SET OF METADATA ESTABLISHED FOR APPLICATION IN LEARNING MATERIALS DEVELOPED FOR BMU

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Abstract: *Recently, various standards have been proposed in order to improve process of creating adaptive e-learning systems. Central role among them is reserved for standards dedicated to creation of reusable learning material. The reusability and discoverability of learning objects can be supported in an efficient way by using metadata. In this paper, we analyzed Learning Object Metadata (LOM) standard and its applicability to Belgrade Metropolitan University (BMU) needs. As a result, we present an established set of metadata suitable for application in learning materials developed for BMU.*

Keywords: *E-Learning, LOM, Metadata*

1. INTRODUCTION

In recent decades, new research in psychology together with the emergence of new technical possibilities have shaken the basic paradigm and concept of the learning process and imposed some new trends. New demands for distance learning and personalization of learning path for each individual separately caused need for more effective creation and presentation of educational materials. One of the basic requirements for fast and efficient creation of new courses is the ability to reuse already created content. To enable this, it is necessary to find a way for efficient organizing and searching through repositories of the created content. For this purpose, created entities are enriched by additional data – *metadata*. Complexity of the process of creating reusable content required introduction of new standards for describing the elements of teaching materials, methods of presentation and methodology of their preparation.

The rest of the paper is organized as follows. In Section 2, we introduce terminology, standards and basic concepts necessary for understanding the flow of the process of creating learning materials. In Section 3, Learning Object Metadata (LOM) standard is presented. In Section 4, we discuss role of metadata in the context of Belgrade Metropolitan University (BMU). In Section 5, we present metadata selected for description of learning objects developed for BMU needs. In Section 6, we define which metadata is applicable to which type of learning object. In Section 7, we give conclusion and some final remarks.

2. BASIC E-LEARNING CONCEPTS

The process of creating reusable teaching material requires knowledge of certain tools, concepts and standards. In this section, we introduce terminology necessary for understanding such process and present a brief overview of existing standards of interest.

The *Darwin Information Typing Architecture (DITA)* is an XML-based, end-to-end architecture for authoring, producing, and delivering technical information [1]. This architecture consists of a set of design principles for creating "information-typed" modules at a topic level and for using that content in delivery modes such as online help and product support portals on the Web. At DITA standard, DITA *Topic* is the basic units of DITA content. Each topic should be organized around a single subject. DITA specifies three specialized topic types – *Concept*, *Task*, and *Reference*. DITA concept topics answer "What is..." questions. They include a body-level element with a basic topic structure, including sections and examples. Task topics answer "How do I?" questions, and have a well-defined structure, which describes how to complete a procedure to accomplish a specific goal. Reference topics describe regular features of a subject or product, such as commands in a programming language. DITA also includes the following topic types to create learning and training content:

- Learning Plan (LPL);
- Learning Overview (LOV);
- Learning Content (LCO);
- Learning Summary (LSU);
- Learning Assessment (LAS);

Detail explanation of each of the mentioned topic types can be found in [2].

Material created according to DITA can be delivered to end-users in various ways. Communication between client-side content and the host system supported by learning management system (LMS) is standardized by *Sharable Content Object Reference Model (SCORM)* [3]. It is a set of technical standards developed for eLearning software products. In its essence, SCORM enables interoperability between eLearning software products. The model determines how online learning content and Learning Management Systems (LMS) communicate with each other.

The basic building block in creating reusable learning material is *learning object (LO)*. As defined by the Learning Object Metadata (LOM) standard [4-5], a learning object is "any entity, digital or non-digital, that may be used for learning, education or training". This definition allows different interpretations, depending on the context of use. According to DITA, LO is collection (map) of learning topics. SCORM standard defines LO in a more general way – as any object which can be used as a teaching material in learning process. For BMU needs, there is a special type of LO - *preparation LO*. Preparation LO are created by teachers according to doc template and delivered to LOR administrators for inserting into LOR.

3. METADATA AND LEARNING OBJECT METADATA (LOM) STANDARD

Metadata are data with the purpose of describing other data. They are used for representing information about a particular data set, object, or resource, for example, how it is formatted, when and by whom it was collected, etc. In the library environment, the term "metadata" is commonly used for any formal scheme of resource description, applying to any type of object, digital or non-digital. The main motivation for using such description of data is to improve efficiency of organizing and administrating of learning objects, to support the reusability of learning objects, to aid discoverability and to facilitate their interoperability. For all these reasons, created learning material for BMU needs is enriched by selected set of metadata.

