

The Effectiveness of Using Knowledge Graph-Based Navigation in Online Learning——Take Xi'an Jiaotong University as an example

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Abstract. The advantages of non-face-to-face teaching interaction in online learning have been highlighted after COVID-19, and it has now become an international trend. However, there is also an issue of poor control ability over students' autonomous learning process. To explore how students can use tools to improve the efficiency of online course learning, this paper selects the MOOC (Massive Open Online Course) tool from online learning platform of Xi'an Jiaotong University to discuss the characteristics, advantages, and relevance of its usage to course examinations of a course learning navigation application based on knowledge graph design. In this paper, empirical research found that navigation affects the performance of online learning and that the chapter and navigation functions help students develop personal learning behavior. Q&A and peer review functions strengthen the thinking connection of group learning and improve the average exam scores. In addition, it helps managers master the dynamics of online learning to improve teaching methods. Finally, this paper gives suggestions from the perspective of scientific value and practical sense that incorporating knowledge graph as a central element in the online course design, more guidance for teachers and students to use this tool, sustainably keeping eyes on effectiveness on other educational levels, active adopting for schools and educational institutions, and being close attention to feedback and continuous improvement on functions developed.

Keywords: Effectiveness, Knowledge Graph-Based Navigation, Online Learning.

1. Introduction

UNESCO in 2023 argues that as the deeper integration of technology and pedagogy unfolds in global education, Massive Open Online Courses (MOOC) learning is confirmed to be one of the most significant technological developments in Online learning [1]. More students from society are inclined to choose MOOC learning after COVID-19 due to the convenience of learning at home and the support provided by accessible mobile learning devices such as smartphones. However, the large-scale sharing of MOOC courseware and the influx of learners have not resulted in an improvement in the quality of MOOC learning, on the contrary, it has further amplified the disadvantages of traditional MOOC learning, such as rigid learning behaviors and standardized learning methods. As a result, students often perceive the learning experience as monotonous, lacking interactivity and autonomy. Therefore, R.K.Sawyer gave Educational Technology a concept of deep learning approach that Internet-based networks of learners might share and combine their developing understandings and benefit from the power of human-machine collaborative learning, which triggered many researchers in educational technology to pay more attention to the connection and application of the knowledge graph concept with learning cognition [2]. A kind of tool called Navigation was base-designed on the knowledge graph for MOOC learning that proved to effectively guide students in personalizing learning and inspiring constructive learning.

Above all, this paper will choose a course learning navigation system designed based on the knowledge graph (Xi'an Jiaotong University) in MOOC learning as the subject of research, and through the analysis of the differences in course scores between a set of comparative groups to investigate the correlation between the using of knowledge graph-based navigation and learning effects in online education, thereby to explore the effectiveness and significance of using knowledge graph-based navigation in online learning [3].

2. The Application of Knowledge Graph-Based Navigation in MOOC learning

The course learning navigation, designed with a knowledge graph as the underlying logic, is a plugin tool embedded within the course materials at Xi'an Jiaotong University. It focuses on facilitating the connection and visualization of knowledge points and students' thinking processes, aiming to support their self-directed learning within the course materials. The plugin is uniformly used in MOOC learning, which makes more convenience to students engaged in online learning.

2.1. Functions

The navigation tool encompasses three main features: the knowledge point chapter directory, note-taking, and a question-and-answer section. The knowledge point chapter directory provides an outline of the course and organizes the knowledge points for students to quickly browse and grasp the content of the course. Each chapter corresponds to a specific time point in the course materials, allowing students to choose and focus on the knowledge content they need to study. The note-taking feature provides students with an area to record knowledge points and expand their thinking. These notes can be digitally accessed during chapter reviews or shared with other students in the course for supplementation or comments. The question-and-answer section is an open platform where students can ask questions and receive responses from both teachers and fellow students. This interactive feature encourages active engagement and collaboration among learners.

