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LAMS Sequence Metadata Application Profile

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Metadata for learning objects, activities and sequences can be significant for learning design as they facilitate search, evaluation, acquisition and reuse. A Metadata Application Profile (MAP) consisting of 17 fields for Learning Objects (LO) and Sequences of Learning Activities (LAs), crafted specifically for the needs of the LAMS Community of Practice (CoP) is presented, justified and discussed. MAPs are sub-schemas of the amalgamation of standard metadata schemata for LOs, in our case LOM, DC and the metadata schema for sequences of learning activities used in the LAMS repository. MAPs are useful as standard metadata schemata are cumbersome in their excruciating detail (whence often not adhered to), incompatible, and still not adequate for the needs of a particular CoP. Our methodology for designing the LAMS CoP MAP is based on an analysis of the LAMS sequence repository; it consists of selecting a globally representative sample of LAMS learning sequences, choosing the statistically most popular ones, evaluating the correctness of their metadata usage and determining suitable corresponding metadata fields from LOM and DC. As a result, the MAP recommended adheres to international metadata standards and the needs of the community of LAMS while respecting the work done in order to promote future interoperability, ease of indexing and effective search of the Learning Sequences in the LAMS repository.

Keywords: metadata, metadata application profile, learning activities, LAMS

Introduction

E-learning poses frustrating challenges to teachers and learners arising, inter alia, from the ever-increasing amount of information available and potential relevant to each particular task . The Web has been described as having a central paradox: the more information available, the greater the likelihood that relevant, authoritative information will not be found (Hudgins, Agnew & Brown. 1). In the chaos of available digital resources, metadata is potentially the key for identifying and classifying Learning Objects (LOs) and thus searching, locating and using them effectively (Littlejohn, 2004), but the most important need is for Communities of Practice (CoP) - like the different communities of educators in which the focus of this paper is about- to develop and consult a metadata application profile (MAP) that will best suit their needs.

To achieve this, one of the first questions that need to be answered is: *for what purposes do these CoPs actually need and use educational metadata?* Different CoPs of educators have different kinds of informational needs (Gardner, 1998). Moreover, in the previously described heterogeneous information environment of available digital resources, the different CoPs actually manage information that has different characteristics and requirements (Mai Chan, 2005). We should also consider the types of questions that they would like to ask concerning a Learning Object (LO) or - by extending it furthermore- a learning activity (LA) or a sequence of Learning Activities (LAs) that can't be answered with the current state of metadata usage (Gardner, 1998). These questions correspond with pre-defined indexing criteria while searching for example a resource with a search engine in the web or in a repository.

In this paper we focus on the use of metadata in order to describe in a consistent and complete way not only LO, but also LAs.

In the first part of this paper we reason on the appropriate use of the metadata elements present in the most dominant metadata schemas today, which are LOM and Dublin Core (DC), in conjunction to the description of LAs. In the second part, we suggest an application profile (AP) of educational metadata and what is the types of values assigned to them tailored to the description of LAs. This AP would be useful in Learning Design systems which follow the learning activity approach, like LAMS and its community.

Literature Review

According to Hodgins "the ability to capture knowledge such that it can be analyzed, reused, and shared with others, thus developing a spiral of more new knowledge creation, is perhaps the most powerful promise information technology can provide" (Hodgins, 2000). In the e-learning field the knowledge can be encapsulated in the form of LOs. There are several definitions of LOs; for the scope of this paper we will adopt a rather inclusive one: "any entity -digital or non-digital- that may be used for learning, education or training" (IEEE LOM, 2002).

Johnston (2003) is proposing the anatomy of an e-LO, as shown in the figure below to claim that an 'information object' is actually a 'learning object' if it is coupled with a learning objective or designed to support a particular learning process.

