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Article

Exploring the Application of Knowledge System of Finance Discipline Constructed on the Basis of Knowledge Graph in College Education

Li He *

Concord College, Fujian Normal University, Fuzhou, Fujian, 350000, China; 30339247@163.com

Abstract: Applying disciplinary knowledge mapping to teaching in colleges and universities, taking the knowledge system of financial disciplines as the entry point, based on the disciplinary knowledge mapping technology, using the CRA model and employing the top-down method to construct a financial disciplinary knowledge map with the characteristics of professionalism, openness, interactivity and intelligence. Through the questionnaire survey, the application of the knowledge graph visualization system is analyzed mainly from three dimensions: system design, learning support, and learning effect. The results show that 60% of the users in the three dimensions of system design, learning support and learning effect are very satisfied and satisfied, and no more than 30% of the users are dissatisfied. The knowledge graph of financial discipline constructed in this paper can adequately represent the knowledge of the field and meet the application requirements such as supporting the deep learning of knowledge in the financial field.

Keywords: CRA model; knowledge graph; visualization system; financial discipline

1. Introduction

In recent years, with the development of artificial intelligence, big data, carbon neutrality, digital economy and other fields, in the financial industry, financial technology, green finance, virtual currency and other new forms are emerging, which makes practitioners in various branches of finance need to have an in-depth mastery of economic theories, computer data methodology, mathematical models and related industry knowledge on the basis of having knowledge of traditional securities trading [1-4]. This puts forward new requirements for the cultivation of students at all levels of finance majors and the construction of curriculum system. How to improve the level of interdisciplinary training of finance majors and the ability to cultivate financial composite talents is one of the hot topics in the field of financial education and research.

As an advanced information organization and representation technology, the application of knowledge graph in the field of education is gradually becoming an important driving force to promote the intelligent development of education [5]. Knowledge graph is a form of knowledge expression represented by a graphical structure, which represents the relationship between entities through the combination of nodes and edges [6]. Each node represents an entity, while edges represent relationships between entities. These entities and relationships have semantic information that enables computers to capture things in the real world and their interrelationships to better understand and reason about knowledge [7-9]. The rise of knowledge graph technology allows massive data information to be managed in a better organized form to achieve domain knowledge cohesion [10].

Discipline knowledge graph is a kind of discipline-based knowledge graph, discipline knowledge graph is constructed around teaching resources such as course materials and lecture PPTs, and it can fully demonstrate the discipline knowledge organization structure by displaying important entities, relationships and attributes within the discipline domain in the form of graphs [11-13]. By constructing a disciplinary knowledge map, the knowledge system within the disciplinary field can be better integrated and displayed to make up for the shortcomings of fragmentation in traditional teaching methods [14-15]. This structured knowledge representation helps to deepen the understanding within and across disciplines, providing students with more systematic and comprehensive disciplinary knowledge [16].

Introducing disciplinary knowledge mapping into higher finance professional education and constructing discipline-specific knowledge maps is of great significance to students, teachers and schools [17]. For students, subject knowledge mapping shows the organizational structure of subject knowledge in graphical form, which enables students to understand the hierarchical structure of the subject and the relationship between knowledge points, the intersection and integration points between subjects more intuitively, and they can explore the subject knowledge more independently, and choose the learning path that suits them [18-19]. For teachers, through subject knowledge mapping, they can better understand the structure of subject knowledge and the association between subjects, which can help optimize the content of subject teaching, better understand the data of students' learning behaviors and mastery of subject knowledge, and accurately grasp the learning status of students [20-21]. For schools, through the effective use of subject knowledge mapping, schools can better adapt to the development trend of the knowledge society and realize the sustainable development of education [22].

Aiming at the problems of numerous knowledge points and correlation in financial discipline, this paper proposes a disciplinary knowledge mapping model based on CRA model. With the subject data obtained from the textbooks of Monetary Banking, Financial Economics, etc., the concepts, relationships, and rules in the knowledge map of the financial discipline are extracted and represented using the ternary model, and the establishment of the knowledge map of the financial discipline is accomplished through the fusion of the subject knowledge and the reasoning process. Taking the first-year students of a university as the research object, a questionnaire survey was designed using the Likert five-point scale method to analyze the application of the knowledge graph visualization system from the three dimensions of system design, learning support, and learning effect, and to validate its effectiveness in college education.