Overall, the course learning navigation, designed with a knowledge graph, offers students a comprehensive set of functionalities, including a knowledge point chapter directory, note-taking, and a question-and-answer section. These features enhance students' autonomy and engagement in online learning, promoting a more effective learning experience.

2.2. Characteristics

Systematics, adaptability, and connectivity are the main features of knowledge graph-based navigation in its application. Students can follow a self-directed learning route thanks to the organization of information points into chapters and the connections between them. Instead of adhering to a rigorous, sequential distribution of course contents, this enables students to pick the subject they wish to learn more flexibly, rather than following a rigid, sequential delivery of MOOC courseware.

Under the background of the continuous development of online learning modes such as MOOC, the effect of exploring the application of knowledge graph-based navigation on course test scores has become a research hot topic.

3. Method

3.1. Research Methods

In this paper, an empirical study approach was employed to investigate the effectiveness of knowledge graph-based navigation applications on course examination scores and student online learning.

The research design consisted of a comparative experiment conducted with a control group [4]. The students who selected by criteria of participants to an experimental group that utilizes the knowledge graph-based navigation application for MOOC learning in the course Nursing Management, and a control group that employs traditional learning methods. Finally, using statistic analysis to compare the differences in examination scores between the two groups.

3.2. Data Collection and Analysis

The students learning online especially those who are from society exhibit diversity in aspects such as age, cultural background, and so on. To ensure representative research data and minimize selection

bias, this paper employs a statistic tool called G power to set the exact sample size algorithm for a randomized controlled experiment [5].

This research selects 206 sample sizes which learners who learn on Xi'an Jiaotong University MOOC learning platform to be the total sample, including 103 learners enrolled with KGN (Knowledge Graph-based Navigation) to group1 and 103 learners not with KGN to group2.

3.3. Data Selection

A comparative experiment was conducted on group 1 and group 2. Students in group 1 use navigation tools to study the Nursing Management MOOC course and complete it within a week. On the other hand, students in group 2 did not use navigation tools and solely relied on watching the Nursing Management courseware, as well as completing it within a week. On the final day, a course examination was conducted, collecting the exam scores from the platform, and using random sampling to set the experimental data which marked scores(Y) to Group1 and scores(N) to group2. There is a basic difference that can be seen from the data collection.

To give a statistical analysis of comparing course scores(Y) and scores(N) of group2, the results are analyzed using SPSS paired T-test, and three aspects can be seen.

Firstly, as shown in table 1, navigation affects the course scores because there is a positive difference between scores (Y) and Scores (N) in this experiment, which is presented by $p=0.003^{**}<0.05$. Furthermore, as the specific analysis shown in Table 1, a significant difference at the 0.01 level between scores (N) and scores (Y) ($t=-3.069$, $p=0.003$), as well as the specific comparison difference shows that the mean of scores (N) (77.52) will be significantly lower than the mean of scores (Y) (82.02). This data indicates that students who utilized navigation achieved significantly higher grades compared to those who did not utilize navigation.

Table 1. Correlation analysis results

Paired <i>t</i> -test analysis results					
name	Paired (mean $\pm$ standard deviation)		Difference (pair 1 - pair 2)	<i>t</i>	<i>p</i>
	Scores(N)	Scores(Y)			
scores(N) paired scores(Y)	77.52 $\pm$ 10.26	82.02 $\pm$ 10.05	-4.50	-3.069	0.003**

Secondly, as shown in table 2, Cohen's d value provides a specific measure of effect size, allowing researchers to observe the magnitude of the difference between scores (Y) and scores (N) and determine the significance of the navigation effect on the difference of scores. In the field of educational research, the critical thresholds for distinguishing small, moderate, and large effect sizes are as follows: 0.20, 0.50, and 0.80 respectively [6]. So, in this experiment, Cohen's d value is 0.307 which suggests that the effectiveness of navigation on the difference in learning performance is moderate.

