converted to tangible ones through charts, videos, and other multimedia components, which in turn help students in comprehending and mastering the course materials. The use of knowledge graph can visualize the research content and interconnections of the course "Multimedia Technology and Application", thus assisting students in constructing a well-rounded knowledge framework.

For course delivery of "Multimedia Technology and Application", teachers create a comprehensive knowledge graph covering key knowledge points in respect of image processing, animation, video processing, audio processing, VR, among other fields. Each knowledge point covered in the knowledge graph is defined in details, with arrows indicating the logical connections between them. Teacher also develops a range of multimedia teaching materials, including demo videos, e-tutorials, animated demos, and script writing exercises. When delivering courses, students initially explores the knowledge graph to get a glimpse of the overall course structure. When they select a given knowledge point, relevant multimedia resources will be automatically delivered to help them digest this knowledge point. For example, clicking on the "Flash Animation Instances" node would pop up a microlecture video showing some 2D animation techniques and real application scenarios, such as frame animation, tween animation, and shape tweening. Furthermore, students can directly submit assignments via the web-based teaching platform, which is taken as an index for learning process assessment. This approach not only allows students to grasp the course-specific knowledge framework from a big picture, but also enables them to gain an insight into the specifics of each concept. By enhancing learning efficiency and arousing interests, this approach empowers students to acquire a broader range of knowledge within a limited timeframe.

The technique of integrating knowledge graph with the course "Multimedia Technology and Application" has revolutionized the landscape of digital education. On the one hand, knowledge graph offers a broad overview of the knowledge structure, which in turn assists teachers in designing courses and instructional strategies. On the other hand, the flexibility of adding nodes and edges to a knowledge graph one after another allows for a seamless transition from a major concept to minor details. The whole framework shows the interconnection of knowledge points at every two adjacent levels step by step. By linking nodes and relationships as part of a knowledge graph with plenty of learning resources, teachers can develop comprehensive and engaging digital learning materials. Students can navigate the knowledge graph by clicking on a given node, facilitating a deeper comprehension of each concept through a variety of materials and highlighting the relationship between major concepts and specific knowledge points.

4. STRATEGIES FOR BUILDING A DIGITAL TEACHING ECOSYSTEM

In order to establish a new digital teaching ecosystem centered on the course "Multimedia Technology and Application", the primary approach involves the utilization of a knowledge map as the central component.

4.1 Curriculum Design

Teachers are advised to develop a curriculum system that aligns with the structure of the knowledge graph, taking into account the subject-specific characteristics and teaching objectives. This requires teachers to have profound expertise, a broad view of the subject, a whole concept from big picture to details, as well as the ability to deliver structured knowledge and the ability to operate software. At present, there are many generative

software for knowledge graphs and mind map, such as Chaoxing, Xmind, which can assist in generating knowledge graph, knowledge tree, mind map to enhance the efficiency of knowledge structured generation. Hence, these software are used for teaching practices.

4.2 Development of Resources

Efforts should be done to develop educational materials in various multimedia formats suited to the knowledge graph, such as texts, images, audios, and videos. These resources should accurately represent the information within the knowledge graph and offer a high level of interactivity and user engagement. "Multimedia Technology and Application", the first-rate web-based course contributed by Zhuhai College of Science and Technology, is accessible to the public through platforms like "Classroom Online" and "Guangdong, Hong Kong and Macao Greater Bay Area Online Open Course Alliance". This course consists of 486 course resources, 14 assignments, 352 questions in the course database, and 14 question papers. The 56 teaching videos available on the platform are linked to specific nodes in the knowledge graph, allowing users to easily navigate to relevant video and tutorial resources.

4.3 Mode of Teaching

A teaching approach called "one map, two tutors, and three integrations" has been developed. This approach combines a knowledge graph with a school-enterprise dual tutoring system. The three integrations means an integration of web-based and face-to-face instruction, industry and education integration, and ideological and political elements integration. When delivering a class, teachers lead students in actively exploring the knowledge graph, enabling them to mobilize a variety of teaching resources for learning. Additionally, teachers continuously refine the knowledge graphs and teaching resources in response to students' comments and data automatically generated by the system.

4.4 Teaching Process

The teaching process is guided by the concept of mapping from end to end. Before the class, the overall graph of the course is introduced, which gradually corresponds to the chapter graph and knowledge points from the broad knowledge framework; then the teaching content of the chapter is introduced by introducing the problem graph, also with MOOC and micro-video resources. The course is delivered in the hybrid form of face-to-face lectures and online Q&A, and the learning platform is used to provide the comments from students. After class, the capability graph is formed and evaluation comment is generated.

4.5 Assessment and Comments

Efforts should be made to build an efficient assessment mechanism to oversee and evaluate students' learning progress and achievements. The total score for the assessment is 100 points, with 50% allocated for a comprehensive process evaluation and the remaining 50% for a flexible assessment. The comprehensive process evaluation consists of 20 points for e-learning and 30 points for face-to-face learning. The flexible assessment includes two types of exams: pre-registered exams and scheduled exams, with the specific assessment method detailed in “Figure 1”. By gathering process evaluation point on a third-party certification platform, teachers can receive prompt feedback on students' learning data in various aspects, enabling them to enhance teaching methods and content effectively.

