Research and Design of a Knowledge Base Application System for K12 Educational Resource Library

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Keywords: Knowledge Base, K12 Education, Educational Resource Library, Knowledge Model, Knowledge Management, Knowledge Base Application System.

Abstract. This paper firstly describes a whole research framework when constructing a knowledge base for K12 education. Then the paper demonstrate thedesign of knowledge base application system for educational resource library, and analyze the how to complete the interoperability between different levels. Finally, it provides the general knowledge description model for the application system.

Introduction

Subject to the popularity of e-learning style, more and more K12 educational resource libraries and e-learning systems are emerging in endlessly. The existing retrieval and management of educational resource library of primary and secondary schools mainly focus on the media management, and few learning platforms begin to organize resources and design learning activities from the perspective of teaching. However, the educational resource library of primary and secondary schools and the e-learning platform tend to lack the resource organization mode based on the learning demands, namely, lack the research and design of knowledge base because they retrieve and manage knowledge from the perspective of knowledge system.

In this paper, the construction of K12 education subject knowledge base and the description framework for general knowledge are studied and designed from the perspective of knowledge management.

Framework for K12 Education Subject Knowledge Base and Its Application Systems

K12 Education Subject Knowledge Base is a teachers' book prepared according to K12 curriculum standards, K12 examination outlines and other major textbooks, not only combing the core concepts, concept properties and relationship between concepts in the interdisciplinary knowledge system, but also modeling and producing K12 education knowledge base in ontology language. Such knowledge base may search and display disciplinary knowledge of K12 education.

The study on K12 education subject knowledge base and its application system is huge and complicated, which covers various aspects such as theoretical model research, tool development and technology research. As shown in Fig. 1, the study on knowledge base may consist of several layers by contents: basic technology layer, knowledge model layer, processing layer, and application layer.
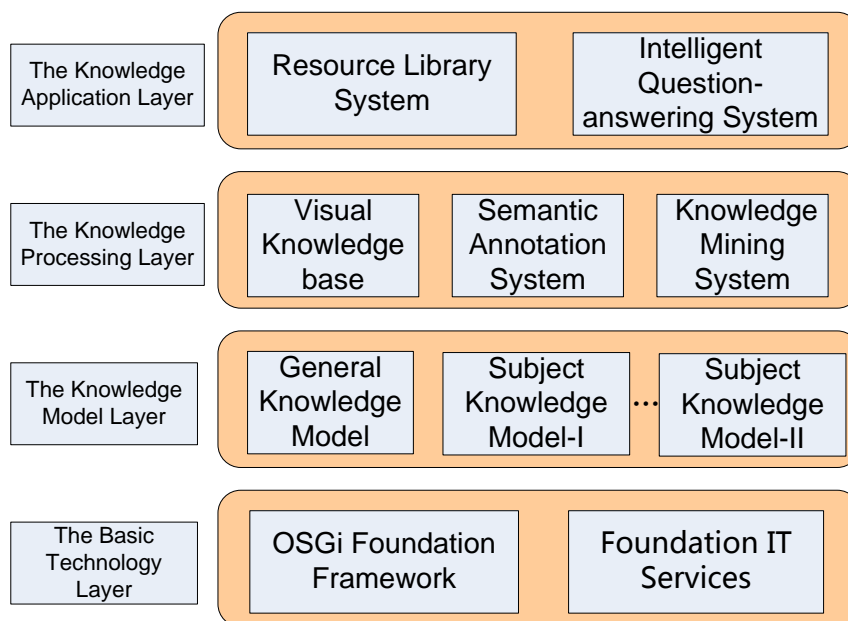
Fig. 1 Research Framework of the paper

The basic technology layer mainly completes the technical study and research for the whole knowledge base, including the OSGi foundation framework (Open Service Gateway Initiative) and other basic IT infrastructures and services. OSGi technology is a Java-oriented dynamic model system, which provides the standardized primitive allowing the application to use the refined, reusable and collaborative components. Such components may be assembled into one application and deployment.

The knowledge model layer mainly defines the relationship between general knowledge model and knowledge, and analyzes the general attributes for semantic annotation demands between knowledge base and resource library, not only combing interdisciplinary knowledge points by studying the interdisciplinary contents, but also describing and displaying the interdisciplinary knowledge model in ontology language.

The Knowledge processing layer mainly establishes the K2 education knowledge base, and manages, inquires, displays, generates and looks up the interdisciplinary knowledge, which consists of such systems required to establish and manage the knowledge base as knowledge management system, visual display system, semantic tagging system and knowledge mining system.