Table 2. In-depth analysis-effect size indicator

In-depth analysis-effect size indicator					
name	Mean difference	95% CI of difference	<i>df</i>	the standard deviation of the difference	Cohen's <i>d</i> value
scores(Y) paired scores(N)	-4.50	-7.410 ~ -1.590	99	14.664	0.307

Thirdly, as shown in figure 1, the overall scores(Y) of the participants who used knowledge graph-based navigation, are significantly higher compared to the scores(N) of the control group, which means that navigation can improve the average scores of the group learning and contribute to overall score stability. Besides, both the lowest score of 65 and the highest score of 100 demonstrate superior performance compared to students who did not utilize navigation, which indicates navigation can improve the individual exam score.

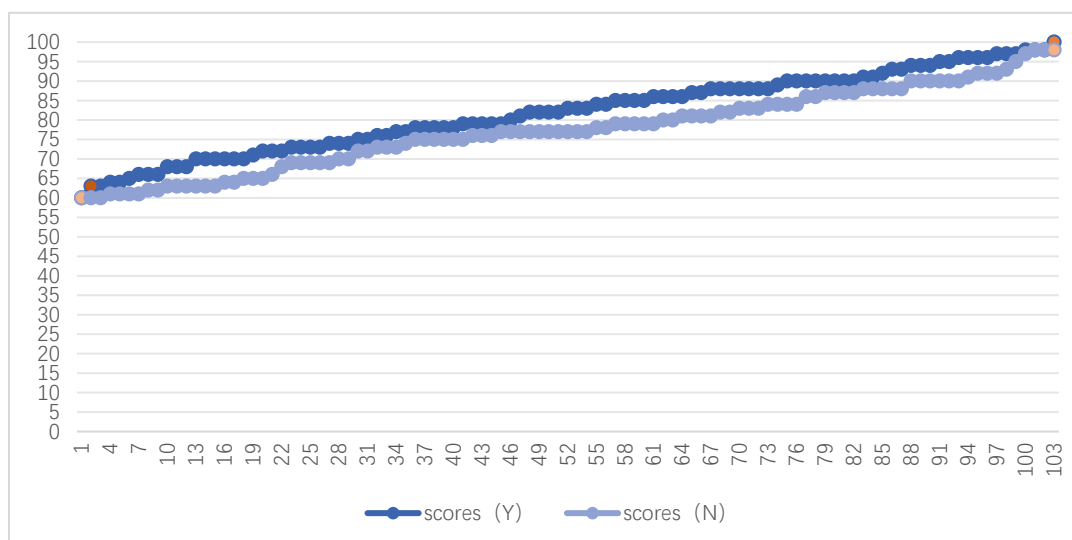


Figure 1. Differences between two pair of scores

4. Reason Analysis

The correlation between knowledge graph navigation and learning improvement has been confirmed above. Combined with the observation of students' learning behavior from the Xi'an Jiaotong University online learning platform, it can be found that Knowledge graph-based navigation could deeply assist students can better completing online learning, specifically in the following aspects.

4.1. Systematically Organized and Navigated for Online Learning

Compared to the traditional MOOC course, the knowledge graph is more systematically used to structure and organize course content hierarchically. It gives students a visual representation of the course's knowledge domain, making it simple for them to move between different themes, chapters, and knowledge points [7]. Students can investigate the relationships between ideas and select the learning route that best fits their requirements. Therefore, for the online learning of professional courses, navigation enables students to have a clearer understanding of their way of learning, thus improving the effect of individual performance.

4.2. Helping Students to Improve Their Advanced Thinking Ability

Taking notes and sharing with students when using the navigation can improve their review and reflection in online learning [8]. Sharing and mutual evaluation, as a Peer review, is an important step in collaborative learning. In addition, through questions and answers, students can constantly examine their online learning of courses, and ultimately improve their high-level thinking skills of online learning. Therefore, online group or class learning, promotes each other's learning thinking, strengthens the thinking connection, and improves the overall average test scores.