2. Modeling of Disciplinary Knowledge Graphs Based on CRA Models

Subject knowledge graph modeling is built based on the CRA model, i.e., the concepts (C), relations (R), and rules (A) in the subject knowledge graph are represented using the ternary model. Here, some chapters of High School Mathematics of the Humanistic Version are used as an example [23]. Here, some chapters of Financial Economics are taken as an example, and the knowledge map is shown in Fig. 1.

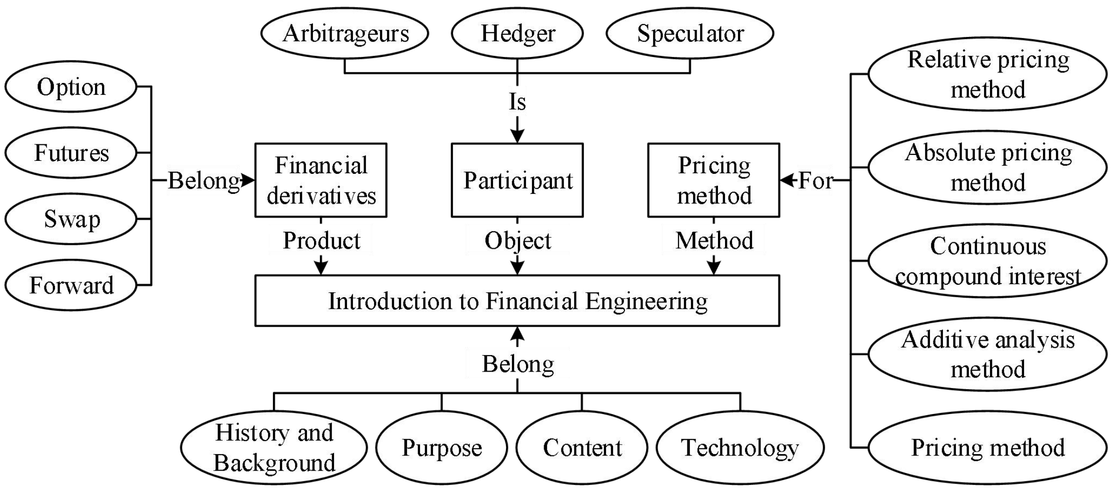

Figure 1. Knowledge graph before optimization.

2.1. Concepts

In disciplinary knowledge mapping, a concept is an individual that uniquely identifies a unit of meaning. It mainly consists of concrete instance objects and abstract concepts constructed based on instances.

(1) Concept:

$$c:T_c = \{t_{c_1}, t_{c_2}, \cdots, t_{c_n}\} \quad (1)$$

The set, $t_{c_1}, t_{c_2}, \cdots, t_{c_m}$ represents m different names and all of these names can be represented by the concept c. For example, vectors can be called both Euclidean vectors and vectors, and can be represented as $c:T_c$ (vector)={Euclidean vector, vector}.

(2) Set of concepts:

$$C = \{c_1, c_2, \cdots, c_n\} \quad (2)$$

In a set, $c_1, c_2, \cdots, c_n$ represents n distinct concepts. For example, set, function, which are distinct concepts, can be represented as follows: c = {set, function}.

(3) Name:

$$t:C_t = \{c_{t_1}, c_{t_2}, \cdots, c_{t_i}\} \quad (3)$$

The set, $c_{t_1}, c_{t_2}, \cdots, c_{t_i}$ represents i different concepts, which can all be denoted by the name t, i.e., more than one concept shares a name, representing the case of multiple meanings of the word in the chain of entity references, in which case, $C_t \subset C$. For example, the word “unit” in mathematics means the name of a standard quantity for measuring things, while in life it refers to an organization, a group, or various departments belonging to an organization or group. It can be expressed as follows: $t:C_t$ (unit)={standard quantity, organ}.

(4) Collection of names:

$$T = \{t_1, t_2, \cdots, t_j\} \quad (4)$$

In a set, $t_1, t_2, \cdots, t_j$ represents j distinct names. For example, the true subset, the empty set, the logarithmic function, and the exponential function are different names and can be represented as follows: T = {true subset, empty set, logarithmic function, exponential function}.