The first internationally-recognized open standard for description of "learning objects" is IEEE 1484.12.1 – 2002 Standard for Learning Object Metadata – commonly referred to as "LOM", published by the Institute of Electrical and Electronics Engineers Standard Association [4]. It specifies syntax and semantics of learning object metadata which may be used to for describing a learning object. The LOM standard provides very general definition of learning object, as mentioned in the previous section. Direct consequence of such broad definition is that there are no domain specific constraints, i.e., metadata specified by LOM are suitable for using in various contexts. LOM standard is fully supported by SCORM 2004 which recommends its use.

LOM have hierarchical tree structure composed of the following nine categories:

- General: general information about learning object.
- Lifecycle: information about history, current status of a learning object and those who have contributed to its creation.
- Meta-metadata: information about metadata describing the learning object, as opposed to information about learning object itself.
- Technical: information about technical requirements and characteristics of learning object.
- Educational: information about educational and pedagogic characteristics of the learning object.
- Rights: information about intellectual property rights and terms of use of learning object.
- Classification: classification schemes used to describe different characteristics of the learning object.
- Relation: information about relationships between the learning object and other related objects.
- Annotation: comments on the educational use of the learning objects, including when and by whom the comments were created.

4. CRITERIA FOR ESTABLISHING A SET OF METADATA IN THE CONTEXT OF BMU

As a starting motivation for defining a set of metadata, we will analyze more closely process of creating learning materials. A typical process is presented in Figure 1.
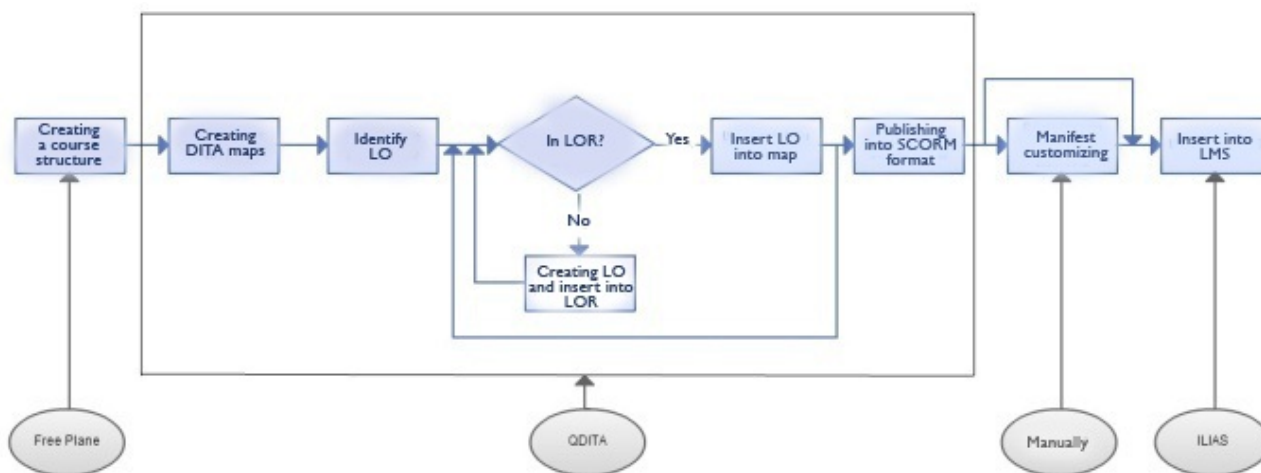

Figure 1 - The process of developing the course with the tools used in each stage

Each step requires using a suitable tool, which is also presented in the figure. For learning objects repository management, BMU has chosen to use QDITA (Qficient DITA) software tool, which is designed to deal with a diverse multi-domain content preparation, content management, publishing and delivery [6].

Before creating a learning object, a user should check if an adequate learning object already exists. If such object exists, it can be reused which accelerate process of creating materials. For example, learning objects which can be reused are course, lesson, course content (LC) and DITA assets (image, video). On the other hand, not all learning objects are reusable. For example, learning summary and assessment cannot be reused because their existence outside of the context of the learning content does not make any sense. However, search procedure should be enabled even for non-reusable objects because there are other activities which may require finding such objects (for example, reviewing, etc.).

