Building a Space of Cultural Heritage Objects to Explore It in the Classroom

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Key words: *Knowledge Sharing, Content Management, Annotation*

Abstract:

Not only for further understanding of subjects but also for learning analytical thinking or inductive inference, it is important to provide a highly engageable environment where pupils can interact with high quality cultural contents easily. The authors have been developed an interactive exploring tool called CEAX Voyager. One of the important issues to make the learning with CEAX Voyager effective is to prepare adaptive descriptions for pupils.

This paper proposes a framework for supporting creation and sharing of adaptive descriptions about cultural heritage objects. In the framework, such descriptions can be authored not only by professionals such as curators but also by school teachers.

1 Introduction

In the classroom, textbooks and some supplemental books are usually used to study culture or history as well as language arts or science. Even though such materials are well-organized according to their corresponding curricula, they are not enough for pupils to appreciate cultural objects and get familiar with them. The authors suppose that it is effective not only for further understanding of subjects but also for learning analytical thinking or inductive inference to provide a highly engageable environment where pupils can interact with high quality cultural contents easily.

The authors have been carried out a research project which aims to reveal a methodology to establish a framework for managing various kinds of information on cultural heritage objects and how to utilize them for educational purposes. We call it CEAX[1].

In CEAX framework, pupils use an interactive system called CEAX Voyager and explore prepared materials including metadata of cultural heritage objects, descriptions, and high quality images in the classroom. We expect that CEAX Voyager and rich contents including not only high-resolution images but also adaptive descriptions to users facilitate their engagement in the space of cultural heritage objects.

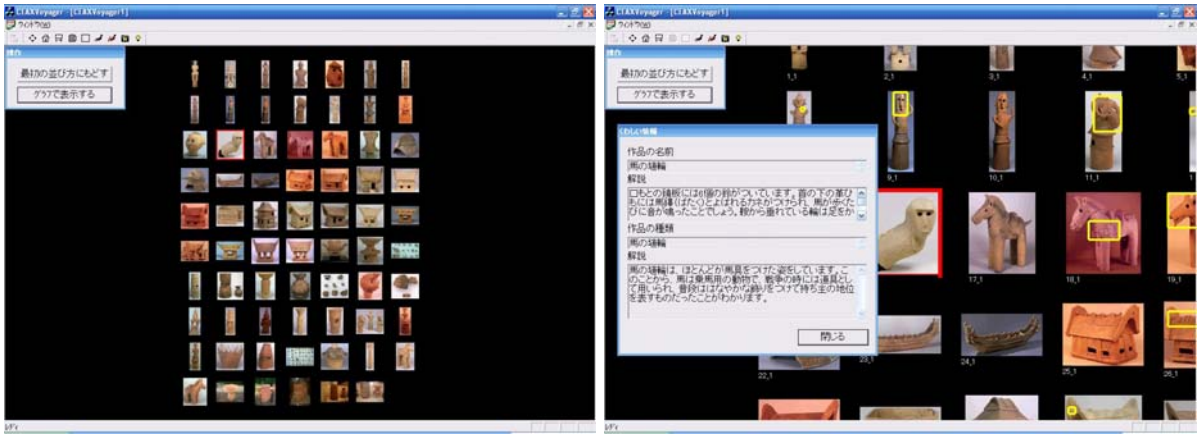
This paper proposes a framework for supporting creation and sharing of adaptive descriptions about cultural heritage objects. In the framework, such descriptions can be authored not only by professionals such as curators but also by school teachers.

[1] CEAX stands for Educational use of Cultural heritage Archives and Cross(X) search.

In this paper, Section 2 overviews CEAX Voyager which is an interactive exploring tool for a space of cultural heritage objects. In Section 4 our framework for creation and sharing of adaptive descriptions is proposed. Then, Section 5 describes our systems for content management of cultural heritage objects and technical terms. An overview and the results from experimental classes are shown in Section 5. Section 6 describes related works. Finally, a conclusion is given in Section 7.

2 CEAX Voyager: an Exploring Tool in the Classroom

CEAX Voyager is an exploring tool for prepared materials including metadata of cultural heritage objects, descriptions, and high quality images in the classroom. It was designed for supporting guided discovery learning in classrooms. Users can view scattered object images in a two-dimensional space and zoom in on a selected image (Figure 1(a)). It can highlight remarkable regions of images, as well as showing detailed information including descriptions (Figure 1(b)).