2.2. Relationships

In disciplinary knowledge mapping, relationships are concept-to-concept, concept-to-knowledge point, and knowledge point-to-knowledge point connections:

$$T_A = \{t_{A_1}, t_{A_2}, \cdots, t_{A_j}\} \quad (5)$$

The set, $t_{A_1}, t_{A_2}, \cdots, t_{A_j}$ represents the names of j distinct relationships. There are many kinds of relationships in the subject knowledge graph. For example: concept to concept: the mapping of two sets is a function; concept to knowledge point: a function contains an inverse function; knowledge point to knowledge point: the boundedness of a trigonometric function is an application of the function's most value. For these various relationships, the following representation is made: T_A = {mapping, containment, application}.

2.3. Rules

In disciplinary knowledge graphs, rules refer to the specification of things in the knowledge graph and can be used for reasoning. The main function of rules is to ensure the normality of the internal organization of the knowledge graph, and to provide the premise for the subsequent reasoning knowledge and mining implicit knowledge. Rules can be categorized into constraint checking rules and knowledge reasoning rules. Constraint checking rules can ensure the normality and unity of the content and internal organization of the knowledge graph, while knowledge reasoning can construct or discover unknown knowledge through existing relationships.

In the process of constructing knowledge graph, for example, the constraint checking rules are used to limit the appearance of relations such as “the nature of the value domain is a function” and “the application of the derivative is deterministic”. According to the rules, you can associate the query in the knowledge map, get the implicit knowledge in the knowledge map using the rules for reasoning, for example: querying the concept of set, not only will get the knowledge about the set, but also about the concept of function and knowledge.

Through the above steps, $KG = (C, R, A)$ ternary model, i.e., CRA model, is formed. Constructing a knowledge graph based on the CRA model makes the semantics clearer, which can make the knowledge graph more suitable for tabulating, storing and reasoning about massive knowledge, and give full play to the function of the knowledge graph to provide learners with richer learning materials.

3. Knowledge Mapping of the Discipline of Finance

3.1. The Current State of the Curriculum in the Discipline of Finance

(1) A large number of knowledge points.

Financial engineering courses are extensive, covering a large number of definitions, models, theories, algorithms, and application methods, and students face great challenges in memorization and comprehension during the learning process. Taking commonly used financial engineering textbooks as an example, they include but are not limited to knowledge points on derivatives markets, financial risk management, asset pricing, fixed income securities and so on. The large number of knowledge points in each category makes it difficult to understand and memorize. For example, the definitions, rules and models in the derivatives market involve options, which involve pricing and risk management of complex financial instruments such as options, futures and swaps. Students need to master a large number of pricing methods and modeling assumptions, and the number of knowledge points in each category is also large and needs to be flexibly utilized in practical applications. In addition, from the point of view of the type of questions, calculations and proofs are difficult for students, and they need a lot of practice to consolidate them after class. The static problem solving process cannot reproduce the thinking process, and it is difficult for students to understand the ins and outs of the answers during self-study, which affects the learning effect.

(2) Strong relevance.

Financial engineering courses not only have a lot of knowledge points, but also a strong correlation, if you remember the wrong or do not understand thoroughly, it is likely that a chain reaction will occur, affecting the overall learning effect. For example, in the asset pricing model, if you want to derive the pricing of complex financial instruments from a basic model, you need to go through multiple steps of calculation, involving multiple concepts and methods. If students forget or misremember a key concept or calculation step, the end result will be wrong. The complex interrelationships between knowledge points require students to understand not only individual knowledge points, but also their position and role in the overall knowledge structure during the learning process, otherwise it will easily lead to errors and incomplete understanding in calculations and applications.

3.2. Subject knowledge mapping construction

According to the quality requirements and application paradigm of knowledge data, this study adopts a top-down approach to construct a disciplinary knowledge graph [24], and the construction method is shown in Figure 2.