The application layer is based on the development of knowledge base, including the application for intelligent question-answering system and the application for resource library. With respect to the application for intelligent question-answering system, the knowledge base established aforementioned is used as the answer source and will answer to the knowledge memory questions through semantic analysis and retrieval. With respect to the application for resource library, the knowledge base is used as the index and will add the knowledge properties for resources through the tagging system, thus realizing the organization, retrieval and gathering of resources by the knowledge systems. The tagged resources may be either linked to the corresponding knowledge display page, or regarded as the answers to the knowledge memory questions.

This paper will describe the application system of knowledge base for resource library and the relevant general knowledge models.

Application System Design of Knowledge Base for Resource Library

The application system of knowledge base for resource library involves various aspects at different levels in the whole research framework, mainly including the knowledge model, knowledge base, semantic tagging system and resource library system. Therefore, in the design process of application system of knowledge base for resource library, it will be focused on the following two aspects: 1) interoperability process at different levels, namely the relationship and

interoperability between resource library, database and semantic tagging system; 2) design of general knowledge models supporting the application systems.

Interoperability between resource library, knowledge base and semantic tagging system

It shall be clarified that learning resource and subject knowledge are two different concepts: the former presents the latter in the form of media, while the latter is just a part of the former. Therefore, the application system of knowledge base for resource library includes the educational resource library, the knowledge base, and the semantic tagging system.

In such application system, the knowledge base provides the resource library with knowledge retrieval, and the manner to organize resources by knowledge points. The resource library provides the knowledge points with resources links, tags the knowledge properties through semantic annotation, and automatically generates provision base of new knowledge for the knowledge base. The semantic tagging system tags the knowledge properties for resource library, and provides the case call basis for knowledge base, thus bridging the knowledge base and resource library. The relationship between and among the three is as shown in the figure below.
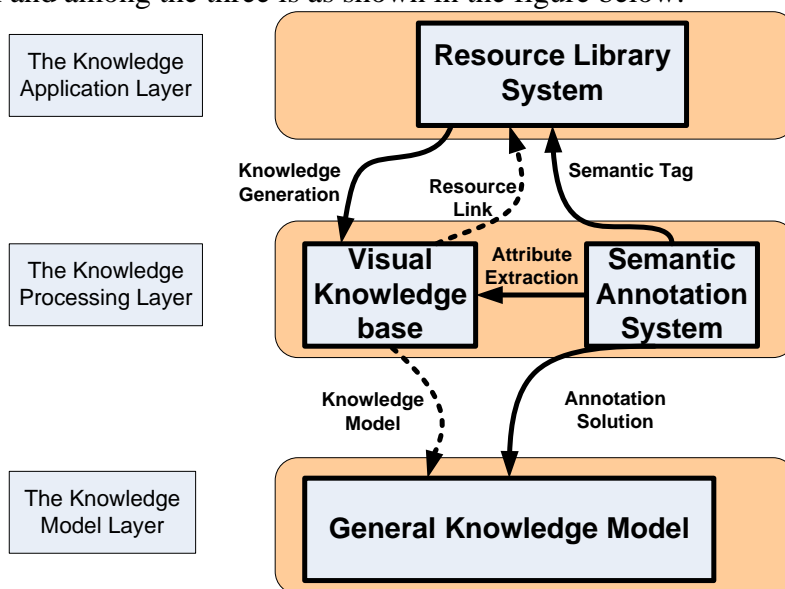

Fig. 2 Interoperability between different layers

Resource library refers to the storage, management and use of digital textbooks (digital education resources), where the resources shall facilitate the reading, the knowledge discovery, the knowledge gathering, and the call of resources by knowledge base. The resources may be categorized into various learning objects at different granularities by the quantity of knowledge concepts or the location of such knowledge concept in the whole knowledge system.

Knowledge base presents the knowledge contents in the form of entries, and demonstrates the relationship between knowledge points through knowledge mapping. In the construction of knowledge base, the initialknowledge base is constructed with teaching reference booksrather than extracted from one textbook, because the knowledge points in textbooks may fail to refine the knowledge content due to the different typesetting. On the other hand, the teaching reference books may focus on the key knowledge points at one stage, and present the relationship between knowledge points from both catalogue and typesetting.

The semantic tagging system may tag the concept, attribute, relationship and instance as per the granularity of tagged objects. In such application system, the semantic tagging system mainly tags the concept, namely tags the resource as belonging to a certain knowledge concept, and tags what is the attribute of the knowledge concept if possible. The semantic tagging system may not only equip the resources with semantic description related to knowledge, but also keep its good readability and appearance.

The application system of knowledge base for resource library uses resources as an example of knowledge. In the presentation of knowledge base, relevant knowledge entries may call one resource in the resource library, or one learning object among the resources. For example, the knowledge entries may be linked to one page, one passage or one figure in a book, or one video or one audio in a video file. The initial knowledge base may contain the interpretation of existing knowledge points and the known relationship between knowledge points; the late knowledge base may push the unknown concepts or attributes to the knowledge base to support the dynamic growth and update of knowledge subject to the development of knowledge discovery and the resources tagged by semantic annotation.