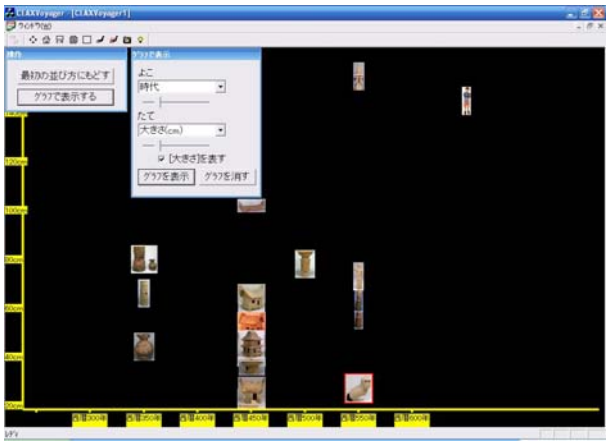
(a) Scattered Object Images

(b) Displaying Description about a Object (Yellow rectangle denotes remarkable regions.)

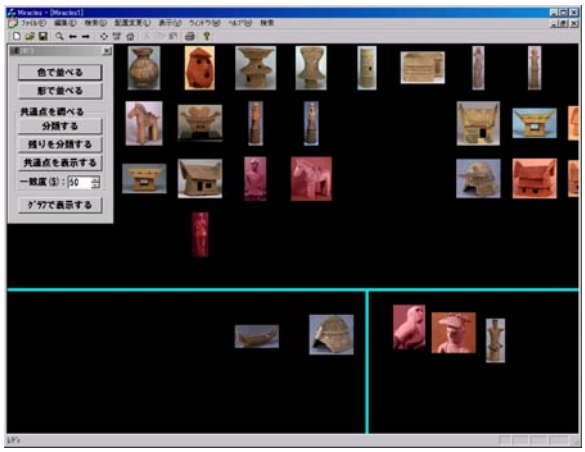
Figure 1 A Snapshot of CEAX Voyager

In addition, the tool gives two computational functions: a graph layout and classification. The graph function coordinates images according to two axes selected by users (Figure 2(a)). The classification function facilitates classifying objects into two categories semi-automatically. When a user wants to find some common factors of two groups or hidden relation amongst objects, they put a few exemplars into a corresponding segment, which is indicated by the two bottom regions (Figure 2(b)). Next, the tool extracts common factors, such that the values of more than N percent objects are the same in each region, but the ones of objects in different regions are different (Figure 2(b) (c)).. We set 50 as the threshold value N experimentally for the feasibility test mentioned in Section 5. Pupils, therefore, not only can view a lot of high quality images of objects “in hand” in the classroom but also are supposed to learn how to think analytically or to infer inductively by experience throughout interaction with the content using CEAX Voyager.

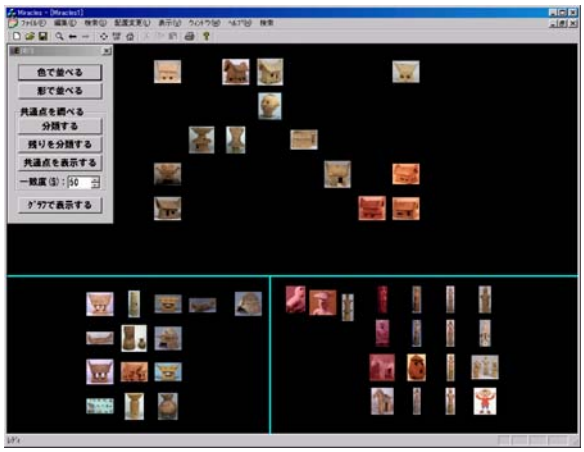
One of the important issues to make the learning with CEAX Voyager effective is to prepare adaptive descriptions for pupils.



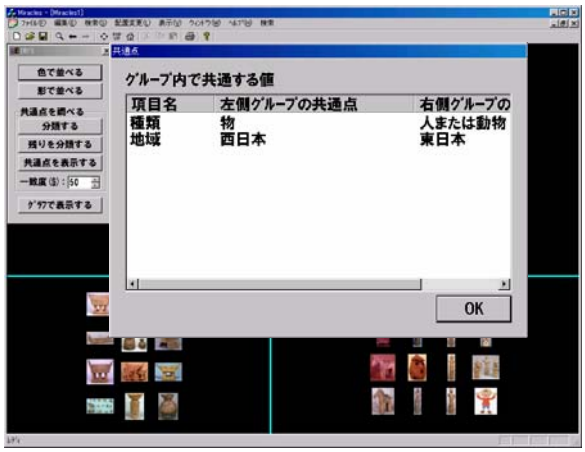
(a) Graph Layout



(b) Classification Step 1: Initial data are dropped into two regions by a user.



