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Applying Semantic Metadata in an Engine Producing E-Learning Interactive Multimedia Content

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Abstract. Metadata is a structural data defining details such as: content, format, object and structure. Within the past years, the IEEE-LOM standard has greatly captured the metadata world in e-learning tools. However, by the emergence of semantic web, e-learning tools particularly the ones issuing e-learning content have upgraded the metadata operation by adding the semantic structure to the present standards and or completely changing the structure into a semantic one. In fact, this change makes it possible to implement a new set of tools issuing e-learning content for the added value to the applied assets.
So, the current essay aims at studying the evolution of utilized metadata in e-learning issuing tools from the standard applied programs to its semantic presentation and putting it into practice in our engine producing e-learning content.

Keywords: Semantic metadata, reusability learning objects, learning object metadata, ontology

1. Introduction

Learning objects can be reused only if they are easily located, evaluated, adapted, and adopted by educational practitioners. In order to facilitate this process of resource description, discovery and evaluation, learning objects should be appropriately described, classified and indexed using standard metadata. Metadata are data that describe a physical or electronic resource and can be used to manage collections of documents, images, and other information in a repository such as an archive or library. Metadata are helpful because they provide standard buckets for keeping data about almost any e-learning resources. The most broadly accepted meta-data standard in e-learning is IEEE Learning Object Metadata (LOM) [1]. With a structuralist approach, it provides 60 elements as a means of developing more Comprehensive descriptions of learning objects and of providing support for user services. The Metadata standard is also included in key IMS and ADL specifications such as Learning Resource Meta-data (LRM) [2] and Shareable Content Object Reference Model (SCORM)[3].

LO is main unit of educational content and its meaning can be integrated into e-learning environment. For that it is necessary that LO has these features:

- Reusability
- Accessibility
- Interoperability
- Portable and
- Durability

Advantages of objects learning in e-Learning environment:

- Flexibility- same resource can be used in different context

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- Administration of content – it is possible to administrate resources in a simple way, because they
- Adaptively – it enables selection and usage of resources by the needs of context
- Economy – thanks to possibilities of re-usage
- Open source- that enables compatibility with different platforms. [4].

2. Employing IEEE-LOM Standard in an Engine Producing Learning Content

LOM (Learning Object Metadata) is a metadata format in SCORM. LOM can be determined for each level in SCORM including: Assets, SCO, Lesson, Course and Organization or as a separated file. It can be also embedded by using a space named XML.

Totally, LOM contains the following metadata sets:

- General metadata containing topic, language, etc.
- Life cycle metadata consisting of version, situation, etc.
- Metadata information including information about metadata itself
- Technical metadata holding requirements, formats, etc
- Educational metadata embracing the conditions of utilizing the resources
- Rights metadata making up of the conditions of utilizing the resources
- Relation metadata involving information related with other educational modules
- Annotation metadata covering the definitions about educationally using the modules
- Classification metadata encompassing keywords, explanations, taxonomy, etc.

Although these metadata are able to precisely describe the resources, LOM can handle metadata standards by utilizing XML [5].

In the engine producing e-learning content that we have created, XMLs have been directed to define the main components of learning content like: Assets, Pages, SCOs, Lessons and courses by adapting appropriate Manifest. Fig. 1 displays the structural relationship between the Learning Object Metadata and the content components.

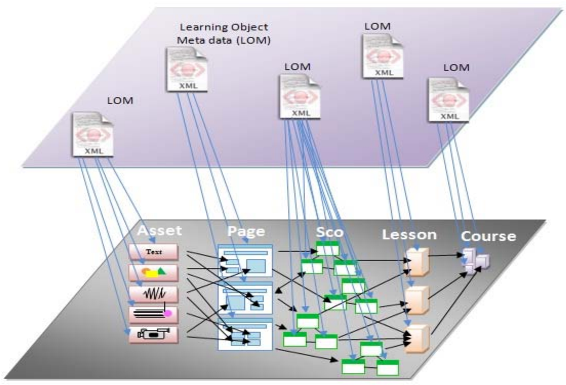

Fig. 1: the structure of e-learning content with IEEE-LOM standard.

Thus, according to the structure defined in the above engine producing content, the following characteristics can be provided in the learning content:

- Making the search possible for user based on the defined learning components
- Facilitating the availability of similar data by user
- Prohibiting some users to access some information
- Training how to interpret data like: typing, coding, encrypting
- Teaching how to reuse the intended information
- Providing the users with the data background (such as the original resource or its main owner)
- Facilitating data management and control
- Appointing the relations between different data and other resources including dividing course into

lessons, lessons to SCOs, SCOs to pages and pages to assets[6],[7].

3. Semantic Metadata Management System based on Ontologies

Semantic metadata can be defined as "… [Linking] related terms to one another" [8]. It can be also defined as "…the process of attaching semantic descriptions to Web resources by linking them to a number of classes and properties defined in Ontology".

Different areas of computer science have different interpretations of what "semantics" mean. For instance, in the domain of databases, metadata is thought of a conceptual schema that describes the structure of a database. The domain of information retrieval, might consider metadata as the set of keywords that describe the main theme of a document, or as a record that confirms to a specific schema (e.g. Dublin Core).

Sheth et al. have described these different depictions of metadata, organizing them into three types of semantics [9]: implicit, formal and powerful. Implicit semantics appear in unstructured text that has loosely defined and less formal structure (e.g. Information Retrieval). Formal semantics appear when the data representation takes a more rigid form (e.g. Knowledge Representation). Finally, powerful semantics imply the combination of simple syntactic structures to represent the meaning of complex ones[10].

