Visualized Layout of Coordinated Information Discussion in Online Teaching

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Abstract
The reliability of knowledge expression methods decides the make or mar of a teaching system. Therefore, knowledge expression methods are the linchpin to ITS development system. This paper progressively studies the knowledge modeling system through several parts. The knowledge expression status and existing problems are first analyzed, and the theories and techniques involved by the model are discussed. Then, the author puts forward a knowledge expression model and illustrates its advantages and significance. In terms of model realization, OOA is employed to analyze the model's category, property and method, and expound. The treatment of pixel objects, knowledge points and other basic data, and the realization of the model appearance are expounded in great details. In this research, a reasonable data structure and algorithm are designed, and the application of multiple techniques to the model is explored. At last, a practical application example of the model is given to introduce the use method of the knowledge modeling platform, and verify the model's feasibility and validity.
Key words: INFORMATION VISUALIZATION, INTELLIGENT TEACHING, TACIT KNOWLEDGE, INFORMATION NODE

1. Introduction

From the perspective of knowledge learning, the essence of teaching applications is to teach learners how to think and learn [1]. In other words, teaching applications aim at cultivating learners with the metacognitive capability instead of confining them to knowledge teaching [2]. By mastering correct thin-king and learning methods, learners can find new inspirations and develop new abilities to achieve continuous innovation and take the initiative to learn different knowledge [3].

Generally speaking, a complete teaching system consists of four basic elements, namely teachers, students, teaching content and teaching process [4]. The element of teachers can influence on the element of students through the element of teaching content and teaching process. In fact, the element of teaching content and teaching progress contains the element of teachers and the element of teaching progress contains the element of students [5]. Therefore, the element of teaching content and teaching progress are two core elements, which constitute the corresponding teaching environment [6].

The element of teaching content and teaching progress is connected with each other [7], but also differs from each other in some way. Their difference lies in that the former is oriented towards the static characteristics of teaching applications; while the latter is oriented towards the dynamic characteristics of teaching applications [8]. As to their connection, on the one hand, the former directly drives the latter; on the other hand, the two are unified on the same theoretical basis, or in other words, they are two sides of the same theory [9].

Therefore, the establishment of the knowledge model of the teaching content element is of vital importance in the whole online teaching [10]. How to build a corresponding knowledge model from the perspective of the application essence becomes the key to the development of the next-generation online teaching [11].

2. Basic framework of the intelligent system

ITS system mainly consists of four parts, namely students module, experts module, curriculum and diagnosis module and communication module [12]. It was Hartley and Seelman who first put forward an ITS framework. They thought that ITS should include: professional knowledge (experts module), students' knowledge (students module) and strategic teaching knowledge (supervisors). Over the past two decades, the composition framework of ITS has generally remained the same. Through proper selection and the specially-design problem-solving section, students learn in the ITS environment [13]. The system has rich learning experiences, so it can better serve students. The prerequisite for the start of the system is that learners should have some experiential knowledge and that the students module has been built. Besides, the system should clarify what knowledge (namely curriculum or domain knowledge) students need. Moreover, the system should confirm which content (namely teaching units) to teach and how to represent it. The process is regarded as supervisors module or teaching strategies. All in all, the system should first make a choice or generate problems; then it provides solution plans (solves with the help of domain experts) or retrieves an already prepared plan. ITS will conduct a real-time comparison of the standard plan and the completed learning plan. The students' plan will be judged according to the difference of the two.

