Invited Paper

Effective Retrieval of Educational Resources by Using Learning Object Metadata for K-12 Schools in Japan

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Abstract

We have customized learning object metadata (LOM) for educational resources on the basis of the LOM investigated by IEEE [1] and IMS [2], in order to make it consistent with Japanese K-12 school education.[3] Since many specifications for the metadata are included in the customized LOM, we extracted necessary metadata especially for taking into account the retrieval of educational resources in schools. The extracted LOM has been installed with more than 13,000 educational resources individually. These resources have been registered in the search engine we developed using the LOM and are now available on the Internet as a first trial for applying the LOM. Using the LOM in the search engine makes it easy for teachers and students to find appropriate resources for their learning needs.

1. Introduction

The use of information technology (IT) at K-12 schools has been proceeding worldwide, including in Japan. Japan is implementing educational reform [4] with new National Curriculum Standards (NCS) [5] for teaching, which will be introduced into schools in 2002. An integrated curriculum designed to foster children's abilities with further use of IT will begin.

As this is an important national project, the government allocated a large budget for developing more than 13,000 educational resources for teachers to use for school lessons. The interesting thing is that these resources mainly consist of short, conceptual video clips with a recording time of between 15 sec. and 5 min., each of which has a clear objective. This corresponds to the teacher's needs, because the most useful resources for them are short, on-target movies, pictures or text providing students with accurate descriptions, rather than conventional, long-duration videotapes. Such short resources are sufficient to supplement students' understanding during subject-oriented lessons. However, since there are is an enormous variety of educational resources in the database, it is difficult for teachers and students to find appropriate resources.

LOM has been investigated and will be standardized as one of the primary solutions to this problem. We extracted some necessary metadata from the LOM and developed a search engine to provide efficient retrieval by using this metadata.

In this paper, we describe the functions of the search engine by considering actual use in schools. We also discuss how the LOM is applied to the various functions.

2. Search engine system

The system structure, including the relationship between the educational resources and the search engine is shown in Fig. 1. The resource developers attached the LOM to each resource on their computers by using the new LOM registration tool operating in the Microsoft Excel and then sent their data to a manager for the search engine. Since the search engine also has a function enabling LOM registration from a browser, the resource developers could also register through the Internet. After the LOM was automatically transformed to the extensible markup language (XML) style, the necessary metadata for retrieval were extracted and installed in the database file. This database provides the retrieval objects from the fixed category of the LOM. The search engine has a function that crawls the textual information written in the resources. The crawling robot gathers such information by accessing the web sites of the resources, based on the URL described in the "Location of LOM 4.3" written in the reference model reported in IEEE Version 4.0 [1]. The stored textual information and the vocabularies of the LOM are indexed according to each resource and become the objects for keyword-input retrieval. Therefore, the range of retrieval objects for keywords is wider than that for the LOM categories.

The retrieval flow is shown in Fig. 2. The users input their ID and password when entering the search engine system. By recognizing the user IDs, the system selects different displays suitable for each user's grade, as shown in Fig. 3. For example, illustrations and simple expressions are shown in the web pages for pupils of grades 1 through 6 to make retrieval easier for them. After the users select resource types, they can choose the retrieval method; that is, they can search from the LOM or by using keywords. The output is displayed and linked to resources in a server on the Internet. After reaching these resources, the users can be guided to other related

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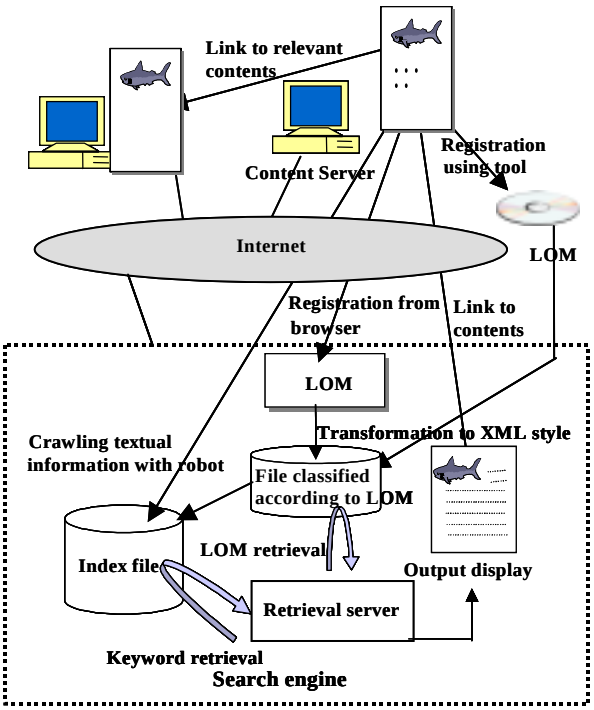