Semantic metadata based on ontologies are applications that rely completely on domain ontologiesto define their metadata. They use RDF (Resource Description Framework) as a vehicle to express the semantics of a learning resource. For these applications, using RDF has advantages over the standard metadata approach .

First, any RDF data model is based on an "open world assumption" where the metadata is selected from heterogeneous ontologies. On the other hand, the majority of systems that implement LOM take a closed-world approach confining their metadata to that implemented by a particular LMS. Second, RDF allows for the creation of complex statements (i.e. metadata can be further annotated with more metadata). LOM, on the other hand, does not allow for the expression of complex metadata; it only supports extensions through taxonomic classification[11].

Therefore, in the engine producing content created by us, we can exercise a format embracing an XML structure and apply IEEE-LOM to express assets, pages, SCOs, lessons and courses relying on their attributes and the process of practicing them in learning path and their inner relationships with each other. As a result, we have considered an ontology that it can supply us with such an exact, formulated and clear discrimination of the learning content. Initially, it is necessary to contemplate the content structure in two levels to reach a suitable ontology throughout the considered RDF:

- Upper Level: set of concepts related to the course topics, selected among the concepts defined in the domain ontology. (Relationship made by Semantic Metadata)
- Lower Level: learning resources (assets, pages, SCOs, Lessons, Course, etc) associated to the concepts. (With the learning resources' inner relationship)

Fig. 2 represents the relation on the defined level to create a convenient ontology in content tending to a learning path.

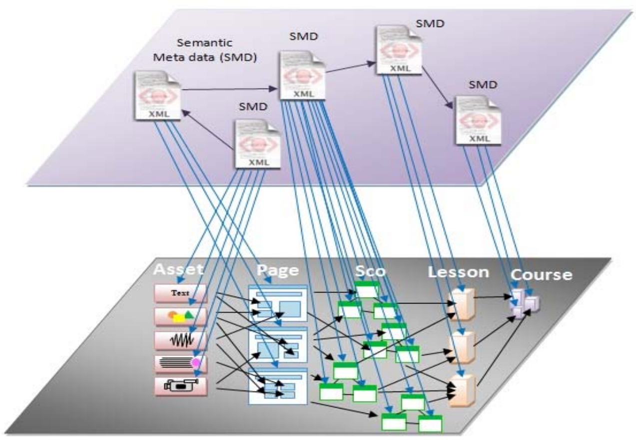

Fig. 2: the structure of e-learning content with semantic metadata based on ontology.

The content with the properties of semantic metadata based on ontology can create learning paths and these learning paths add the characteristics below to the structure of e-learning content:

- A sequence of concepts selected during the ontology browsing. This sequence gives the order of access to the learning objects.
- A corresponding sequence of learning-objects, associated to the ontology concepts, that compose the customized course (by making relationships among semantic metadata)

Learning paths can figure out the relationships between learning components and concepts through two distinct dimensions of horizontal and vertical. In horizontal dimension, learning sequence is determined due to main topic (starting from a giving concept) and browsing the ontology (through the decomposition relations). As shown in fig. 3, main topic with other components can make a PO (Part Of) relationship.

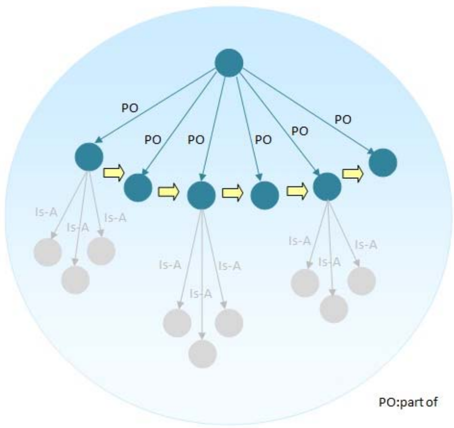

Fig. 3: horizontal dimension in learning paths.

Vertical dimension in learning paths follow a set of specialization links holding both up and down views in which:

- Up: Synthesis and wrap-up of the topics
- Down: Further elaboration of a given topic

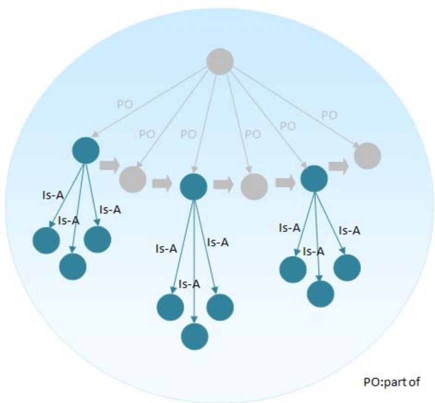

Fig. 4: Vertical dimension in learning paths.

Fig. 4 illustrates the vertical dimension in learning paths to elaborate the topics with an IS-A relation. Finally, we introduced the ontology model reclining on extending the application of IEEE-LOM to semantic metadata based on ontology (case study).

4. Conclusion

Ontologies can organize learning objects in contents and maintain a semantic accessibility for them and this directs instructors to provide learning process and assessment based on processes by creating learning paths in making content and to receive the knowledge they need. Learners creatively carry on learning paths by having a suitable learning content. For this approach, semantic queries of ontology are required to be arranged for improving the reusability of the learning process. Moreover, the structural techniques of learning paths are verified in accordance with their limitations and prerequisites. This is possible when a unified structure be defined by utilizing metadata standards like IEEE-LOM for learning object. Consequently, essential capabilities are equipped for making the content intelligent through expanding it toward semantic metadata based on a convenient ontology model.

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