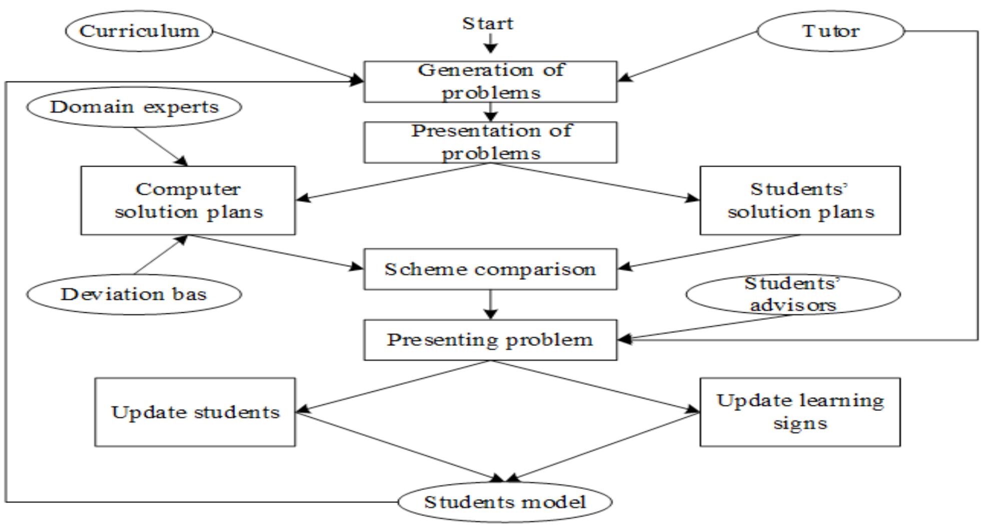

Figure 1. Intelligent teaching system and correlation between basic components

(1) Students module

Students module is an important concept of ITS. It abstractly represents the learners' situation in the computer system. As an important approach to learners' comprehension of knowledge, it generally describes learners' knowledge status. Generally speaking, it includes three kinds of models, namely covering model, differential model and deviation model (or perturbation model).

(2) Experts module

The functions of the experts module includes: providing resources for knowledge presentation, namely interpretation of concepts and students' response, students' tasks and questions; offering standards to evaluate students, such as giving solution plans for the middle step of a given question; generating well-targeted plans so as to guide problem solutions; dinging multiple possible plans to improve academic performance, etc.

(3) Curriculum and diagnosis module

The module can provide a mechanism for the adaptive representation of knowledge in the supervisors system. In order to ensure the adaptive representation of knowledge, the system can adjust curriculum based on the domain knowledge and students' reaction. The module has three functions. First, it must control the representation to ensure that the representation order and the chosen materials are the most suitable to students. Second, it must be able to answer students' questions. Third, it must be able to help students, encourage them or warn them that they have not yet find the optimal solution plan.

(4) Communication module

Communication module can ensure the interaction among learners, including dialog and screen design. It plays an important role in the ITS system and becomes an important symbol of ITS system's practicability. The development of man-machine interface is reflected in two aspects. One is that learners become direct participants in the field. The other is that the control of domain knowledge is realized by teaching the system the required actions. Miller thought that the man-machine interface technique in the ITS system will be further developed in the following three directions: 3D images, continuous voice processing and presentation of mass data. The matching between the content and the interface contributes to the integration of different ITS modules through the interface technique.

3. Design of system functions

The visualized coordinated discussion system has the following functions:

(1) Type in key words of speech

The speed information during the coordinated discussion process will be record through the record of semantic keywords of all syntagmas. Since there is a high requirement of the real-time nature of the keywords typed in during the conference discussion process, the man-machine interaction type-in is adopted. Through the real-time record of the semantic keywords in syntagmas by the registrar, the accuracy of the keyword acquisition and the high real-time nature of the conference discussion can be ensured.

(2) Give prompts about the key words

According to the semantic keywords typed in by the registrar, relevant expanded information will be searched from the internet to assist discussants to obtain more information according to the discussion theme. In this way, the discussion content can be deepened.

(3) Provide dynamic layout of keyword nodes and expanded information nodes

In order to display the discussion process, the platform can conduct dynamic layout of the keyword nodes and the expanded information nodes through effective visualized methods. During the layout process, the current discussion points and other relevant information are highlighted to directly display the current discussion points. In this way, the discussion can be more targeted.

(4) Provide calculation methods to measure the importance of the expanded information

In order to screen the expanded information, importance of the expanded information page is adopted as an important measurement of the importance of the expanded importance. Rank the expanded information according to its information. Through the setting of the threshold value, the expanded information whose importance is smaller than the threshold value is automatically eliminated so as to achieve the goal of reducing information redundancy.

(5) Provide global visualized discussion interface and display content nodes by individual discussants

In order to meet different searching demands of discussants, the visualized coordinated discussion platform provides two visualized interfaces. First is the visualization of global discussion, namely to display all the current discussion information and expanded information. Second is the visualization of all relevant keywords touched by individuals during the discussion process.

