Thinking Semantic Wikis as Learning Object Repositories

Juan Ignacio Vidal
Lifia, Facultad de Informática, UNLP
50 y 120
(1900) La Plata, Argentina
+54 221 4236585
ignacio.vidal@lifia.info.unlp.edu.ar

Alejandro Fernández[†]
Lifia, Facultad de Informática, UNLP
50 y 120
(1900) La Plata, Argentina
+54 221 4236585
casco@sol.info.unlp.edu.ar

Alicia Díaz
Lifia, Facultad de Informática, UNLP
50 y 120
(1900) La Plata, Argentina
+54 221 4236585
alicia.diaz@lifia.info.unlp.edu.ar

ABSTRACT

Wikis have been extensively adopted in educational contexts becoming repositories of potentially reusable, self-contained learning units (commonly known as learning objects). Unfortunately, wikis lack of the packaging and metadata facilities that are needed to enable effective reuse of these units. In this article we propose an approach to use semantic wikis as learning object repositories, we discuss its challenges and its potential, and we present a conceptual model and its implementation based on the Semantic MediaWiki engine.

Categories and Subject Descriptors

K.3.1 [Computer Uses in Education]: *Collaborative learning, Distance learning*

General Terms

Management, Design, Human Factors, Standardization.

Keywords

Learning Objects, Learning Object Repositories, Semantic Wikis.

1. INTRODUCTION

Wikis are pervasive. The key factors that drove the wide adoption of wikis are the simplicity with which they support publishing of on-line contents, lightweight and effective support for collaboration (editing, versioning, permission control), and their minimal deployment requirements.

The organization of most wikis is given by the way pages are structured (sections, paragraphs, text, pictures, tables) and linked. In addition, semantic wikis, specifically Semantic MediaWiki [4] have an underlying model for the semantics of its content. Pages can be put into categories to indicate the types of objects they talk about (e.g. City, Country). The meaning of links between pages can be also typed (e.g., *hasCapitolCity* for a link between a page describing a country and the page describing its capitol city). Text in the page can be annotated to make properties of objects explicit (e.g., to indicate that a number in the text expresses the city's population). These wikis are not only editable hypertext, but also queryable knowledge repositories.

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Wikis have been extensively adopted in educational contexts. Educators use wikis to publish material for their students. Students use wikis as personal workspaces. Wikis show their full potential when they are used to support collaborative content production, as is the case of students working on a group assignment or a team of professors creating lectures notes. With time, these wikis become repositories of potentially reusable, educational content.

Reusing educational content saves effort, improves content quality (through various cycles of improvement and use), and promotes collaboration between educators, content creators, and students. To foster reuse, educational content must be packaged, and augmented with additional information such as subject matter, intended audience, copyright, and level of difficulty. The IEEE Standard for Learning Object Metadata [3] defines *learning object* (LO) as "any digital or non-digital entity that may be used for learning, education or training". A more specific definition is provided by Chiappe [1]: "A digital *self-contained* and *reusable* entity, with a *clear educational purpose*, with at least three internal and editable components: content, learning activities and elements of context. The learning objects must have an external structure of information to facilitate their identification, storage and retrieval: *the metadata*".

From the perspective of LOs, a wiki can be seen as a single LO, or as a place where to find multiple LOs, each of them consisting of a single page or a group of pages. Unfortunately, wikis lack of the packaging and metadata facilities that are needed to enable reuse of LO. A wiki cannot normally answer questions such as: is this page a lesson, an exercise, or a test? Is this page the complete exercise or only part of it? Is this content adequate for primary students or for high school students? Those are questions that LOs annotated with the LOM standard (Learning Object Metadata Standard) [3] could answer.

Learning Object Repositories [2] (LORs) are systems that support the storage, search, and retrieval of LOs. They answer questions like: Is there a lesson here, in Spanish, for introduction to programming in Java? Standard protocols (e.g., the Open Archives Initiative Protocol for Metadata Harvesting) define the services that LORs expose. Those protocols allow the construction of query interfaces for final users. Moreover, they are the cornerstone for the creation of federations of repositories. If a wiki is to be used as a LOR within a federation of repositories, then it must implement those services.

In this article we propose an approach to use semantic wikis in the context of LOs and LORs, we discuss its challenges and its potential, and we present an implementation based on the Semantic MediaWiki engine.

[†] Also at Facultad de Ciencias Exactas e Ingeniería, UCALP

2. LEARNING OBJECT IN WIKI TERMS

The smallest unit of content in a wiki is a Page. Pages can relate to one another explicitly through links. A category (e.g., City) defines an implicit relationship between all pages tagged with it. Consequently, these are the primitives that make up learning objects in an educational wiki.