Searching through learning repository can be performed based on various parameters. For example, if a topic to search for is "operations management", a plain textual search, often encountered in web-browsers and textual processing applications, can be satisfying solution. A user can simply look for all LO which contains that particular phrase somewhere in the text. However, this is quite limiting solution. What if a wanted object is not in textual format, if it is, for example, image or video? In addition, a user may require objects based on other characteristics, not just content. If a reviewer wants to check material created by a particular user, how to enable finding such material? Typical questions when a search procedure is performed are:

- Find all LO written by Petar Milić;
- Find all objects created in the past year;
- Find all the objects whose content is related to the concept of "operations management".

Except for metadata with main purpose to facilitate the search (title, keywords, description...), there are also metadata which help users with re-using learning object after finding them. For example, the decision if a particular learning object is suitable can be made based on semantic density or the time needed to master the material. Furthermore, for administrative and security reasons, it is necessary to keep a record of the process of creating and modifying the learning objects (who created/modified, when the creation/modification has been made, what type of modification is don, etc.). Therefore, whether a particular feature of learning object is suitable for metadata set or not is defined by three main criteria:

- Does metadata allow searching the repository of learning objects?
- Does metadata enable user to more efficiently exploit a particular LO?

- Is metadata useful for administrative and security purposes?

5. SET OF METADATA DEVELOPED FOR BMU NEEDS

In this section, we present a list of metadata selected for the purpose of usage in courses developed for BMU. Majority of metadata is adopted from LOM standard and their explanation and meaning can be found in [4]. We provide additional information for metadata which require further clarification in order to be used in a proper way for BMU learning materials. Other selected metadata are just listed for the sake of completeness. The list is given by categories, which is inherited organization from LOM standard.

General category

1.1 Identifier – Composite element which consists of *Catalog* and *Entry*. The format for setting URI at BMU is *catalog_name:resource_name*.
    1.1.1 Catalog – BMU will use *URN:BMU* catalogue. This scheme does not involve any additional semantic for ID.
    1.1.2. Entry – ID value is created automatically for each object (mechanism adopted from RDBMS) – the system finds the smallest available integer and assigns it as the ID for the current LO.
1.2 Title
1.3 Language
1.4 Description
1.5 Keywords
1.7 Structure
1.8 Aggregation Level

Life cycle category

2.2 Status
2.3 Contribute
2.2.1 Role
2.3.1 Entity
2.3.3. History – This metadata is not from LOM standard. It should be generated automatically.
2.3.3.1 Date of action – The date of action – (creation, modification, turned off).
2.3.3.2 Username – All users are logged on the system using their username, which is used for recognizing who made a modification.
2.3.3.3 Description of action - Description of performed action. Possible values for this field are: Created, Modified, Unavailable (LO is turned off).

Meta-metadata category

3.4 Language

Technical category

4.1 Format
4.5 Installation Remarks

Educational category

5.1 Interactivity Type

5.3 Interactivity level
5.5 Intended End User Role
5.6 Context
5.8 Difficulty – At BMU, materials which must be mastered for grade 6 is *very easy*, grade 7 corresponds to *easy*, grade 8 corresponds to *hard*, grades 9 and 10 corresponds to *very hard*.
5.9 Typical learning time

Rights category

6.1 Cost
6.2 Copyright and Other – At BMU, all materials are protected.
6.3. Description – Default value for this field is: "*The use of this LO is allowed under the conditions regulated by BMU. For more information, contact the BMU*".