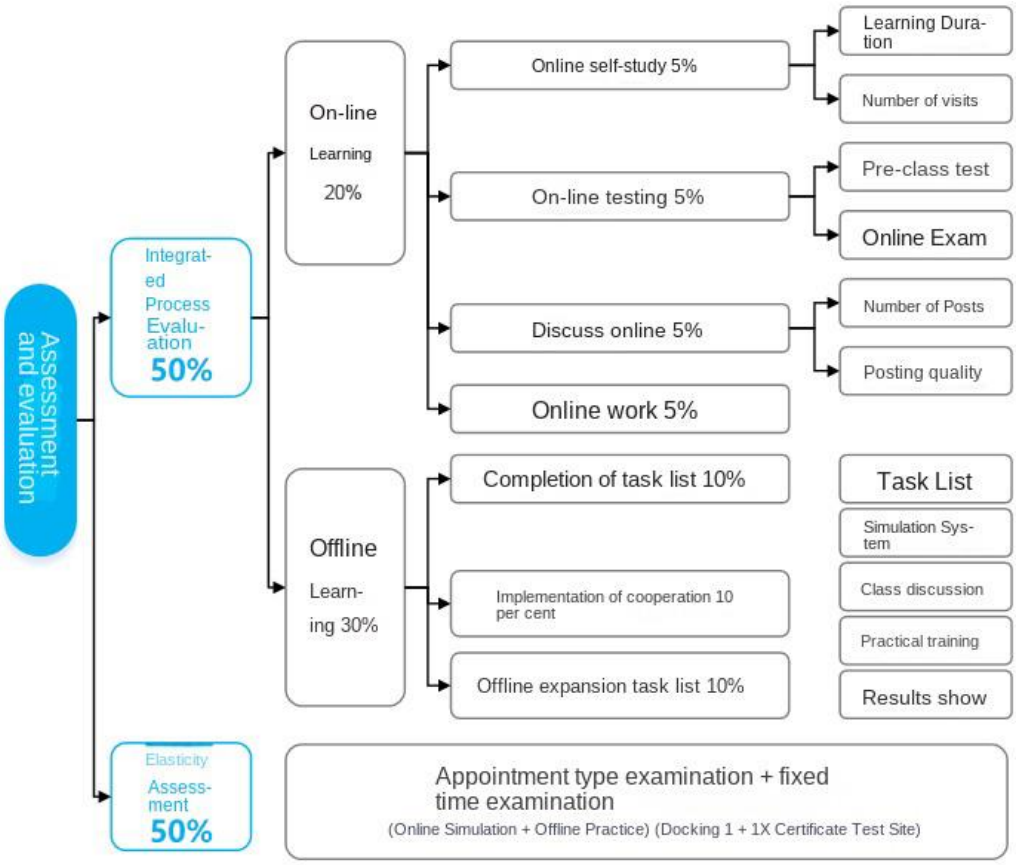

Figure 1 Assessment procedure.

5. ANALYSIS OF TEACHING EFFECTIVENESS

Knowledge graph is essential in the "Multimedia Technology and Application", as it tailors the concept of a broad range of course clusters to students, enabling personalized teaching and collaborative learning effectively.

5.1 Conceptualizing Course Group

The creation of the "Multimedia Technology and Applications" course clusters involves conceptualizing course clusters of the prerequisite and follow-up courses, and infusing the ideological and political components. This approach facilitates a seamless connection of knowledge points across courses, enabling students to get the big picture of the relationships across knowledge levels. Emphasizing the importance of developing a knowledge graph guides students to take a proactive approach to learning, both in and out of the classroom. This not only enhances students' engagement and motivation but also boosts their comprehension and retention of new information, ultimately preparing them for future career track [5].

5.2 Delivering Personalized Teaching Instructions

Personalized learning is a significant trend in the education sector, and the application of knowledge graph in this area reveals immense benefits. Knowledge graph inspires some new ideas and approaches on the way to education information. Through the integration of knowledge graphs with multimedia technology, teachers can develop more engaging, interactive, and tailored instructional materials. This in turn creates a learning setting that is more intuitive, engaging, and effective for students. Machine learning algorithms analyze the data concerning students' learning records and interactions to deliver precise personalized recommendations. These recommendations are based on their individual learning behaviors, enabling them to follow the most appropriate learning paths. For instance, students with a keen interest in animation production can receive recommendations for

learning resources related to Flash animation design and animation programming. Similarly, those interested in video post-processing can access guidance on video editing software, case studies, and other relevant content. Those more interested in image processing can benefit from recommendations on Photoshop production, image processing techniques, and color theory.

5.3 Facilitating Collaborative Learning

Collaborative learning offers a crucial tactic for enhancing learning efficiency, and knowledge graph can facilitate interaction and collaboration among students. Within an open learning space, students are able to monitor learning progress each other, exchange their individual learning experiences, and collaborate on specific project assignments, such as teaming up to finalize an ad design and production or shooting and editing a short video. This open learning setting serves to inspire their motivation to learn and encourages an insightful and creative application of knowledge.

5.4 Commenting the Effect of Application

The recent years has seen a surge in students' interest for learning following the introduction of knowledge mapping. Consequently, the merit and pass rates of students have shown a steady increase annually.

6. CONCLUSION

Knowledge graph is holding an immense potential for “Multimedia Technology and Application”. However, there are several practical considerations that must be taken into account for bringing out its anticipated role. Developing a full-scale and precise knowledge graph requires a lot of time and effort, thus putting a hurdle against some teachers. Moreover, both teachers and students should be adequately trained to become proficient in using and modifying knowledge graphs. Technical hurdles also include how to ensure the reliability and scalability of the knowledge graph, as well as protecting students' privacy and data security.

As AI, machine learning, big data, and other technologies are expected to advance, it is projected that knowledge graphs are transiting to the intelligent and efficient track. This enables the automatic creation and updating of knowledge graphs, making them an essential tool in “Multimedia Technology and Application”. Students will benefit from a more engaging, interactive, personalized learning experience, while teachers will find their workload eased. The application of knowledge graphs in education will go wider and deeper, opening up new opportunities for digital teaching. Looking ahead, it is advisable to explore further to enhance and evolve this proposed teaching approach.

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