Not every page in an educational wiki is a reusable entity with a clear educational purpose. There are index pages, sandbox pages, and workspace pages that do not qualify as LOs. It is necessary to tell apart pages that are LOs from those that aren't. Certain LO can't be self-contained in a single wiki page; they span several pages (e.g., a well organized step by step tutorial). It must be possible to identify them, and their composing pages (the LO boundaries in the wiki). It must be possible to tell from any given page whether it is part of a LO (and which) or not. Learning objects in the wiki must be accompanied with metadata.

Figure 1 presents a conceptual model to express LOs in terms of wiki primitives. Two specializations for Page are necessary: LearningObject and LearningObjectPart. LearningObject pages are those that include a complete learning unit (i.e., one LO equals one Page), or those that are the entry point of a learning unit that spans multiple pages. LearningObject pages contain the meta-information about the LO. LearningObjectPart pages are those that contain a portion of a LO that spans multiple pages (other than the entry point). LearningObjectPart pages are related to the LearningObject page they belong to. An explicit relation between LearningObject pages is required in order to aggregate learning objects to produce others of higher granularity. We have defined this composition via a relation between LearningObject pages.

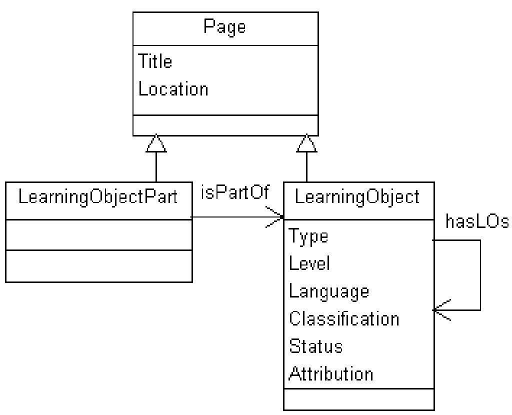

Figure 1: Conceptual model

All pages in a wiki have a Title and a Location (their URI). LearningObject pages additionally have metadata elements. There are various proposals for metadata sets for LOs, LOM being the most widely accepted. Detractors of LOM critic its complexity, and argue that for most cases LOM is an overkill. They propose smaller sets of attributes based on usage experience. The metadata elements included in the conceptual model are the ones used by the Wikiversity[1] project to annotate educational content.

The conceptual model is general enough to be implemented on different wiki systems. In doing so, there are constraints that must be observed. The evolving nature of wikis implies that pages will change type, from simple pages to LearningObjectParts, and possibly to LearningObjects. This requirement calls for a lightweight and flexible mechanism to classify pages. Wikis are successful because they reduce the effort required to create content. This should also be the case for the mechanisms used to provide metadata. These mechanisms must ensure consistency in the use of attributes and acceptable values. The fact that authors don't always provide metadata must be accepted and consequently, a strategy has to be devised to foster the emergence of complete, high quality metadata. Type and metadata need to be clearly presented to the user. Moreover, such information must be available in a form that enables automated processing, for example to support recommendations.

3. A REFERENCE IMPLEMENTATION

Semantic Mediawiki (SMW) [4] extends the successful Mediawiki[2] engine used to power Wikipedia with additional semantic constructs. The result is a wiki engine rich enough to implement the proposed model. In fact, much of the model can be implemented using the categories, a functionality that is available in Mediawiki.

In a SMW implementation of the model, LearningObject pages are tagged with *[[Category:LearningObject]]*. Similarly, *[[Category:LearningObjectPart]]* marks LearningObjectParts. Categories are simple to use and efficiently implemented (for example regarding search). There are built in mechanisms to browse categories, and API functions to query categories from extensions and external systems.

When authors create content units that span multiple pages, they normally use hyperlinks to connect them and to propose a navigation path. In a semantic wiki, these links could be typed to indicate a *isPartOf* relationship (as required in the conceptual model). However, the part-of relationship can also be expressed with categories (a simpler and more widely available feature). Each learning object page belongs to two categories. They belong to *[[Category:LearningObject]]* as stated before, and to a new and unique category named after the learning object's title (e.g., for an object titled "QnA about derivatives", it could be *[[Category:QnA about derivatives]]*. All parts of multi-page learning object will share the unique category. Using mediawiki templates this can be simplified to *{{LearningObject}}* and *{{LearningObjectPart | QnA about derivatives}}*. In a similar manner, a category (and helping templates) is used to indicate that a learning object is a composition of further objects. Following the vocabulary used by the LOM standard the category *[[Category:AggregatedLearningObject]]* is used.