Knowledge General Description Model for the K12 Education

The establishment of a knowledge model is the precondition for the development of knowledge base, so the abstract knowledge model shall be established first in the research on application system of knowledge base.

In the knowledge base, each knowledge concept will be presented by a series of instances of knowledge points stored in the RDF triples. With respect to the K12 education knowledge base, a knowledge system will be formed according to the curriculum standards and teaching outlines at each learning stage of the subjects, which will be reflected in the relationship between knowledge points and their instances in the knowledge base.

The general knowledge description model of K12 education describes the knowledge concepts and the relationship between them from the perspective of semantics, which shall not only manage the knowledge bases of various disciplines at the same time, but also provide a frameworkcompatible with the knowledge attributes of each subject. Therefore, a general knowledge description modelcompatible with the subject attributes is constructed in this paper, as shown in the figure below.
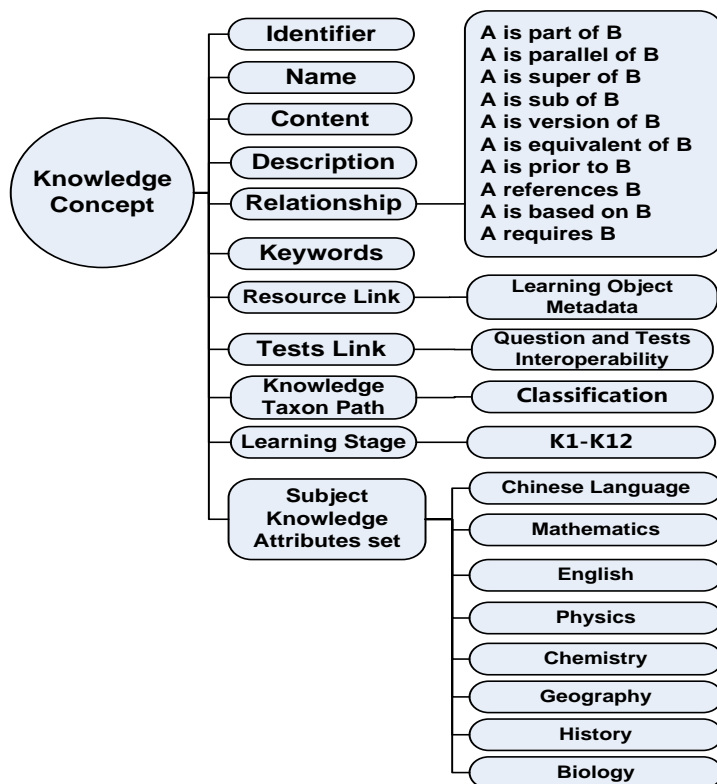

Fig. 3 General knowledge description model

The general knowledge shall include the following attributes: identifier, knowledge name, knowledge content, description, relationship, keywords,resource link, tests link, subject path, learning stage, and subject attribute set.

1）Identifier is the unique identifier automatically given to a new knowledge concept by the system.
2）Knowledge Name, Knowledge Content andDescription mainly introduce the concept and content of such knowledge.
3）Relationship describes the relations between knowledge concepts, and there are ten relationships in the field of K12 education in this study:
- A is part of B
- A is parallel of B
- A is super of B
- A is sub of B
- A is version of B
- A is equivalent of B
- A is prior to B
- A references B
- A is based on B
- A requires B
4）Both Resource Link and Tests Link are URL sets, which may point to such teaching resource and test links dominated by the explanation of such knowledge concept.
5）Taxon Path at different learning stages may be found out by virtue of the fixed code of each knowledge concept in the K12 knowledge system, because there is a clear and unified structure relationship between knowledge concepts at different K12 education stages.
6）Learning Stage refers to at which K12 education stage one knowledge concept is studied and mastered.
7）Subject Attribute Set is an interface adding the specific attribute sets of each subject into the general knowledge model.

In the whole construction process, such general K12 knowledge description model not only ensures the consistence of knowledge models between all subjects, but also saves the differences of them.

Conclusions

This paper mainly discusses the application system of knowledge base for resource library and the general knowledge description model in the knowledge base for K12 education. The application system of knowledge base for resource libraryincludes the knowledge base, resource library and semantic tagging system. The general knowledge description model incorporates the general knowledge properties and subject knowledge properties, not only providing data storage prototype for the follow-up dynamic editing system of knowledge tree, but also providing specific tagging contents and references for the semantic tagging system. However, the future study will focus on how to design extensible coding system for subject path.

Acknowledgment

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