Relation category

7.1 Kind
7.2 Resource

7.2.1 Identifier
7.2.1.1 Catalog
7.2.1.2 Entry
7.2.2 Description

Annotation category

8.1 Entity
8.2. Date
8.3 Description

Classification category

Metadata from this category describe where the current learning object falls within a particular classification system. Multiple instances of this category should be allowed in order to enable specification of more than one classification. The main taxonomy used at BMU is taxonomy based on body of knowledge developed at BMU. As an example, part of such taxonomy developed for Faculty of management at BMU is given on Figure 2.
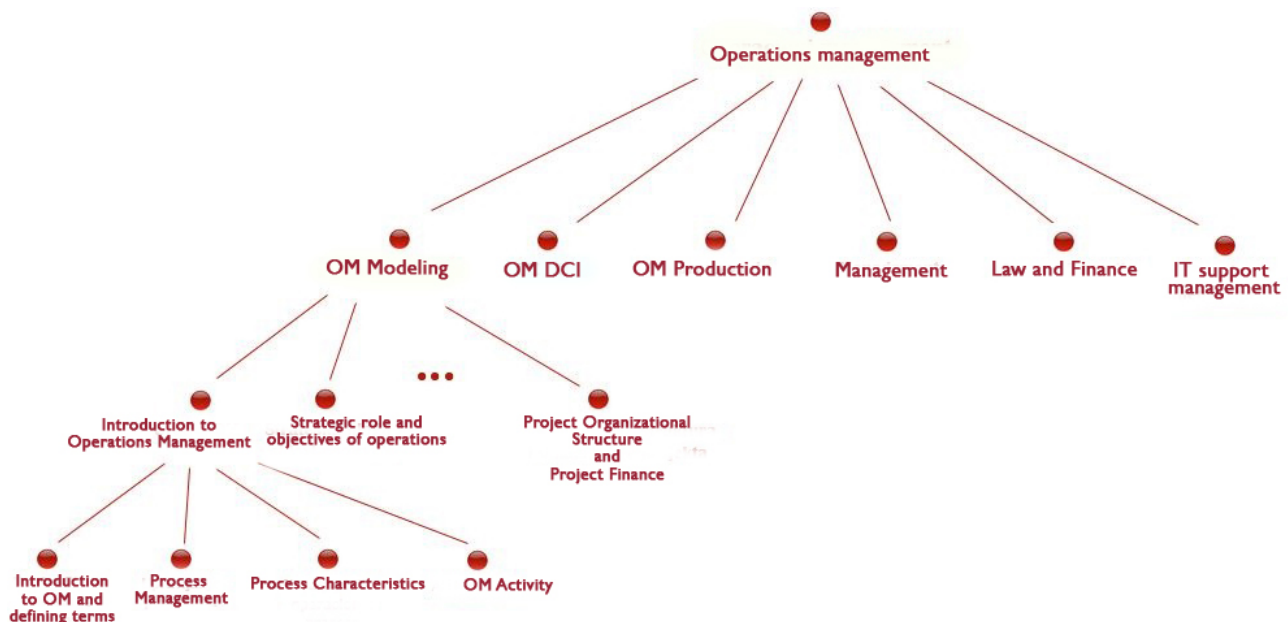

Figure 2 - Detailed view of part of the taxonomy based on the body of knowledge for the Faculty of Management.

9.1. Purpose – The purpose of classifying current learning object. At BMU, values should be: *discipline* (scientific area), *skill level* (A, B C lessons) and *educational level* (basic study, master study, PhD study). For, example, taxonomy in Figure 3. is based on discipline.
9.2 Taxon Path – A taxonomic path in a specific classification system. The path is an ordered list of nodes and creates a path in taxonomy. It is defined from a general to specific nodes, from root to leaf of tree, specified in format {[node1], [node2]...}. Node is specified in square brackets as pair of [ID, label]. The meaning of these two fields will be explained below. For example, a valid path corresponding to Figure 3 is *{["0", "Operations Management"], ["0.1", "OM model"] ["0.1.1", "Introduction to OM"]}*.

9.2.1 Source - The name of the classification system. At BMU, taxonomy is created from a created body of knowledge. For example, for the taxonomy from Figure 3 developed for Faculty of Management, the name of classification system is "FMBodyOfKnowladge".
9.2.2 Taxon - A taxon is a node specified by node ID and node label.
9.2.2.1 ID - The identifier of the taxon. Rules for specifying ID at BMU: a) ID of taxonomy root is 0. b) If a node A has an ID a, IDs of its descendants are: a.1, a.2, a.n. (For example, Operations management has ID 0; OM modelling has ID 0.1; OM IKU has ID 0.2; introduction to OM has ID 0.1.1.)

9.2.2.2 Entry - Textual label of the taxon. For example, for the root node of taxonomy form Figure 3, label is "Operations management".
9.3 Description
9.4 Keyword

6. METADATA DEFINED FOR DIFFERENT TYPES OF LEARNING OBJECTS

Learning material created according to DITA standard is composed of various types of objects (learning plan, learning overview, learning content, learning summary and learning assessment). The fact that there are types of LO which are reusable and types which are not reusable (as mentioned in Section 4), directly implies that not all of previously listed metadata can be applied to each type of object. Below, we specify which metadata corresponds to which type of created object.

Preparation LO has following metadata in BMU context:

- *General* category: Title, Description, Keywords
- *Educational* category: Intended End User Role, Difficulty, Typical learning time
- *Classification* category: Purpose, Taxon Path, Description, Keyword.
- *Annotation* category: Description.