(c) Classification Step 2: Similar objects with each initial data set move automatically to the corresponding region using learned classifier.



(d) Classification Step 3: Common factors can be shown for each group.

Figure 2 Layout Functions

3 Framework of Growing Metadata

To globally share high-quality content on cultural heritage objects, we must consider to effectively associate objects with various levels of knowledgeable but subjective descriptions. We proposed our conceptual framework called “Growing Meta-data” and a flexible content management system called Owlery [1].

Table 1 shows a typical example of the metadata of the object called “Haniwa Armored Man”. As shown in Table 1, even one object may have various titles. For example, “埴輪”, appearing in all the titles, means “Haniwa”, which is an earthenware burial figure. Although “武人” means a warrior and an ordinarily educated Japanese person can understand it, another term, such as “兵士”, is used nowadays in Japan instead. “挂甲” is also regarded as an unfamiliar term and it is difficult for even native Japanese speakers except an archaeologist to understand what it means. Titles that don’t include “挂甲” inside them might be used for younger people, such as K-12 pupils; “Title 1”, “Title 3”, and “Title 4”.

Table 1 Example of Metadata for "Haniwa Armored Man"

attribute	Value
Item No.	J-36697
Title 1	[国宝] 埴輪武人
Title 2	Haniwa Armored Man
Title 3	武人の埴輪
Title 4	埴輪武人
Title 5	埴輪 挂甲をつけた武人
Title 6	埴輪 挂甲着用男子
Title 7	埴輪 挂甲の武人
Place 1	太田市飯塚町出土品
Place 2	Object from site at Iizuka-cho, Otashi, Gunma
Period 1	古墳時代
Period 2	late Kofun period
Dimension 1	130.5

Table 2 Example of Descriptions about "Haniwa Armored Man"

Description 1	全身像。各部石膏復原。高 130.5。明茶褐色。胎土に砂粒・赤色粒を含む。冑には，三尾鉄表現がみられる。顔は粘土薄板貼付引伸ばし成形。台は断面楕円に近い隅丸胴張方形。透かしは上部両側に 1 対で円形。外面ハケ一部ナデ調整。赤彩は顔・靱・脚の小札にみられる。(from [2])
Description 2	挂甲と頬当・錣の付いた衝角付冑に身を固め，両腕には籠手をつける。靭を巻いた左手には弓を執り，右手を大刀の柄にかけ，完全武装の東国武人の姿を表している。人物埴輪の中でもきわめて優れた作品で，熟達した工人の作品であることを窺わせる。埴輪では数少ない国宝の一つである。
Description 2 (translation)	The haniwa warrior wears a a visorless keeled helmet (J. shôkakutsuki kabuto) with an armor (J. keikô), cheek-guards (J. hôate) and protective flaps (J. shikoro), and puts the bracers (J. kote) on both forearms. His left hand bound with protecting tie (J. tomo) holds a bow while right hand holds a sword, which is displayed the shape of the full-armed warrior in the eastern country. It is an extremely high-quality haniwa warriors, indicating that the figure was produced by an accomplished artisan. It is a rare example of the national treasure in the haniwa.
Description 3	頬当（ほおあて）・錣（しころ）の付いた縦矧板鋲止衝角付冑（たてはぎいたびょうどめしょうかくつきかぶと）と小札（こざね）を革ひもで綴じた挂甲（けいこう）に身を固め、両腕には籠手（こて）をつけています。靭（とも）を巻いた左手は弓を執り、大刀の柄に右手をかけ、いまにも抜かんとする様相です。背中には矢を入れた靱（ゆき）を背負っており、完全武装の東国武人の姿を表しています。人物埴輪の中でもきわめて優れた作品で，埴輪では唯一の国宝です。
Description 3 (translation)	The haniwa warrior wears a visorless keeled helmet (J. tatehagi-ita by ôdome shokakutsuki), a armor (J. keikô) which consists of small panels of iron (J. kozane) laced together with leather lace and puts the bracers (J. kote) on both forearms. His left hand bound with protecting tie (J. tomo) holds a bow while right hand holds a sword. He has an air to be going to revolt the sword. He puts the arrows in the quiver (J. yuki) on his back, and what is displayed is the shape of full-armed warrior in the eastern country. It is an extremely high-quality haniwa warrior and the only national treasure in haniwa.
Description 4	完全武装した東国の武人をかたどった埴輪です。ほお当て、首の後ろを保護する錣（しころ）が付いた衝角付冑（しょうかくつきかぶと）をかぶり、挂甲（けいこう）とよばれる甲（よろい）に身を固めています。両腕には、腕を保護する籠手（こて）をつけています。左手に弓をもち、右手を大刀の柄にかけ、今にも抜こうとしているようです。背中に