Fig. 1 Search engine system structure

resources. The functions will be described in more detail in the next sections.

At present, more than 13,000 resources for grades 1 through 12 are attached with the LOM and registered in the search engine.

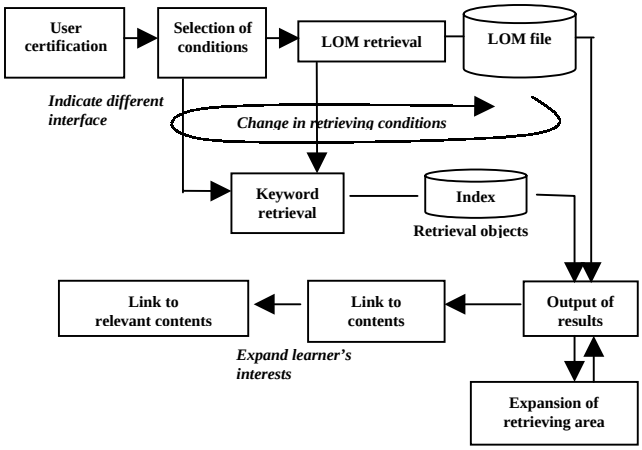

Fig. 2 Retrieval flow

3. LOM application to retrieval functions

3.1. Selection of resource types

There are many types of materials and presentation in the educational resources. Moreover, the appropriateness of each resource depends on the use environment.

(a) Image for pupils of grades 1- 6

(b) Image for teachers or educators

Fig. 3 Image display depending on age

Teachers and students face various problems in trying to use these resources at school, as it takes a great deal of time to find resources matching the learner's needs. To enable users to find the desired resources quickly and accurately (for example, to focus on video resources for a chemistry experiment or sound for appreciation), the resource types should be selected before retrieval according to the users' needs.

In addition, when students use these resources at school, there may be issues of copyright infringement. Students often download the educational resources to their personal computers, then revise them or upload them to their school's web sites without the author's permission. To prevent copyright infringement, the range of use permission should be selected according to how the resources are used. If teachers want to publish students' study notes with some of the resources, they must choose appropriate resources only from among those with the use permission for "distribution". The resource types and use permissions classified in the LOM are shown in Fig. 4. The affixed numbers of the LOM in Fig. 4 correspond to the numbers used in the reference model reported in IEEE Version 4.0[1].

Among the resource types, the lesson plan and case study are necessary only for teachers. These resources should not be open to students. Therefore, the system recognizes users by their IDs, displays lesson plans and case studies on the browser when a teacher accesses them, and allows only teachers to select them.

The selected conditions are listed in the left frame for user reference. An interesting characteristic is that although all conditions used in the LOM are indicated in the display, if the conditions are not registered in the search engine, they are not selectable. Moreover, the number of resources matching the selected conditions is immediately calculated and shown. Therefore, the user can readily know how many resources are available as retrieval objects for every set of conditions.