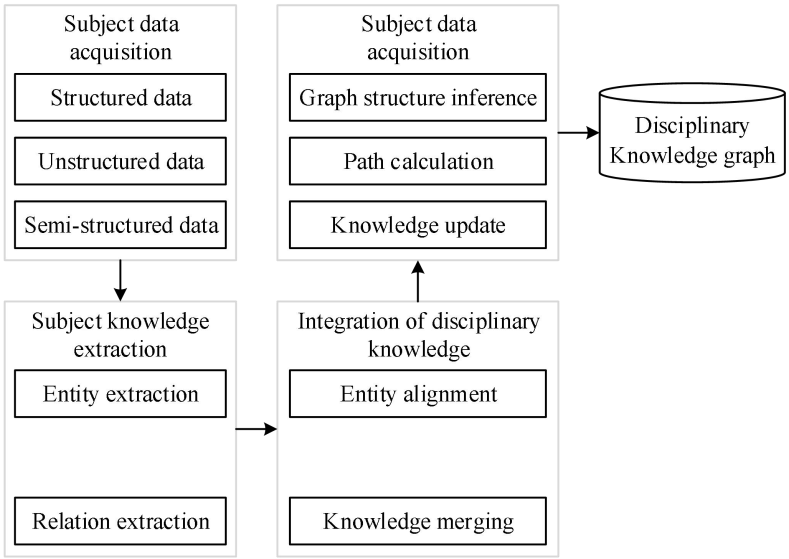

Figure 2. The construction method of the disciplinary knowledge graph.

3.2.1. Access to disciplinary data

Using data mining techniques, this model obtains disciplinary data from educational big data distributed in the field of finance disciplines, including structured data unstructured data and semi-structured data. Based on the educational big data, CRA modeling techniques are used to identify and extract the entities of discipline knowledge to obtain structured data that can be directly processed, and then processed using the Resource Description Framework (RDF) and stored to the data layer and model layer of the discipline knowledge graph to construct the discipline knowledge database.

3.2.2. Subject knowledge extraction

Discipline knowledge extraction is divided into two parts: entity extraction and relation extraction. Based on the conditional random field model and KNN algorithm, concepts, formulas, theorems and other knowledge elements related to subject knowledge are automatically extracted from subject data, and their contents and attributes are associated with them as subject knowledge entities, thus forming subject knowledge elements. The conditional random field model is used to define, extract and serialize the annotation of the subject knowledge elements. Using knowledge mapping technology to store the labeled subject knowledge elements to the subject knowledge base, to realize the representation and storage of subject knowledge entities; using Markov logic nets and Bayesian models to mine the relationship between subject knowledge elements and learning resources, to realize the association relationship extraction and mapping relationship extraction, so as to form a collection of subject knowledge [25].

3.2.3. Integration of disciplinary knowledge

Within a unified data framework, knowledge mapping technology is used to normalize, unify and standardize the processing and handling of knowledge elements and their relationships in order to improve the data quality of disciplinary knowledge mapping. The specific methods are: machine learning-based entity alignment and knowledge merging technology for disciplinary knowledge mapping partition indexing, similarity matching calculation and entity merging, to realize entity alignment and entity disambiguation of the knowledge base, so as to obtain high-quality disciplinary knowledge data.

3.2.4. Reasoning about disciplinary knowledge

After the discipline knowledge extraction and discipline knowledge fusion sessions, the hidden entities and semantic relationships in the discipline knowledge graph are mined using knowledge reasoning technology, and the original discipline knowledge graph is reasoned and supplemented. If there exists a learning path to reach the target node, the two nodes with semantic associations are added to the subject knowledge base, which realizes the expansion and updating of the subject knowledge graph and improves the generalization ability of the subject knowledge graph model.

4. Exploration of the Application of Knowledge Mapping in the Discipline of Finance in Tertiary Education

4.1. A Case of Instructional Design of Subject Knowledge Mapping Applied to College Finance

This study designs and implements it with the mandatory content of the finance discipline.

(1) Teaching content analysis

The textbook is “Monetary Banking”, “Financial Economics” is the learning resource for learners in this lesson using knowledge mapping as a knowledge integration and presentation tool. Through the teaching of this lesson, learners can recognize and prevent computer viruses, and apply the knowledge of this lesson to practical life and study.

(2) Analysis of Teaching Targets

The learners are first-year students in a university. Students at this stage have active thinking, strong hands-on ability, and a certain ability to recognize and judge. After the study of the previous courses, the learners have a certain knowledge of financial fundamentals and subject knowledge mapping, and during the teaching process, the learners are able to share their experience of using financial knowledge in their daily lives with others, cooperate with others to complete the relevant learning content, and complete the learning tasks independently under the guidance of the teacher.