	は、矢を入れた靫（ゆき）を背負っています。人物埴輪の中でもきわめて優れた作品で、埴輪ではただ一つの国宝です。
Description 4 (translation)	It is a haniwa in the shape of the full-armed warrior in the eastern country. The haniwa warrior wears a visorless keeled helmet (J. shôkakutsuki) with cheek-guards and an armor called keikô. It puts the bracers (J. kote) on both forearms to protect them. The warrior's left hand holds a bow while his right hand holds a sword slung from his waist. It seems to be going to revolt the sword. He puts the arrows in the quiver (J. yuki) on his back. It is an extremely high-quality haniwa warrior and the only national treasure in haniwa.
Description 5	Haniwa warrior. Terra-cotta. H. 130.5.
Description 6	This armor-clad haniwa (burial-figure) warrior is armed with a sword, a bow, and a quiver of arrows. Its high level of detail provides invaluable insights into the arms and armour of the warriors of eastern Japan in the late Kofun period (c. 250-c. 600). The haniwa warrior wears a visorless keeled helmet (J. shôkakutsuki) with protective flaps on either side of his face and behind his head. The small buttons on the helmet show how it was made of small iron plates riveted together. The armor, a type known as keikô (literally, “hanging armor”), consists of small panels of iron laced together. The detailed modelling shows all the features of the armour, including padded guards for the shoulders, knees, forearms, and legs, and shoes. The warrior's right hand holds a sword slung from his waist, while his left hand holds a bow. Tied just above his left wrist is a device to protect his hand from the bowstring. The arrows in the quiver on his back have their heads pointing upwards. The ten loop ties that are visible show how the armour was fastened-the knee- and leg-guards from behind and the main body from in front-with a slight overlap from left to right. Short sleeves protrude from below the shoulder-guards, while the forearm-guards are worn directly on the skin. The face has a tranquil expression and the body as a whole is well balanced, indicating that the figure was produced by an accomplished artisan. Several other examples of high-quality haniwa warriors with similar features have been excavated in the vicinity of Ôta City in eastern Gunma Prefecture, suggesting that a center for haniwa manufacture existed somewhere in this area. (from [3])

In general, all the titles in Table 1 seem acceptable, because the creator of this object is unknown and it has no “correct” title. In fact, each title is declared at the same museum for its own purpose, such as for a card catalog or for exhibitions.

In the case of description, various descriptions can be written for even one object, as shown in Table 2. We would like to emphasize that each description has to be written for its own expected readers, such as experts, general adults, or children. We, therefore, must handle the descriptions for corresponding target readers. For example, “Description 1” from a catalog [2] seems to be written for experts, and “Description 3” is rewritten for children from “Description 2” for adults. In general, it is difficult to understand “Description 1”, and it may also be hard even to read aloud to them. Another longer description about the object can be found on the Internet [3] (“Description 6”). The authors suppose that the descriptions for a web page or a printed article may be able to be longer than the ones for an exhibition where visitors stop by and read them for a minute, even if the expected readers are adults.