3.2. Retrieval matching to learner's skill level

A large volume of educational resources — with various degrees of difficulty ranging from child to adult

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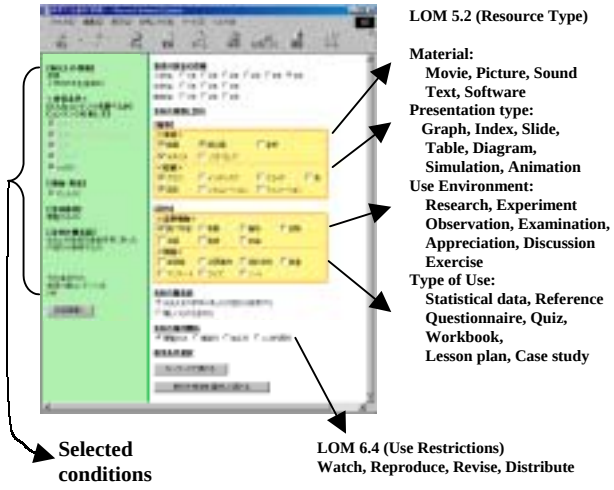

Fig. 4 Display image for selecting resource types

use — currently exists on the Internet. As a result, it is difficult for learners, especially pupils, to find resources they can understand. We can solve this problem by recognizing the intended user, written in LOM 5.5 and the grade associated with the resources, in LOM 5.7.

The users input their grade and select any retrieval method; that is, retrieval from the NCS, by features relevant to 5W1H, and by keywords. Based on the selected conditions, the search engine lists the resources retrieved from the resources corresponding to the user's grade. The search engine also has a function for extending the retrieval area to a higher degree of difficulty, even including the resources for "teachers" in LOM 5.5. Therefore, students can search resources with range of degrees of difficulty. Meanwhile, teachers can select any grade from 1 through 12 and any degree of difficulty from "learner" to "teacher" before retrieval. Simultaneous multiple selection of retrieval conditions across these methods is also available.

3.3. Retrieval from vocabulary of LOM

3.3.1. Retrieval based on NCS guidelines

Almost all schools in Japan provide for instruction according to the NCS guidelines, which describe what teachers should teach their students. Therefore, retrieval according to NCS guidelines is seen as the best way for Japanese teachers and learners to easily find proper resources. The vocabularies of the NCS depend on the subject and grade and have hierarchical structures, as shown in Fig. 5. The number of the stratum depends on the subject and grade. When a user tries to retrieve resources based on NCS guidelines, the system automatically indicates the corresponding vocabularies for the grade by recognizing the user's grade. The user can select the retrieval conditions at any stratum. For example, if the user selects "Materials and Energy" at the third stratum in Fig. 5, all resources relating to "Materials and Energy" for 4th-grade science are retrieved.

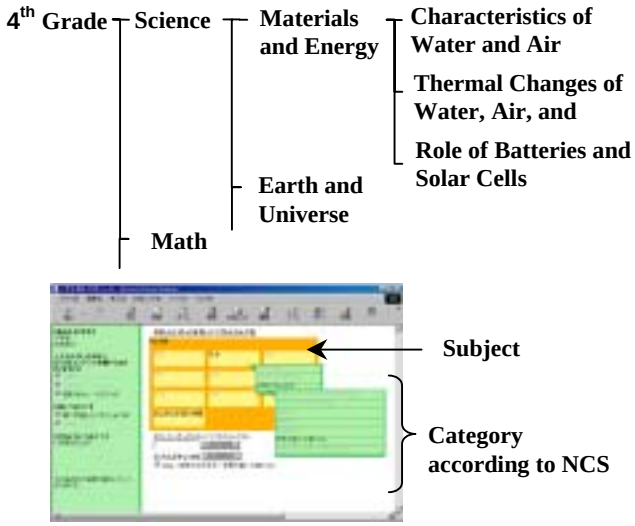

Fig. 5 Example of the category of "Science" according to the NCS guideline for elementary school

3.3.2. Retrieval by features relevant to 5W1H

The user can retrieve features relevant to the questions, "Where", "When", "What", "Who" and "How" as shown in Fig. 6. Students, especially primary-school pupils, tend to retrieve educational resources by using search target features relevant to 5W1H as well as from the curriculum [6]. As a result, this classification has been adopted to let them find resources in this way more quickly and easily.