4.2. Questionnaire Design

Based on the above objectives and problem hypotheses, in order to understand the effectiveness of the application of knowledge graph visualization system in the teaching of finance discipline. This study prepared a questionnaire on the use of knowledge graph query system in finance discipline. The questionnaire includes two parts: basic personal information and the use of knowledge mapping visualization system in finance discipline. The use of the knowledge mapping visualization system is mainly designed from the three dimensions of system design, learning support, and learning effect, using a five-point Likert scale method. The three dimensions of interface, operation, and interaction are the common measurement dimensions of system design.

This section measures learners' satisfaction with the use of the visualization system for the financial discipline from a software perspective. Knowledge presentation, knowledge construction, and instructional resources constitute the three aspects of the learning support dimension. The knowledge presentation dimension aims to address the question of whether knowledge mapping can present conceptual structures clearly, explicitly, and systematically during the teaching and learning process. Knowledge construction is mainly measured by students' recall of what they have learned and the effect of correlation with existing knowledge, which mainly addresses the question of whether the knowledge map is conducive to learners' correlation of what they have learned previously with what they are learning now, and to the integration of old and new knowledge, which promotes the construction of the knowledge structural system by learners. The teaching resources dimension reflects the improvement effect of the digital teaching resources integrated in the knowledge graph visualization system on the aspect of query efficiency. The learning effect is mainly designed from three aspects: learning efficiency, learning input, and tool use. Learning efficiency refers to the effect of the way the knowledge graph characterizes knowledge on extracting knowledge from long term memory. Learning input is the added output value of using the knowledge map, i.e., the knowledge map is able to focus more of the learner's learning effort. Tool use is a manifestation of learner knowledge transfer, if learners are willing to use knowledge mapping to organize and manage knowledge in other disciplines, to a certain extent, it can be reflected that the tool is beneficial to learners' learning, the questionnaire survey specific details as shown in Table 1.

Table 1. questionnaire dimension.

Primary dimension	Secondary dimension	Detailed entry
System design	Interface design	The interface of the knowledge map of the subject is friendly and concise
	Operation design	The visual system of the subject is good interactivity
	Interaction design	The operation of the knowledge map visualization system is convenient
Learning support	Learning support	The knowledge map of the subject is clearly and systematically to demonstrate the knowledge system of the subject
	Knowledge building	Using the knowledge map of the subject, it is better to recall learning in the mind
		The visual system of the knowledge map is conducive to the knowledge of the knowledge and the knowledge that have been learned before
	Teaching resources	Use the knowledge map of the subject, the knowledge structure in the mind is clear and no longer scattered
Learning effect	Learning effect	Using the visual system of the knowledge map of the subject, it can quickly find the knowledge of information technology and save the time of search
	Learning input	Using the knowledge map of the subject, we can quickly recall the knowledge and its knowledge system
	Tool use	Using the knowledge map visualization system, I prefer to concentrate on learning
	Personalized learning	Learn more about learning than the traditional class
		It is more convenient and comfortable than the traditional school
		It's more convenient, more content, and more time-consuming than a traditional class little

4.3. Analysis of Application Results

The questionnaire survey was conducted using whole group sampling, 53 copies were distributed and 53 copies were collected. Among them, 30 were for male students and 23 for female students, and the recovery rate of the questionnaire was 100%. SPSS software was used to process the data, and the Cronbach's alpha was 0.8257, the reliability of the questionnaire was high. The questionnaire was counted and analyzed from whole to part. From the overall view, the class in general was satisfied with the trial of the knowledge graph visualization system. From a local point of view, the dimensions basically achieved the expected hypothesized effects, but there were slight gaps between the dimensions as follows:

4.3.1. Overall Analysis

In the overall analysis, in order to discern the overall attitudinal tendency of the class, the scores were tallied on the basis of 5=Strongly Agree, 4=Agree, 3=Unsure, 2=Disagree, and 1=Strongly Disagree. The number of people in each dimension was summed and then multiplied by the corresponding score, and the overall attitude tendency was judged by the total score. The results after scoring are shown in Figure 3. The bar chart visually reveals that the class as a whole holds a satisfactory attitude and the largest number of people hold an agreeable attitude. Therefore, the effect of using the knowledge graph visualization system is still in line with the expected value in general.