(6) Rank the important of ideas put forward by different discussants

Calculate the contribution degree of different discussants towards a discussion according to their ideas expressed, the importance of their ideas to the discussion theme and degree of interest of ideas among discussants.

3.1. Basic system framework

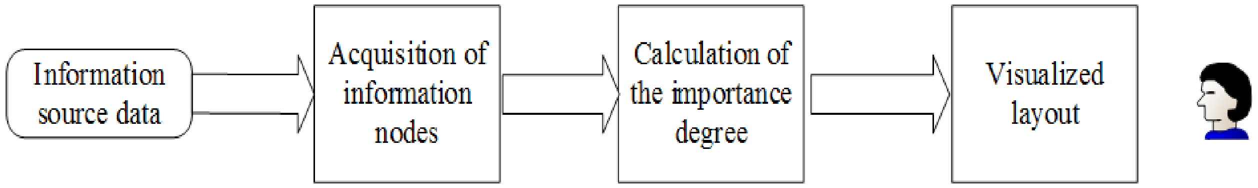

Figure 2. Visualized coordinated discussion information system flow schematic diagram

Coordinated discussion consists of a moderator, several discussants and a registrar. The system low schematic diagram is shown in Fig. 2. During the thinking divergence period, the registrar records the keywords of ideas expressed by all discussants. According to the typed-in keywords, the system will conduct a semantic relevance searching to obtain relevant semantic phrases to assist expansion. The expanded information searched will be ranked in the order of their importance so as to achieve the goal of refining the expanded information. At last, the system can visually display the relevant between the keywords and the expanded information through the visualized layout algorithm. Relevant expanded information is an effective approach to assist thinking divergence. The dynamic layout of the visualized interface can help discussants to clearly master the current discussion points, lead them to discuss some themes in more a targeted way and deepen the discussion themes as well. In this way, a discussion process featuring man-machine coordination, man-man coordination and orderly organization is formed.

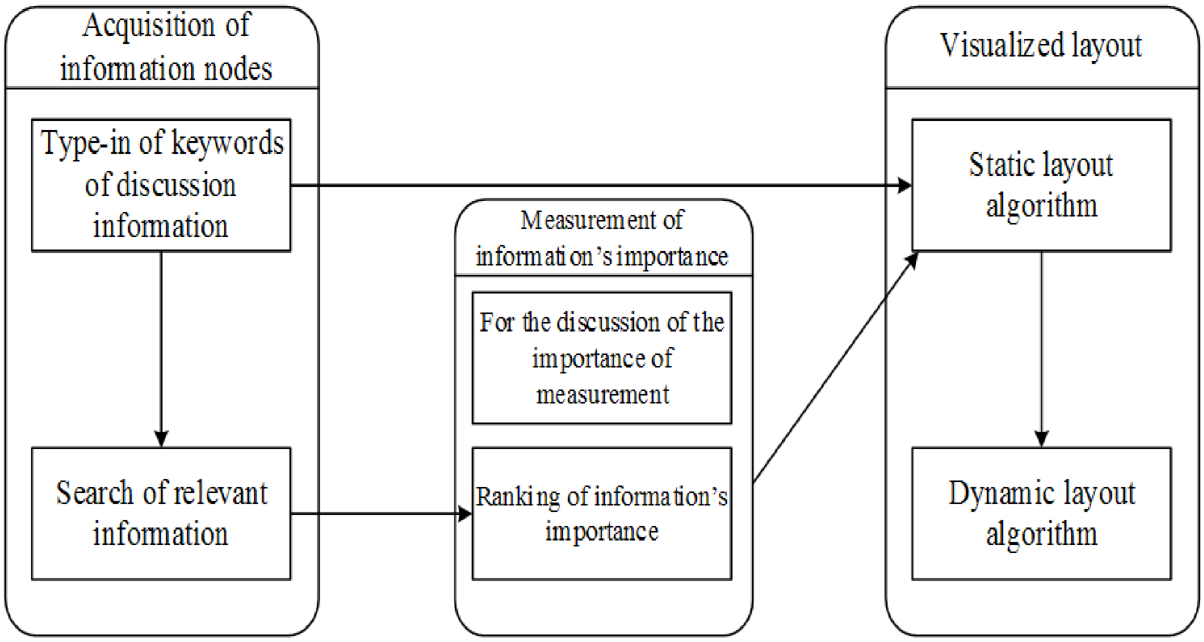

Figure 3. Visualized coordinated discussion information system framework

The visualized coordinated discussion information system framework shown in Fig. 3 consists of three modules, including information node acquisition module, information measurement module and visualized layout module.