4.3. Convenient to Learning Analysis for Management

Navigation supported by the knowledge graph can store all kinds of data on students' learning, including the click-through rate and frequency of each chapter of the catalog, note entries, content, and the collection of questions and answers in the question and answer area. For example, the all data in this paper was collected from the navigation system on Xi'an Jiaotong University's online learning platform. As a manager, analysis of this data provides insight into learner progress, engagement, and level of mastery. It is beneficial for managers to master personalized feedback from online learning, identify improved areas, and optimize teaching strategies to achieve better online learning outcomes.

5. Suggestion

Through the above data and analysis, this paper puts forward some suggestions from the perspective of scientific value and practical sense.

From the perspective of scientific value, knowledge graph-based navigation helps students to strengthen the connection between personal knowledge and thinking and improve the way of online learning, to improve the performance of online learning. Therefore, knowledge graph navigation can be further integrated into the design of online courses and strengthened in terms of usage. Here are some specific suggestions.

5.1. Reflect the Role and Effectiveness of Knowledge Graph

Teachers and course designers can consider the functionalities of knowledge graph-based navigation to present the learning content in the form of a graph or chapter when designing online learning courses. This helps students gain a clearer understanding of the relationships and hierarchical structure among different concepts. It assists students in building a stronger knowledge framework and improves their ability to synthesize and apply knowledge.

Researchers should contribute to a deeper understanding of the impact of navigation technology on different learner populations and provide more specific guidance for customized learning support, to expand the application scope of knowledge graph-based navigation, such as its effectiveness in primary education and higher education [9].

In a practical sense, in the face of the trend of online learning, the flexibility and convenience of knowledge graph navigation can not only use MOOC but also extend to all kinds of online courses to open the market of online resource learning.

5.2. Strengthen Guidance on Use

Educational institutions and online learning platforms can actively adopt knowledge graph-based navigation as a tool to improve students' learning performance. Students can navigate, organize, and understand learning materials more effectively by using this tool in learning online, thereby enhancing their learning achievements. To help teachers and students make the most of this tool, schools, and educational institutions can organize more training to give a detailed explanation of how to use knowledge graph-based navigation. Teachers can learn how to create and maintain knowledge graphs effectively to better support students' learning processes. Meanwhile, students can receive guidance on how to use the navigation features to maximize their learning outcomes.

5.3. Focus on User Feedback, Sustainable Development

An extensive collection of resource links should be practiced in this tool which utilizes knowledge graph as the foundation of the design, so it is essential to address the current limited expansion of resources in knowledge graph-based navigation. That means continuous attention should be given to learners' needs for expanded resources, and the development of additional functionalities to facilitate online learning [10].

6. Conclusions

This paper focuses on the application of knowledge graph-based navigation in MOOC learning on Xi'an Jiaotong University's platform, discussing the effectiveness of this tool in online learning. The data reveals that this navigation can help students from society to conduct online independent learning and improve their examination performance. From the perspective of using, the usage of tools breaks the traditional mechanized learning method of watching the courseware and connects with students' knowledge reserve. Through the directory selection of the list of knowledge points chapters, selective learning is flexibly conducted, which cultivates students' personalized learning mode of online learning. At the same time, peer review, notes, and Q&A functions help social students strengthen their deep-thinking skills and develop their memory, reflection, and collaborative learning skills in

the online learning process. From the perspective of learning effectiveness, through a group of control experiments, the usage of knowledge graph-based navigation can improve the learning effect of online professional courses, so that students can get higher exam scores. The learning navigation tool is designed with a knowledge graph as the underlying logic mainly strengthens the connection between knowledge and thinking in the process of online learning, and promotes the cultivation quality of online learning.

As the conclusion of the above data analysis and discussion, this paper proposes specific suggestions, including incorporating knowledge graph as a central element to course designers, organizing more training and guidance to teaching managers to help teachers and students use this tool better, sustainably keeping eyes on the effectiveness of navigation for other educational levels to researchers, active adopting to schools and educational institutions and being close attention to feedback and continuous improvement on functions developed to navigation designers.

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