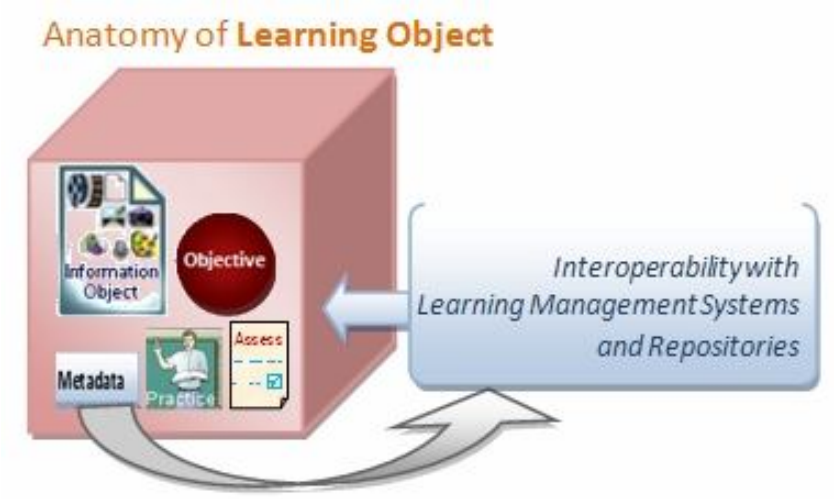

Figure 1: The anatomy of an e-learning object

Metadata elements, most commonly known as 'data about data', are used by educators as an integral part of LOs (technically in the form of an .xml file) and as a means of describing them in several different aspects (technical, pedagogical, etc.) and in such ways that they can be easily managed, located and evaluated. Figure 1 also indicates the existence of metadata as a part of a LO and as a means of facilitating interoperability with learning management systems and repositories.

According to (IEEE, 2002), 'a metadata instance for a learning object describes relevant characteristics of the learning object to which it applies'. The educational value of a LO increases while its accompanied metadata increase in completeness and plenitude. The reason for the creation of educational metadata, from the viewpoint of supplier of educational material is for increasing the probability of successful search of educational material in the internet, as well as for facilitating the control and the selection of educational material.

The e-learning standards and specifications

Standards defined as “documented agreements containing technical specifications to be used consistently as rules, guidelines, and definition of characteristics to ensure that materials, products, processes and services are fit for their purpose” (Bryden, 2003). In e-learning, standards are used in learning management systems to ensure interoperability, portability and reusability. Moreover, the authoring tools need to function properly and in a consistent way in different platforms and also communicate with other tools. The various stakeholders should be able to easily search, locate, index and retrieve the LOs and LAs which are located in distributed places on the WWW. Finally, there exists the need of discrimination of the useful learning resources from the abundance of the information available on the web. Standards and specifications are (among other things) designed to facilitate: the description (metadata), the packaging and the sequencing of the LOs in order to facilitate the accessibility to educational content, learning activities and learner information (CETIS, 2004). Specifically in the case of educational resources, the purpose is also (IEEE LOM, 2002) 'to facilitate the sharing and exchange of learning objects ‘while taking into account the diversity of cultural and lingual contexts in which the LOs and their metadata are reused'.

LOM and DC are two leading metadata standards developed in order to promote ‘semantic interoperability’ between the systems that actually use them to describe their resources. In the field of educational technology ‘semantic interoperability’ among various types of systems that promote technology-enhanced learning, such as learning management systems (like LAMS, a management system for learning activities) is still a wishful thinking. Various stakeholders such as : (IMS, 2001), (Sutton, 1999) have attempted to map the elements of the previously mentioned standards, aiming to the promotion of the semantic interoperability between DC and LOM abstract models and contribution towards better alignment between them (Johnston, 2007). In the latest outcomes of the on work of ‘Joint DCMI/IEEE LTSC Task Force’ it is mentioned that “*both DC and LOM have notions of metadata application profile, but they are based on different Abstract Models*” and that “implementers want to use component parts of different metadata standards in combination” (Johnston, 2007).

An application profile is an assemblage of metadata elements selected from one or more metadata schemas (base schemas) and combined in a compound schema...The basic goal of “mixing and matching” metadata elements is to meet specific requirements of a particular context through a profile of a generic standard or otherwise, to adapt or combine existing schemas into a package that is tailored to the functional requirements of a particular application or a particular CoP while retaining interoperability (D-Lib, 2002), (CEN, 2006). A Community of Practice could represent a wide range of grouping – large or small, for example, (CEN, 2006): i) National, e.g. UK LOM Core (http://zope.cetis.ac.uk/profiles/uklomcore), ii) Subject specific, e.g. ManUeL for Computer Science (http://sticef.univ-lemans.fr/num/vol2004/passardiere-11/sticef_2004_passardiere_11.htm), iii) Application Oriented’, e.g. LAMS (http://www.lamscommunity.org). Our case will be the third one, as we will propose an AP oriented to a category of applications (LMSs, LCMSs and the like) using the learning activity approach and specifically LAMS.