Many of the existing global content management frameworks, such as the Semantic Web, assume that a global schema can be obtained, shared, and accepted by all concerned. Furthermore, it is necessary for all content creators to describe documents consistent with the conceptual schema. We, however, must not forget that people often consciously and unconsciously say incorrect things. The authors, therefore, make another approach to managing the content. The basic idea of our approach is that descriptions are separated from the factual data, such as a unique identification number or its dimensions, as shown in Table 1 (a), in the metadata and associated with the related factual data or other descriptions, as opposed to the existing frameworks whose descriptions on each object are included within the

metadata, as well as in the factual data. Some typical factual data are the person, work, time, location, and organization.
In this paper, the term annotation will be used to refer to descriptions related to the content. Annotation includes various titles, descriptions about objects or terms, expressions of time periods, location names, and so on.
We believe that our approach has the following advantages:
Dynamism of content repository: In our framework, basically any authorized user can append their description, as well as blog [4] or Wiki [5]. The content repository gets dynamically grown, although existing frameworks [6, 7, 8] are based on a global schema, such as RDF.
Maintaining quality of content: As opposed to weblog or Wiki, our framework can maintain the content quality because our major content creators are experts, such as researchers or curators of museums. Our framework is open to general users, although a subject gateway approach [6] strictly controls its content.
Enhancing content to be searched: The content can be extended with associated descriptions and that helps it to be searched. For example, when the original title doesn't contain "武人", which is used as a search keyword, "埴輪挂甲着用男子" can be covered.
Association among contents: In the same manner as the advantage above, our framework gives dynamic links among related contents that share the same factual data. This advantage helps users to browse content archives.
Assistance for readers: Our framework gives links to technical terms stored in the content repository automatically, like Wiki. When a user reads a description but it contains unknown technical terms, they can get help with it.

4 Systems for Content Management

4.1 Overview

Figure 3 illustrates our systems for content management based on Growing Metadata. The overall system consists of a content management system called Owlery (middle of the figure) and clients of Owlery (right and left).
To apply our systems for educational purposes, there are several roles in our framework: experts from museums (bottom right), educators (middle right), learners (top right), a content management service provider (middle), and general users (left). Experts, such as curators of museums, use our client system, called Owlery Client, for authoring metadata and descriptions about cultural heritage objects. Although educators also use the same client, they describe not only their own contents, such as neighboring historic sites, for classes but also tasks that must be prepared prior to a class. Tasks contain some metadata, such as objectives, dates, and subjects, and a content set as the course material to be used in the class. The content set will be used with CEAX Voyager in the classroom by learners, under the guidance of the educator. On the other hand, general users can use our web-based client, called Owlery Web Client, to browse different contents. Some users may append their own annotations.
Educators create their material as a content set and pupils explore the space which consists of it.