The *whole course* has following metadata in BMU context:

- *General* category: ID, Title, Language, Description, Structure, Keywords, Aggregation level.
- *Life cycle* category: Status, Contribute.
- *Technical* category: Format, Installation Remarks
- *Educational* category: Interactivity Type, Interactivity level, Intended End User Role, Context, Difficulty, Typical learning time
- *Right* category: Cost, Copyright and Other Restrictions, Description.
- *Relation* category: Kind, Resource
- *Annotation* category: Entity, Date, Description.
- *Classification* category: Purpose, Taxon Path, Description, Keyword.

The *lesson* has following metadata in BMU context:

- *General* category: ID, Title, Language, Description, Structure, Keywords, Aggregation level..
- *Life cycle* category: Status, Contribute.
- *Technical* category: Format, Installation Remarks
- *Educational* category: Interactivity Type, Interactivity level, Intended End User Role, Context, Difficulty, Typical learning time
- *Right* category: Cost, Copyright and Other Restrictions, Description.
- *Relation* category: Kind, Resource
- *Annotation* category: Entity, Date, Description.

- *Classification* category: Purpose, Taxon Path, Description, Keyword.

The *learning topic overview* has following metadata in BMU context:

- *General* category: ID, Title, Language, Description, Structure, Keywords, Aggregation level.
- *Life cycle* category: Status, Contribute.
- *Technical* category: Format, Installation Remarks
- *Relation* category: Kind, Resource
- *Classification* category: Purpose, Taxon Path, Description, Keyword.

The *learning topic content* has following metadata in BMU context:

- *General* category: ID, Title, Language, Description, Structure, Keywords, Aggregation level.
- *Life cycle* category: Status, Contribute.
- *Technical* category: Format, Installation Remarks
- *Educational* category: Interactivity Type, Interactivity level, Intended End User Role, Context, Difficulty, Typical learning time
- *Right* category: Cost, Copyright and Other Restrictions, Description.
- *Relation* category: Kind, Resource
- *Annotation* category: Entity, Date, Description.
- *Classification* category: Purpose, Taxon Path, Description, Keyword.

The *learning topic summary* has following metadata in BMU context:

- *General* category: ID, Title, Language, Description, Structure, Keywords, Aggregation level.
- *Life cycle* category: Status, Contribute.
- *Technical* category: Format, Installation Remarks
- *Relation* category: Kind, Resource
- *Classification* category: Purpose, Taxon Path, Description, Keyword.

The *learning topic assessment* has following metadata in BMU context:

- *General* category: ID, Title, Language, Description, Structure, Keywords, Aggregation level.
- *Life cycle* category: Status, Contribute.
- *Technical* category: Format, Installation Remarks
- *Educational* category: Interactivity Type, Interactivity level, Intended End User Role, Context, Difficulty, Typical learning time
- *Right* category: Cost, Copyright and Other Restrictions, Description.
- *Relation* category: Kind, Resource
- *Annotation* category: Entity, Date, Description.
- *Classification* category: Purpose, Taxon Path, Description, Keyword.

Assets (multimedia files, images, videos, flash animations, etc.) have following metadata in BMU context:

- *General* category: ID, Title, Language, Description, Structure, Keywords, Aggregation level.
- *Life cycle* category: Status, Contribute.
- *Technical* category: Format, Installation Remarks
- *Educational* category: Interactivity Type, Interactivity level, Intended End User Role, Context, Difficulty, Typical learning time
- *Right* category: Cost, Copyright and Other Restrictions, Description.
- *Relation* category: Kind, Resource
- *Annotation* category: Entity, Date, Description.
- *Classification* category: Purpose, Taxon Path, Description, Keyword.

7. CONCLUSION

In this paper, we discussed role of metadata in creating reusable learning materials. The main goal was to establish set of metadata suitable for application in learning materials developed for BMU. Developed set is then applied on learning objects created for one lesson of OM100 BMU course. Starting point in discussion was LOM standard. Having in mind BMU needs, we analyzed application of metadata from LOM on the previously developed course OM100. Our analysis resulted in conclusion that metadata defined by LOM are broad enough to be used in various contexts. This property of LOM has two direct consequences:

- Majority of metadata for BMU are adopted from LOM. Only one additional description field is added (*History*).
- Specific needs of BMU allowed restriction of LOM. From original set of metadata, for BMU needs is selected only a subset of LOM.

One of special requirements in the process of defining metadata set for BMU was to enable establishing semantic relationships among learning objects. Although LOM does not provide significant support for this purpose, metadata from Description field and *Relation* category are found capable of fulfilling this void for BMU needs.

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