Guidelines, principles and practices about building a MAP

To create a good application profile, it is important to have an in-depth and explicit understanding of those specific requirements. This means that a clear scope and purpose statement must be developed: what –and for whom- are the metadata going to be useful? From such an inquiry, application requirements and -consequently- metadata requirements may be deduced (CEN, 2006).
The general underlying principle (CEN, 2006) is that, where a new application profile is being produced, it should either be based on one or more standards or on one or more existing application profiles of those standards and it should not compromise interoperability by breaking conformance with the existing standards.

Attention should be placed to the selection of metadata elements, with respect to principles such as those mentioned in (D-Lib, 2002): the principle of modularity, of extensibility, of refinement, of multilingualism, of the completeness of description. Moreover, in the implementation of a MAP there are contradicting factors that should be balanced like the tradeoffs between detailed vs simple metadata descriptions and objective vs subjective metadata and others that will be discussed in this paper.

Methodology

The scope of this paper is to review the existing application profiles that are based in DC or LOM, to define any gaps in using them for the purpose of satisfying the needs of a specific educational community, the community of LAMS and for a specific purpose. That is, to focus on the description of LAs, as opposed to LOs only. The need for additional meta-data required to describe learning activity sequences is discussed in (Dalziel, 2003), where it is explicitly written that *"while some aspects of DC or LOM will be relevant to a description of a learning activity sequence (title, author, etc), it is possible that some new descriptive meta-data fields may be required"*. This paper continues by making the following suggestions on descriptive educational metadata suitable for LAs: a) Number of participants/Number of learners; b) Period of time; c) Synchronous/Asynchronous/Blended; d)References to (content) Learning Objects (or activities if in a Learning Object) and e) Other requested fields: Quality assurance and secondary usage.

In order to do that we will "mix and match" the metadata of the previous mentioned standards and their application profiles while taking into consideration the mappings between them. To be more specific, in the scope of our paper, we will examine further DC- Education Application Profile and the LOM metadata standard. The Dublin Core Education Community was among the first groups to begin talking about "mixing and matching" from more than one metadata schema, an idea first proposed in (Ariadne, 2000). The DC-Ed AP defines metadata elements for use in describing properties of resources related to their use in teaching and learning (DCMI-Ed, 2007). The DC Education Application Profile (DC-Ed AP) includes the following attributes or properties relating to educational use of resources. The DC-Ed AP was developed with the LOM in mind and includes both DC and LOM originating elements (IMS, 2006).

Statistics on the usage of metadata in LAMS: Methodology of the sampling

Learning sequences were gathered and examined from all 5 communities that currently exist in the LAMS repository ("Public Sequences", "Higher Ed & Training", "Research and Development", "K-12 Schools" and "Getting Started") proportionally to the population of sequences in each community. The criterion for their selection was the number of downloads. The original thought the criterion of the big number of downloads in conjunction with the high average rating was rejected due to the low percentage of rates (6 at most, where the number of downloads was frequently more than 100). The table below shows the name of the element, the number of its occurrence (out of the 50 learning sequences) and the corresponding percentage.

Table 1: The occurrences of the metadata in the LAMS repository

Name of the element	Number of occurrences (out of 50)	Percentage of occurrences
Sequence	50	100%
Description	40	80%
Keywords	46	92%
Subject	44	88%
Audience/Target audience	48	96%
Run Time	39	78%
Delivery Mode	34	68%
Resources	24	48%
Outline of activities	39	78%

The elements: "LAMS Version", "Sharing with", "Status", "Number of downloads", "Number of previews", "Authored by" (the name of submitter of the learning sequence), "Date" (the date of submission of the learning sequence) are generated automatically from the system (Figure 3). Moreover, the elements below exist if the conditions mentioned next to them are satisfied:

- Support Files: exist if the submitter adds them (24 out of the 50 sequences had attachments and 2 of them were the outlines of the activities)

- Average Rating: exists if one or more users have rated this sequence (only 2 out of the 50 sequences were not rated yet, although the mean of the ratings is low)
- License: exists if the submitter chooses to use some the licenses available in the LAMS repository, in order to characterize the rights of the learning sequence he or she submits (Figure 2).