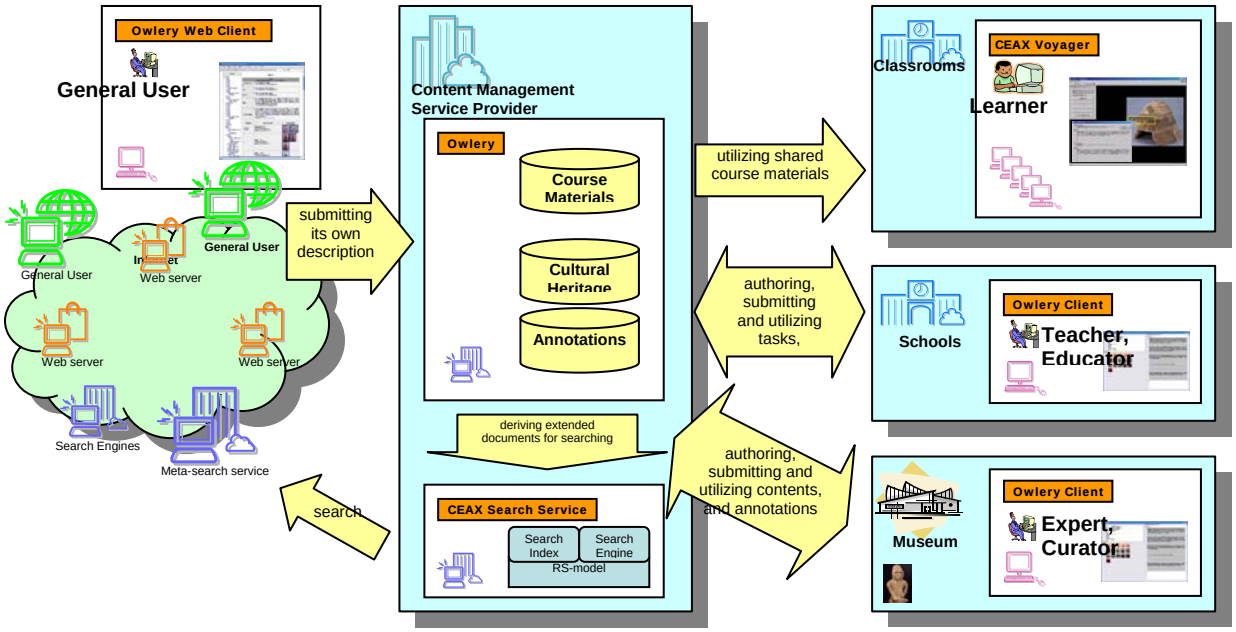


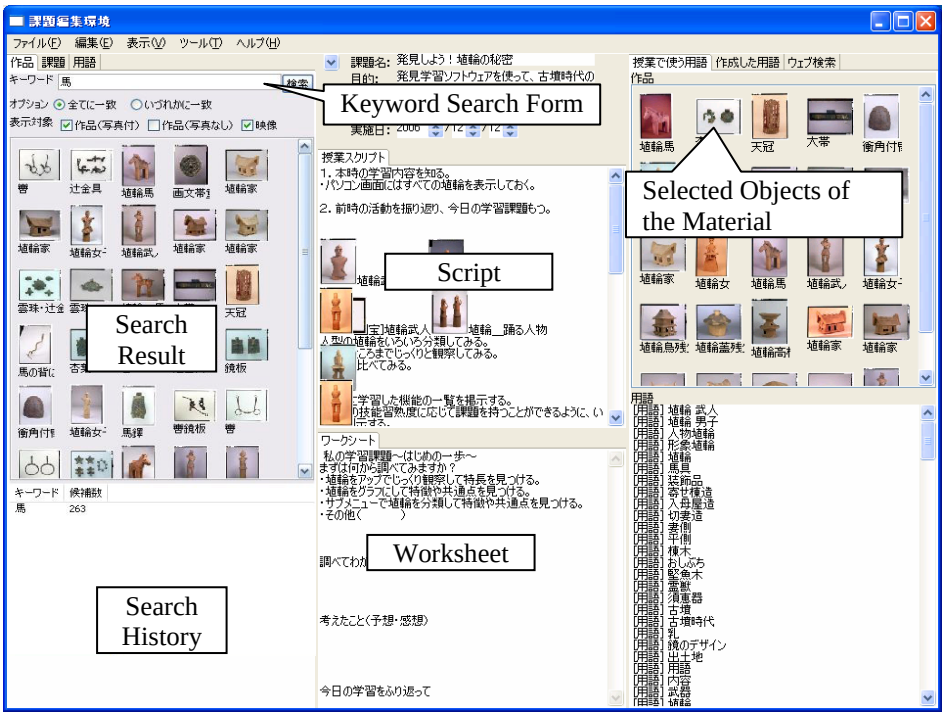
Figure 3 Owlery and its Clients

4.2 Owlery: Content Management System

Owlery is our content management system. It stores the metadata of cultural heritage objects, annotations, and course materials declared by educators. The prototype system is implemented as Web Services on Apache Axis2 and Java and the data are managed by PostgreSQL.
Owlery has a CEAX Search Service, which gives flexible full text search functions based on an RS-model [9]. However, this is irrelevant to the main subject of this paper.

4.3 Clients of Owlery

Owlery Client: Owlery Client is a fully-functional client system for authoring, submitting, and utilizing the contents of Owlery. Figure 4 shows a snapshot image of Owlery Client, which contains the main window (top) and pop-up detailed information of a selected content (bottom). The main window has three panes: a search pane (left), an authoring pane (middle), and an information pane (right).
A user can search objects, terms, and tasks in the search pane, while authoring their task in the middle. In the example of Figure 4, retrieved objects for the keyword “馬” (horse) are shown in the search pane. The result includes objects related to horses, such as burial figures and harnesses. Information panes give various kinds of information including selected contents, suggestions related to the authored task, and history of the creation of the content.
In the detailed information window, they can declare their own description and select images and descriptions to be used in class.
Owlery Web Client: Owlery Web Client is a web-based client. Although some functions and its usability are less than with Owlery Client, it is easy to start using.