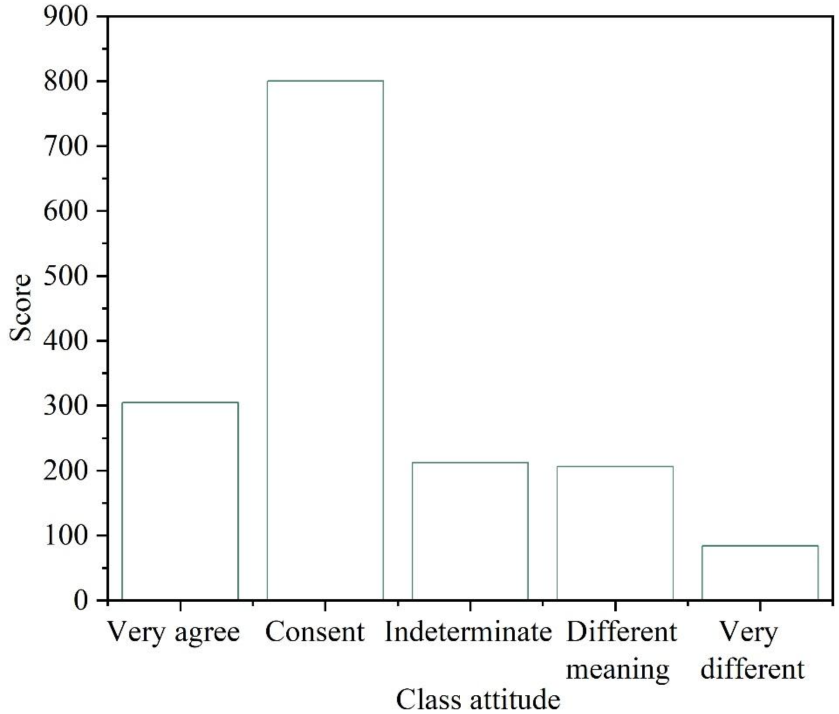

Figure 3. Overall analysis.

4.3.2. Dimensional Analysis

(1) Analysis of system design satisfaction

The analysis of satisfaction with the use of the system design of the financial discipline knowledge graph is shown in Table 2. The data in the figure can be obtained from the users' satisfaction with the use of the knowledge map system design based on the knowledge graph of financial disciplines, and most of the users chose the two items of Agree and Strongly Agree. At the same time, in terms of interface and operation, users said that it is clear and concise.

Table 2. System design satisfaction analysis.

Detailed entry	Different meaning	General	Consent	Agree
The interface of the knowledge map of the subject is friendly and concise	8	4	12	29
	15.09%	7.55%	22.64%	54.72%
The visual system of the subject is good interactivity	6	4	25	18
	11.32%	7.55%	47.17%	33.96%
The operation of the knowledge map visualization system is convenient	6	15	14	18
	11.32%	28.30%	26.42%	33.96%

(2) Learning support analysis

Table 3 shows the analysis of the learning support of the financial discipline knowledge graph, in which the data analyzes whether the functions of the platform meet the needs of users and investigates the recognition of the functions of the platform by users. The data in the table show that more than 20 users expressed satisfaction or even satisfaction in the three aspects of the system, "the subject knowledge graph clearly and systematically displays the knowledge system of the discipline" and "the subject knowledge graph can better recall the learned knowledge in the mind", "the subject knowledge graph visualization system is conducive to associating the knowledge learned before and the knowledge learned now", and "the subject knowledge graph, the knowledge structure in the mind is clear and no longer scattered". The above data shows that users are more likely to agree with the platform's display of financial knowledge graph and knowledge presentation, knowledge construction and teaching resources, and the system has a strong supporting role as a learning tool. At the same time, some users also choose the general option, indicating that the visualization function of the platform's knowledge graph still needs to be further improved and perfected.

Table 3. Learning support analysis.