If only categories are used, why choosing Semantic Mediawiki over Mediawiki? Semantic Mediawiki has a feature rich, semantic query language. An inline query can automatically display all parts of a multipage LO as an index in the object's starting page (e.g., *{{#ask: [[Category:{{PAGENAME}}]]}})*. Queries can be used to create dynamic index pages that classify learning objects according to the different metadata dimensions. Besides these queries, SMW adds faceted searches, automatic created lists, and the possibility to enter data via forms, among others. All these features help improving the creation, search and display of LOs within the wiki.

We mentioned before the simplified version of categorization through templates. This is not only a matter of simplicity, but

[1] www.wikiversity.org

[2] www.mediawiki.org

also a way to guarantee the correct use of categories. Misspelling or ignorance about the proposed categorization system could generate mistakes when a user assigns a category to a page. As a matter of fact, a user who has misspelled a category on a page won't have any feedback of his/her error. This occurs because categories are assigned whether they exist or not, creating a new one if needed.

Predefined templates, allows users to avoid these mistakes, mainly because if they misspell a template this will not appear at the wiki page.

Consider as an example a tertiary education template (*{{tertiary education}}*) this template generates two main actions, in the first place it adds a colored box, as shown in Figure 2, indicating that the annotated page is an educational resource intended for tertiary education, and in second place it adds to the page the category *[[Category:TertiaryEducation]]*.

As the template is correctly defined, and the incorrect usage or misspelling wouldn't add any category or colored box, the user will have the necessary feedback to realize that he/she has done something wrong.

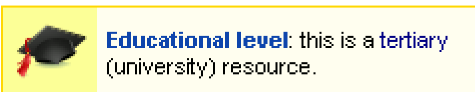

Figure 2: Tertiary level colored box.

3.1 The wiki implemented as a LOR

We have defined a conceptual model describing the different means to interpret a wikipage as a LO. We also have described the main issues about the implementation of LOs within Semantic MediaWiki. Nevertheless, this requires a LOR definition; otherwise, the LOs stored as wikipages will be accessible only through the wiki search pages, or indexed searches realized entirely by humans. The access to each LO's metadata by means of an external LOR wouldn't be possible, situation that limits the collaborative notion of the LOs. Once the metadata is exported, the LO itself would be accessible throw the wikipage's URL, which is included inside the metadata. Also, it will be possible to export the data in different standards such as SCORM[3], using the wikipage URL as the resource's *href* and the exported LOM XML as the resource's *metadata*.

Now we take a step forward in order to define the main requirements for the implementation of the whole wiki as a LOR.

The first problem that needs to be resolved is how to publish a set of web services that allow the interaction with different LORs. As we are developing throw SMW, the best choice is to implement a SMW extension that exports the required services. Using PHP, the technology needed to develop a SMW extension, we are able to publish and execute the services intended to communicate with others LORs.

In addition, we need to define the set of services that will be accessible throw the extension. This set of services would define the LOR's API.

As our main objective is to allow the federation of LO, we have decided to follow the OAI-PMH[4] protocol for metadata harvesting. This protocol defines the minimal requirements for implementing a metadata harvesting communication API for repositories, in our case, LOR.

As an example of the LOR's API develops, we are considering one of the services defined at the OAI-PMH. The *ListRecords* request. This request returns a list of records with the header of the resource (identifier, date of creation, among others) and the resource's metadata. In order to respond to this request, it is enough with iterating throw every resource and generating, by means of executing proper queries, the corresponding metadata. The queries mentioned, should retrieve the categories in a given context (learning level, language, status, etc.) that each LO, or its containing LO belongs to.

Once we have this information, the only step that remains is to convert it in the proper XML that will allow external repositories to harvest the information stored in our wiki.

The other 5 requests defined by OAI-PMH are implemented similarly, as well as other requests specifically elucidate for our LOR.

4. CONCLUSIONS AND FURTHER WORKS

In this paper we have shown a way to model and implement a LOR in a Semantic MediaWiki.

The most important contribution is the one derived from the possibility to harness the inherent collaborative environment of wikis in order to achieve completeness and quality in LO metadata. Together with the possibility of resources' federation, we have developed the full idea of implementing a LOR within a semantic wiki environment.

This conception brings up a few interesting problems that will be discussed in future works, mainly the eventually lack of consistency after a change over the wikipage content and/or its metadata. Beside this situation, there are other unexploited characteristics, like the auto-generation of metadata and the assistance in metadata generation to users and authors. Characteristics that will be studied in future works, as a continuation of the present essay.

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