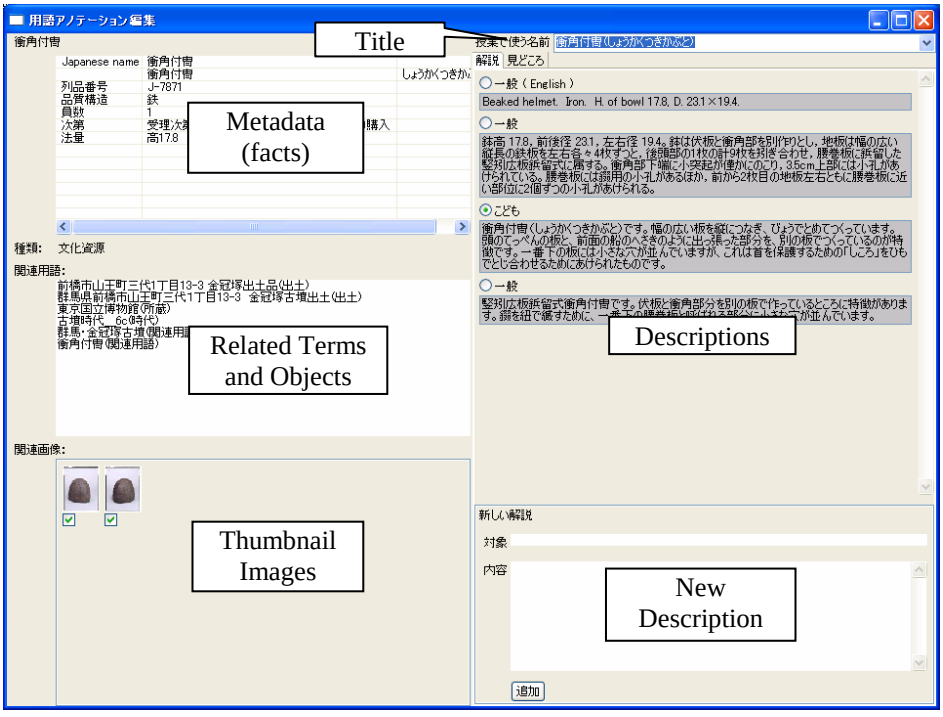


Figure 4 Owlery Client

5 Feasibility Test

To reveal the feasibility of our approach, experimental classes were conducted using CEAX Voyager at an authentic elementary school in Nishi-Tokyo city since 2004. The learners were about 90 6th-graders from three classes for each year. The theme of the class, which was configured by the teachers in charge, was to discover the secrets of Haniwa. The teachers

aimed to let pupils discover any secret, or hypotheses, by themselves and learn the process of discovering through abductive inference, verification, and presentation.

5.1 Data Set

In these experimental classes, we selected historic heritage objects from the Kofun period of Japan, which was from the late 4th to the 7th century A.D., including the national treasures of Japan owned by the Tokyo National Museum (TNM). We did this because Haniwa was supposed to be familiar to the pupils and TNM owns the largest collection of Haniwa in the world. First, an archaeologist described annotations for each object and technical terms (e.g. “Description 2” of Table 2). Then, a science writer rewrote the annotations for the pupils (e.g. “Description 3” of Table 2).
We prepared over 180 objects, 860 images, and 380 descriptions. From this collection, 291 images and corresponding annotations were selected to load into CEAX Voyager.

5.2 Results

In the classes, some of the supportive evidences for our approach were observed as follows:
Pupils were willing to read descriptions: The teachers and the authors had expected that pupils would not want to read descriptions about objects, because they usually tended to give up reading and loose concentration when unknown characters appeared. However, the teachers were surprised that the pupils got well-engaged with the beautiful images and tried to actively read descriptions about one object after another. In fact, the actions related to reading the descriptions were done much more than any of the other actions. The most selected action was “holding the description window” which facilitates visualizing the window that contains the descriptions. In addition, pupils tended to refer to detailed information just after using the classification of the objects and graph layout functions.
Even descriptions for adults might be acceptable: We used some unrewritten descriptions, that is, descriptions for adults. Some pupils complained about the low readability of them, which we expected. However, some tried to read these descriptions even when unknown characters appeared.
We have observed that the more descriptions for pupils, the less complainers.

In an interview with the teachers after the classes, they strongly agreed about the success of the tasks and the effectiveness of our systems and contents, although they couldn’t get sufficient help from the usual search engines in the past. As a result, we believe that an appropriate form of expression for a description is necessary and our approach is feasible for this purpose.