One of the purposes is to reach a common understanding about the indented usage of the metadata elements. For example, there is a need to clarify what are the indented values for the field “subject”. Most of the users understand that it stands for the scientific field the content is about. A small proportion repeats the title of the sequence as the value of this field. As a result, the values vary from: ‘science, and ‘astronomy, to ‘interactive whiteboards adoption role play’ and ‘introduction to some useful ICT tools’. There is an additional difficulty in distinguishing the semantics of “keyword” and “subject”.

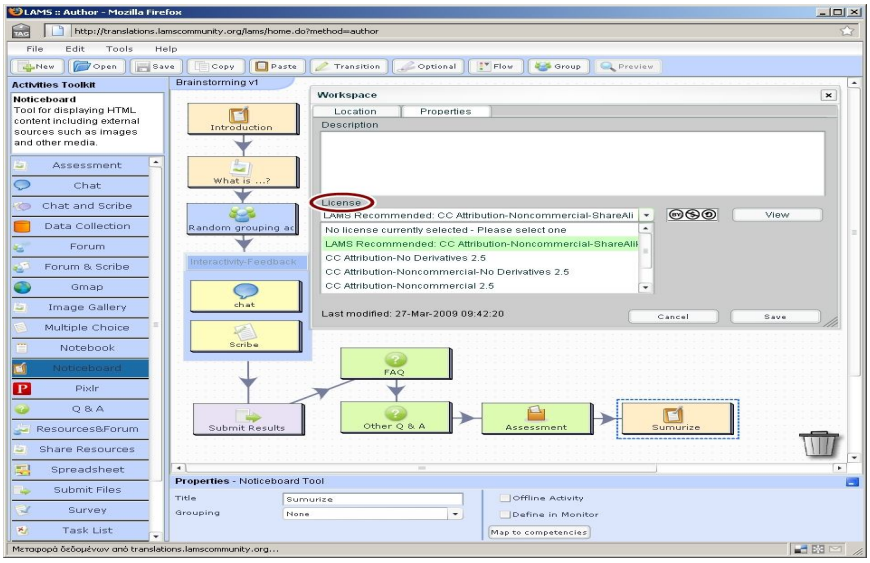

Figure 2: Metadata included in a LAMS sequence

Moreover, in some cases the submitter (technically the value of the filed “Authored by”) is not the same as the author. In most of these cases this is stated in the description field. For example, the description of a sequence may start like this: “X authored this sequence in the Y University.” A solution on that would be to rename the “Authored by” field as “Submitted by” and to create a new field named “Author(s) (of the learning sequence)” for that purpose.