Information node acquisition module provides a final visualized data source for the system. Information measurement module provides two measurement methods, namely the calculation algorithm targeted at the importance of the expanded information and the calculation algorithm targeted at the importance of discussants. The former can help refine the important information among the expanded information, and visualize it as well. The latter is an effective way to measure discussants' contribution to discussants. Visualized layout module is the key to displaying discussion information, including static and dynamic layout of information nodes.

3.2. Acquisition of information nodes

According to characteristics and requirements of two kinds of information nodes to be displayed, this paper employs two different node acquisition methods. This paper first conducts formalized definition of information nodes according to different types of information nodes. After characteristics of information nodes are discussed according to their kind, methods to acquire different information nodes are given.

3.2.1. Definition of information nodes

Definition 3-1: Assume that $N_1 = \{n_1, n_2, \cdots, n_p\}$ is the node set, where p stands for the quantity of nodes. In terms of every node, n_i, there might be three types, namely $Ntype_i \in \{Theme, Partic, KW\}$, which is corresponding to *Theme, Participants* and *Keywords.*

(1) If the node type is $Theme$, then:

$n_i =< Ntype_i, Name_i >$,

Where, $Ntype_i = Theme$ and $Name_i$ is a description of the keywords of the theme.

(2) If the node type is $Partic$, namely participants, then:

$n_i =< Ntype_i, Name_i, Par\_Ord, Par\_BColor_i >$,

Where, $Ntype_i = Partic$; $Name$ is the name of every participant; Par_Ord_i is the serial number and the unique identification of every participant (ranking in the natural order of 1, 2, 3…Generally speaking, the moderator is under the serial number of "1."); Par_BColor_i is used to identify the background color of a node. Only one color is distributed to every participant. Add the serial number to every color. Ideas put forward by different participants will be distinguished through different background colors.

(3) If the node type is KW, namely ideas, then

$n_i =< Ntype_i, Name_i, VP\_Ord_i, Par\_Ord_i, Par\_BColor_i >$

Where, $Ntype_i = KW$; $Name_i$ is the description of keywords of an idea; VP_Ord_i is the only number to identify keywords of an idea (ideas are numbered based on when they are put forward in the natural order of 1, 2, 3…); Par_Ord_i is the serial number of the participant putting forward the idea; Par_BColor_i is the background color of the idea.

Definition **3-2**: Assume that the side set is $E_1 = \{e_1, e_2, \cdots, e_q\}$, where q stands for the quantity of sides. As to every side,

$e_j =< n_{j1}, n_{j2}, Etype_i >$,

This means that Node n_{j1}, and Node n_{j2} are connected and that the side type is $Etype_i \in \{KK\}$. Where, KK stands for the connection between keywords of ideas.

3.2.2. Acquisition of KW information nodes

Coordinated discussion is a thinking divergence process with multiple participants discussing one theme. The deepening of the discussion theme is based on a full understanding of the theme and the expansion of knowledge related to the theme. Information nodes of *KW* include two important information elements: 1) discussion of keywords; 2) discussion of expanded information of keywords to supplement the knowledge of the theme. A large amount of relevant knowledge can effectively help discussants achieve thinking divergence. From the perspective of discussants, relevant knowledge can lead them to choose points they are interested in. In this way, a discussion theme will be enriched, and deepened. Thus, keywords and expanded information constitutes two elements of the system information source.

The discussion of keywords is a simple overview of discussion content. The acquisition of keywords can help remove some irrelevant content, including structural words, adjectives and so on. By doing so, the discussion content can be further refined and be more clear. The expansion of relevant information revolving on keywords can provide more discussion perspectives for discussants, so it is an effective way to contribute to thinking divergence.

Through the above analysis, it can be found that keywords and relevant expanded information are two data sources of the visualized coordinated discussion information model. The following part is an introduction of methods to acquire two kinds of information.