Vocabularies showing these features were extracted to cover words and phrases to be learned in primary school. This classification also features a hierarchical structure, like that of the NCS. In the "When" vocabulary, the names of eras unique to Japan, such as the Edo era, are used in the same way as centuries. In the "Where" vocabulary, the names of countries, prefectures in Japan, and habitats are included. The "What" vocabulary is classified into living things, materials, earth and universe, environment, culture, industry, and other categories. Each category is then further broken down into several sub-categories. The "How" vocabularies include "how to" (how to breed, how to live, how to make things, etc.), "mechanisms" (structure, function, causes, influences, etc.), and "things for the purpose of" (things for the purpose of eating, things for the purpose of living, things for the purpose of using things, things for the purpose of decorating, etc.).

Using these classifications makes retrieval easy. When a pupil wants to find information on the breeding habits of a beetle, for instance, he or she can get the information by selecting "insect" from "What" and "how to breed" from "How".

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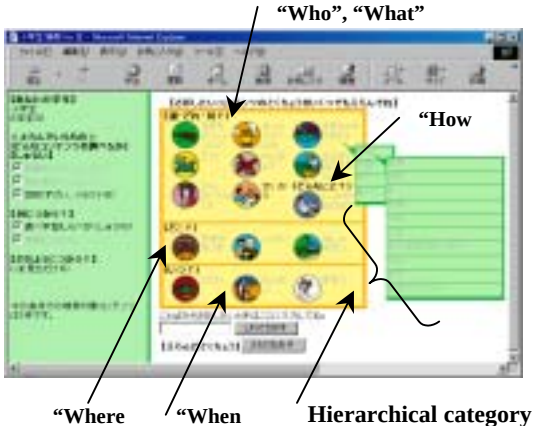

Fig. 6 Display image for retrieval by 5W1H

4. LOM Application to retrieval output

4.1. Display of output

After retrieval, the output of resources with titles, 100-characters content descriptions, content sizes and other information with thumbnail pictures is displayed so that user can understand the structure of the available resources, as shown in Fig. 7(a). This information is extracted from the LOM and shown automatically by the system. By clicking the thumbnail or title, the linked resources are displayed with a detailed description and the purpose of the resource (Fig. 7(b)). Here, the user can retrieve resources from a wider selection, including resources with higher degrees of difficulty, as described in the section 3.2.

4.2. Expansion of learner's interests

With a conventional search engine the retrieval flow terminates when the objective resources are retrieved. This system, however, shows relative characteristics and other resources in order to expand the user's interests. The relative characteristics and resources are extracted from the LOM (Fig. 7(c)). The user can select interesting words from among these characteristics and retrieve related resources to deepen his or her understanding of other fields (Fig. 7(d)).

5. Conclusion

We have developed an effective search engine for educational resources for K-12 schools by using the LOM for the retrieval conditions and output display of the search engine. LOM was created for 13,000 educational resources one-by-one and registered in the search engine. The search engine will be available to students and teachers via the Internet in August 2001. In the interests of LOM standardization for Japanese K-12 school

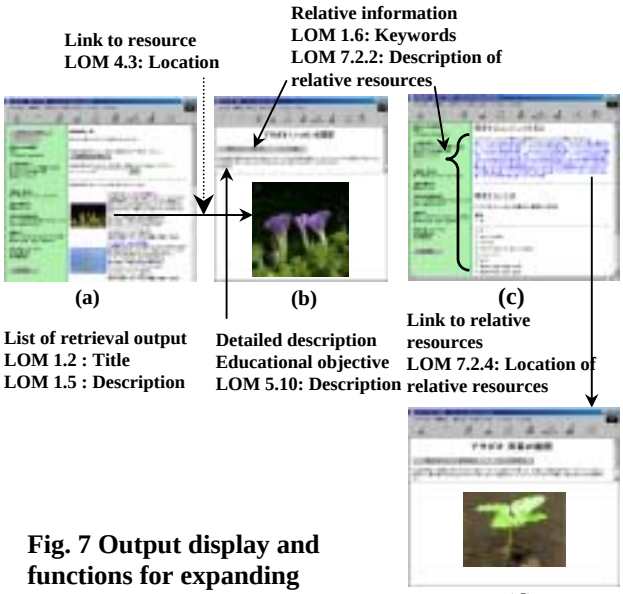

Fig. 7 Output display and functions for expanding learner's interests

educational resources, we will continue to conduct experiments at schools and evaluate LOM efficiency in depth.

6. Acknowledgments

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