6 Related Works

6.1 Managing Metadata of Cultural Heritage Objects

The importance of the metadata is increased when the cultural heritage objects are digitized. For example, metadata can improve the search effectiveness and usability of the search system by providing multiple access points and preserving the semantics and context of the objects. It is also critical in linking the multiple versions of the digitized contents of the same object and objects from the same collection. It can provide detailed description frameworks

appropriate for each community as well as more general frameworks for resource discovery across different communities.
However, for management reasons, cultural heritage object metadata has its own difficulties and problems, such as 1) diversified descriptions, 2) linking multiple versions of the same objects, and 3) readability for different user groups.
For the diversified descriptions, even titles can often be changed since they are given in rather recent time periods. For example, the titles of archaeological objects are usually object names and may be changed for each exhibition. In addition, the description of cultural heritage objects may differ in the principles, paradigms, viewpoints, and interpretation of each creator of the metadata and its users.
For multiple versions, digitized images and other related contents of objects are created for various purposes and different occasions by contents producers for different users with differing levels of quality and resolutions. Linking them together while maintaining your own contexts and differences, is critical for better usage of the contents. Traditionally, those contents were created by museum experts, but these days we can often see various cultural heritage related contents on the web, especially on Wikis [5] or in blogs [4]. They add a variety of viewpoints and perspectives, but their quality and authenticities do vary quite a bit.
Any other related materials, for example catalogs for exhibitions or auctions, textbooks, course materials prepared by school teachers, and even classroom reports by students or pupils can be kinds of metadata or annotations about the cultural heritage objects and are also useful, and can be considered variable contents if they properly managed to keep their own contexts. In these ways, related metadata and contents are increasing and are being enhanced by various content creators. The problem of diversified descriptions increases in such environments.
Providing readable and understandable metadata and annotations for different user groups, such as non-experts, children, and users with different backgrounds, is particularly important for cultural heritage objects.
To address the above mentioned problems, we identify the following tasks:

– resolving the diversified descriptions
– implementation of a flexible content management mechanism
– content creation support systems
– adaptive levels of presentation.

We proposed a framework for cultural heritage object metadata called “Growing Metadata” and a system to manage the Growing Metadata in order to tackle these tasks [1].

6.2 Systems for Sharing Overall Content

For sharing content globally and managing it, metadata integration is recognized as one of the important issues [10, 11]. The Semantic Web [12], which aims to make web pages understandable by computers, has been proposed and many applications based on the Semantic Web using a Resource Description Framework (RDF) [13, 14] have also been proposed. One of the proposed systems is Piggy Bank [15]. Piggy Bank is a web browser extension that helps users to create Semantic Web content in their use of the existing web content. This research deals with one of the important issues of the Semantic Web: a bottleneck for producing Semantic Web content.
In addition, some content management systems (CMS) have been proposed for instant web publishing, such as Wiki [5] and blog [4]. CMS enables users to not only create web content easily, but also to make links to related content dynamically. Wikipedia [16], which is a Wiki-based free-content encyclopedia, can be used globally.

In the field of cultural heritage, it is important to keep in mind that many of the web pages may include not only knowledgeable explanations but also a variety of expressions, ambiguities, and even incorrect things. In fact, recall in general web search engines seems low because there is relatively less content than for general topics, although there are various expressions on even one concept.
We assume that it is essentially difficult to create ontology for this field, because it is hard to obtain an authorized consensus, other than experts' subjective opinions. Therefore, we have to consider a more flexible approach other than the Semantic Web, to manage the content, such as Semantic Blogging [7] and Semantic Wikipedia [8].

7 Conclusion

This paper proposes a framework for supporting creation and sharing of adaptive descriptions about cultural heritage objects. In the framework, such descriptions can be authored not only by professionals such as curators but also by school teachers. As a result of experimental classes that used the content and systems of our proposed framework, we found that the proposed framework is feasible for managing cultural heritage objects and utilizing it for educational purposes.
There are some future issues to consider and they are as follows:

- Usability testing of Owlery clients
- Dynamically adapted descriptions

8 Acknowledgments

The authors wish to express our gratitude to the Tokyo National Museum and Mr. Yoichi Inoue, Mr. Mitsuharu Iwasa, and Mr. Satoshi Tarashima for their valuable advice and permission to use the images and metadata of the museum.
Thanks are also due to Tanashi Elementary School of Nishi-Tokyo city for their cooperation with the experimental classes.
This study was supported in part by the Ministry of Education, Culture, Sports, Science, and Technology of Japan under the "Development of Fundamental Software Technologies for Digital Archives" program .

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