3.2.3. Acquisition technique of semantic expanded information

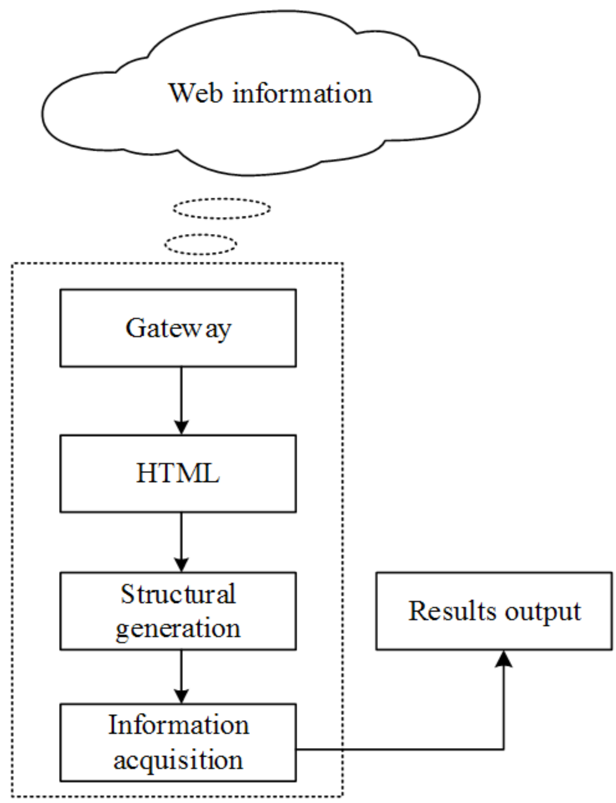

Figure 3-2. Keyword information acquisition flow

Through the spiders, this paper acquires the linking words on the first paragraph of Wikipedia explanation, namely to acquire semantically relevant phrases. Spiders are an effective tool to acquire webpage information. The working flow of spiders starts from URL of an initial webpage to acquire all links on a webpage. The links on webpages of already obtained websites are searched. Repeatedly, the URL of the webpage is added to the searching queen until reaching certain objective. Webpage acquisition through spiders can be divided into two kinds, namely depth-first and breadth-first. The former means that spiders start from the initial page of a website, obtain the website from the current page, find the linked page and acquire the linked website. The advantage of depth-first is that users can pre-define the number of layers to be acquired. The latter means that spiders first acquire all linked websites on the initial interface, choose one and open it, and acquire all websites within. The advantage of breadth-first is that it can simultaneously handle pages, but the acquisition process is relatively complex. Based on the comparison of the two webpage acquisition methods by spiders and the supplement of keywords in the visualized coordinated discussion information model (three-layer link searching of all link words on the first paragraph of the Wikipedia explanation page), this paper adopts the depth-in method as the spiders-based information acquisition.

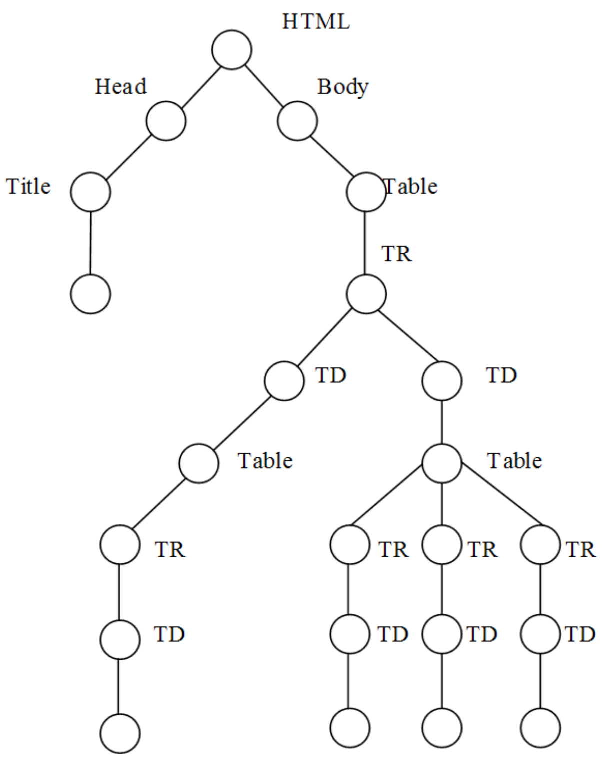

Figure 4. Document structure DOM tree-diagram

3.3. Spider chart knowledge expression model

Based on the relevant theories discussed in the above parts, this part puts forward the spider chart knowledge expression model. (See below for the explanation of the square boxes with Akn and the round frames with Hkn and their subscripts):