Detailed entry	Different meaning	General	Consent	Agree
The knowledge map of the subject is clearly and systematically to demonstrate the knowledge system of the subject	7	10	14	22
	13.21%	18.87%	26.42%	41.51%
Using the knowledge map of the subject, it is better to recall learning in the mind	9	10	16	18
	16.98%	18.87%	30.19%	33.96%
The visual system of the knowledge map is conducive to the knowledge of the knowledge and the knowledge that have been learned before	12	7	22	12
	22.64%	13.21%	41.51%	22.64%
Use the knowledge map of the subject, the knowledge structure in the mind is clear and no longer scattered	9	10	20	14
	16.98%	18.87%	37.74%	26.42%

Table 4 shows the analysis of the learning effect of the knowledge graph of financial disciplines. The data in the table shows that 37 users agree or even agree with the "financial subject knowledge graph, which can quickly recall knowledge points and their knowledge system". Thirty-seven users agreed or even agreed that "I would rather concentrate on financial learning with the knowledge graph visualization system". Thirty-five users agreed or even agreed that "the way the knowledge presented in the knowledge graph of the financial discipline can be applied to the learning of other disciplines". However, there are also a considerable number of users who generally or even disagree with the application of the knowledge presentation method in the knowledge graph of finance to the learning of other disciplines, which may be related to the fact that learners have a relatively large number of tools to use.

Table 4. Learning effect analysis.

Detailed entry	Different meaning	General	Consent	Agree
Using the visual system of the knowledge map of the subject, it can quickly find the knowledge of information technology and save the time of search	6	10	12	25
	11.32%	18.87%	22.64%	47.17%
Using the knowledge map of the subject, we can quickly recall the knowledge and its knowledge system	6	10	18	19
	11.32%	18.87%	33.96%	35.85%

Using the knowledge map visualization system, I prefer to concentrate on learning	5	12	21	15
	9.43%	22.64%	39.62%	28.30%
Using the visual system of the knowledge map of the subject, it can quickly find the knowledge of information technology and save the time of search	6	12	17	18
	11.32%	22.64%	32.08%	33.96%

The analysis of the effect of personalized learning is shown in Table 5. The data in the table shows that nearly 60% of the users said that the online platform learning is more convenient than the traditional classroom learning, learning more content and spending less time. The data analysis proves that this study has basically accomplished the expected purpose, achieved the effect of users spending less time to learn more knowledge, and improved their learning efficiency. However, there are still a small number of users who have an average experience of the online learning platform, which is related to their personal learning habits and learning style preferences.

Table 5. Personalized learning effect analysis.

Detailed entry	Different meaning	General	Consent	Agree
Learn more about learning than the traditional class	9	10	16	18
	16.98%	18.87%	30.19%	33.96%
It is more convenient and comfortable than the traditional school	9	8	18	17
	16.98%	15.09%	33.96%	32.08%
It's more convenient, more content, and more time-consuming than a traditional class little	7	14	15	17
	13.21%	26.42%	28.30%	32.08%

In summary, through the analysis of the questionnaire results can be obtained: the main functions of the system basically meet the needs of the learners and the operation is simple and convenient to use, such as the visual demonstration of the knowledge mapping of financial disciplines, the operation of the knowledge point design and the interaction design functions are designed from the perspective of the needs of the learners. Due to the influence of factors such as the length of use, the number of contacts and the learning habits of learners, a small number of learners have not been able to obtain a good learning experience and effect through the platform learning mode, which is also a problem that needs to be considered in the design of subsequent functions of the platform. Evaluation and analysis of the overall use of the financial knowledge mapping system shows that the platform functions basically meet the learning needs of the users, and from interface design to functional design, the personalized characteristics of the learners are better considered, which enhances the experience and effect of personalized learning of the learners, and basically achieves the expected goal of the research.

5. Conclusion

Aiming at the characteristics of the current professional courses in financial discipline with many knowledge points and strong correlation, the paper proposes the modeling method of disciplinary knowledge mapping based on the CRA model, which adopts the top-down construction method to construct the mapping conveniently and effectively, and give full play to the function of the mapping. In order to verify the validity of the model, the textbooks of Monetary Banking,Financial Economics and so on are selected as learning resources,and the first-year students of a university are taken as the research samples,which are analyzed through questionnaires.The results show that in terms of the overall class as a whole holding a satisfactory attitude,the largest number of people hold an agreeable attitude. From the analysis of the three dimensions of system design, learning support, and learning effect, about 60% of the users chose very satisfied and satisfied. More than half of the users were satisfied with the learning effect of Knowledge Mapping for Finance Subjects.

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