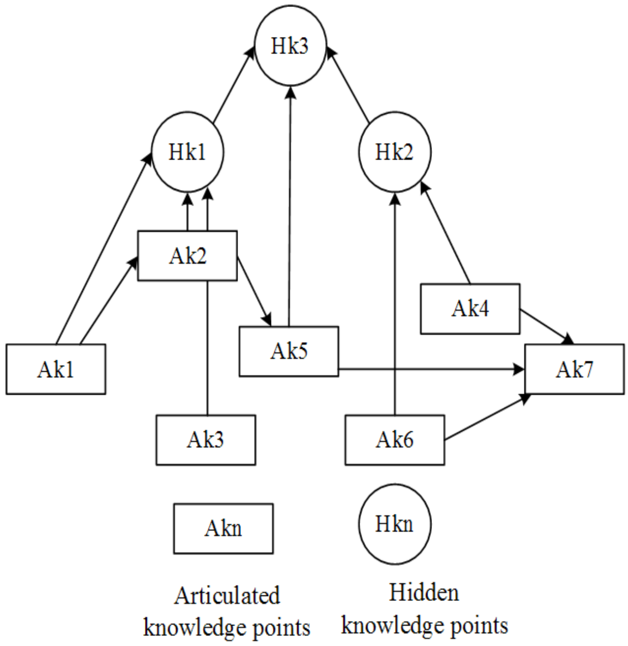

Figure 5. Spider chart knowledge expression model

In Fig. 5, every hidden knowledge point of a higher level can be obtained by several explicit or hidden knowledge points at a lower layer based on their prerequisite relationship. The prerequisite relationship refers to the necessary relationship between knowledge points to be learned and some conditional knowledge. The conditional knowledge is the preceding-stage knowledge, or knowledge of several stages below or the combination of the two.

The chart features a spider structure. However, the branches show that this is also a tree diagram or even a linear structure. This chart shows a logic relationship in terms of knowledge structure. The horizontal and vertical learning process can be evolved into the assimilation or adaption process of Constructivism learning theories.

Every explicit or hidden knowledge points (Akn or Hkn) can help obtain the supplementing sub-model for the knowledge expression model based on their sub-knowledge class name, attributes and operate (). (See below)

SubKnowledge Class name
Attributes:
Operate()

Figure 6. Sub-model of knowledge points

3.4. Formalized explanation of models

The formalized explanation of the knowledge expression model can be conducted from the perspective of the automata theory and the reflection relationship.

The knowledge expression model in this paper can be explained from the perspective of the automata theory.

The model can be expressed by a six-element group, $M = (KL, AK, HK, \delta, KLO, KLF)$, where:

KL ——The knowledge set, namely the state set, Q;

AK ——The articulated knowledge set;

HK ——The hidden knowledge set

KLO ——The initial state QO, namely the state at the beginning of the learning' period;

KLF ——The final state, Qf, namely the state at the end of a learning period;

δ ——The mapping function, namely the mapping of $Q*(AK,HK) \rightarrow Q$. (HK and AK) should have a prerequisite relationship. See below:

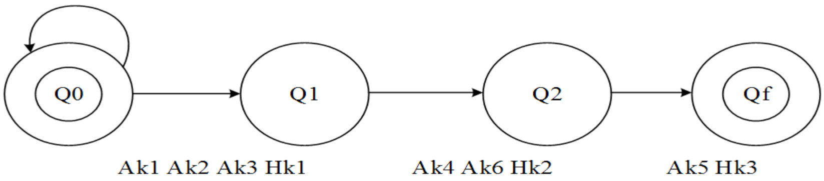

Figure 7. Model explanation based on the automata theory

This chart shows that the state before the beginning of learning a new knowledge point can be regarded as a final state. Articulated and hidden knowledge is learned in the middle. Then, it enters the transition state. At the end of the knowledge point learning, learners will enter another final state. The knowledge state set and the knowledge layer of the knowledge is not corresponding to each other. The supplement (adding of articulated and hidden knowledge based on the original knowledge) or change (adding of articulated and hidden knowledge of different attributes) of any knowledge state set should be regarded as the next stage. The state set in the chart is a dynamic-changing process. After conversion, the state set will become a new state set, which will increase the amount and scope of knowledge in the knowledge set.

The knowledge expression model generally reflects the following inference framework:

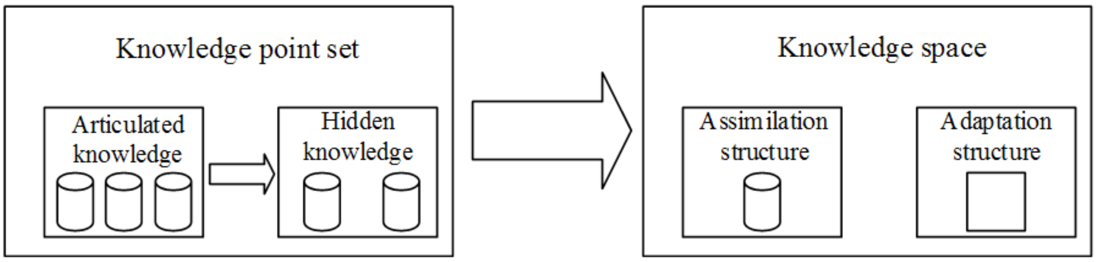

Figure 8. Model's corresponding inference framework chart

From the microscopic perspective, the articulated knowledge points can be converted into the implicit knowledge points to form the knowledge point set. From the macroscopic perspective, different knowledge structures are formed according to different attributes of individual knowledge characteristics. Assimilation structure refers to the expansion of the amount of knowledge without changing the knowledge structure; while the adaption structure refers to the change of the original knowledge structure. The two different structures form individualized knowledge space. The process is a dynamic loop rising process along with the increase of knowledge. In other words, with the increase of knowledge through continuous learning, the knowledge structure will be continuously expanded or changed.

4. Conclusions

The current online teaching has a striking defect, that is, it is formal and lacks soul. Lack of the foundation of education psychology theories, online teaching is often regarded as a direct or indirect representation of books with articulated knowledge as its focus. Due to the traditional, humdrum and dull knowledge expression, poor system nature and poor interactivity, it can hardly reflect the knowledge structure and the new development situation of modern know-ledge development. With the qualitative and quantitative increase of knowledge, it is imperative to find a complete knowledge expression model to reasonably and completely express knowledge and improve the current teaching efficiency. This research is a response to the current situation. It combines the Constructivism teaching theories and basic knowledge expression theories, and employs the object-oriented ideas and new techniques. The knowledge expression model has the following characteristics.

1) The model can quickly and directly build the knowledge structure, and improve the teaching efficiency and quality: The model can quickly analyze, refine, synthesize and expand knowledge points. Du-ring the teaching process, teachers just need to conduct a basic analysis and division of knowledge to build knowledge points with rectangles or ovals, and save the basic knowledge points into the knowledge dialog box. The knowledge model structure can obviously reflect teachers' control of some knowledge points.

2) The model articulates the hidden knowledge and build relevant cases: Through a specific analysis of the hidden knowledge points, the knowledge expression model can directly express the hidden knowledge and build relevant cases. In this way, the abstract becomes operable. The articulation of the hidden knowledge can help learners master knowledge and its rulers faster and better. In terms of teaching, teachers can help students complement the knowledge meaning construction, and master essence and rules of knowledge. In this way, teaching is no longer oral, but becomes simple, direct and feasible. At the same time, it puts forward a higher requirement of teachers about their understanding of knowledge and their course preparation.

3) The model enriches the knowledge expressions and can correctly and efficiently search knowledge: The model is built on the basis of knowledge expression, application and other techniques. It combines knowledge ideas and techniques, such as knowledge management and Ontology. The object-oriented technical analysis makes the model applicable to the knowledge expression and research of other fields. In particular, it can find the hidden knowledge among a mass of knowledge, learn the knowledge's structural relationship and classify knowledge for the convenience of searching. The assessment interface can accurately help learners choose which knowledge to learn.

Acknowledgements

This work was supported by Hunan Province Education Science "Twelfth Five Year Plan" 2015 year project, The Integration of Thinking Visualization Technology and Foreign Language Teaching in Colleges: Teaching Model and Practice (XJK015BGD001).

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