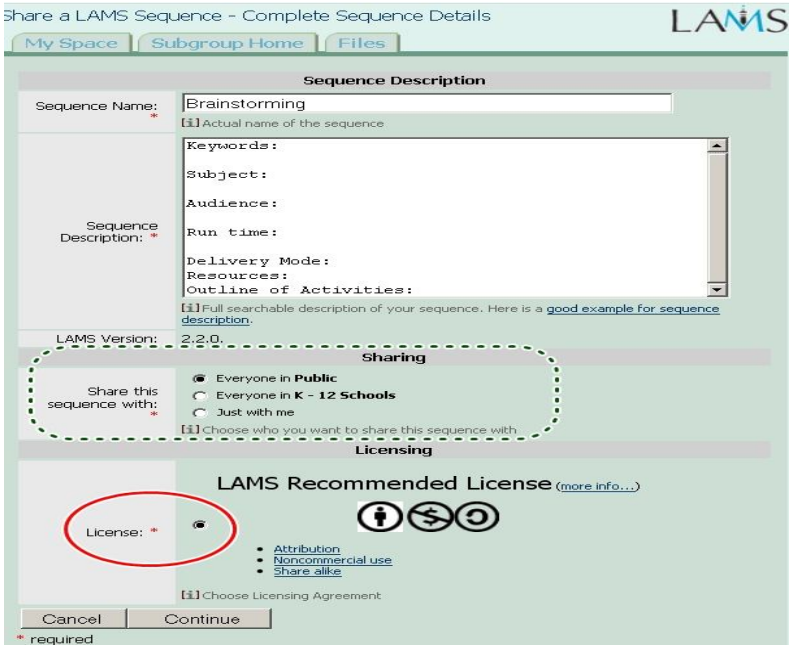

Figure 3: Metadata fields that are generated automatically from the system

Additionally to that, in some cases there is a need to clarify that the date that the resource was initially created is not the date of submission to the LAMS repository. Whenever that need occurs in the records of learning sequences in the LAMS repository, this is also stated in the "Description field". A solution on that would be to rename the "Date" field into "Date of submission" and to create a new field named "Date of creation".

In the next section of the paper we propose a MAP oriented for learning systems that follow the LA approach, like LAMS. For that purpose, we will "mix and match" metadata elements derived from LOM metadata standard and the DC-Ed application profile, while bearing in mind all the above and especially:

- the suggestions of (Dalziel, 2003),
- the guidelines in (CEN, 2006),
- the mappings between the elements of DC-Ed application profile and the IEEE LOM, as suggested in the (DC-Ed, 2007)
- the sequence information in LAMS, as derived from the previous section

Table 2: The suggested MAP and its mapping with LOM and DC metadata schemata

a/n	DC –Ed element	LOM element	LAMS MAP
1	dc.title	1.2 General. Title	**Sequence (title)**
2	dc.description	1.4 General.Description	**Description**
3	dc.subject	1.5 General.Keyword	**Keyword**
4	dc.relation.conformsTo	9. Classification with 9.1 Classification.Purpose = "Educational Objective"	**Subject**
5	dc.audience.educationLevel	5.6 Educational.TypicalAgeRange	**Audience**
6	No equivalent. "dc.audience.deliverymode" could be used	5.6 Educational.Context	**Delivery Mode**
7	No equivalent. "dc.audience.learningtime" could be used	5.9 Educational.TypicalLearningTime	**Run Time**
8	dc.instructionalMethod	5.10Educational.Description	**Outline of Activities**
9	dc.date.created	2.3.3 Life Cycle.Contribute.Date with 2.3.1 Life Cycle.Contribute.Role="Author" and 2.1 Life Cycle.version= "current"	**Date of creation**
10	dc.date.submitted	2.3.3 Life Cycle.Contribute.Date with 2.3.1 Life Cycle.Contribute.Role=" initiator" and Life Cycle.version= "current" NOTE: "initiator" is the entity that made the learning sequence tavailable i.e the name of the submitter of the learning sequence in the LAMS repository	**Date of submission**
11	No equivalent. "dc.contributor.author" could be used	2.3.2 Life Cycle.Contribute.Entity with 2.3.1 Life Cycle.Contribute.Role= "Author"	**Authored by**
12	No equivalent. "dc.contributor.submitter"could be used	2.3.2 Life Cycle.Contribute.Entity with 2.3.1 Life Cycle.Contribute.Role= "initiator"	**Submitted by**
13	dc.relation.references	7 Relation	**Resources/References**
14	No equivalent. "dc.description.annotation" could be used	8 Annotation	**Comments**
15	dc.Relation.hasVersion	4.4.1.3 Technical.Format.OrComposite.MinimumVersion with 4.4.1.2 Technical.Format.OrComposite.Name= "LAMS"	**LAMS Version**
16	dc.rights.license	6 Rights	**License**
17	dc.relation.requires	7.2 Relation. Resource	**Support Files**

Methodology followed on the building of the suggested MAP

In the first phase, 17 metadata elements were carefully selected in order to describe, as far as possible, in a complete and precise way the learning sequences in the LAMS repository. The MAP shown in the table 2 was created with respect to the guidelines offered in CEN (2006). The general rule is that the Application Profile may be more restrictive than the base standard is; it cannot be less restrictive. In order to maintain interoperability, this MAP was built in both namespaces, DC and LOM. Some of the elements existed in the records of each of the learning sequences, like the 'number of downloads' and the 'number of previews' were excluded from the MAP. This was due to the fact that –although these elements have their own value, which is to inform the user of the popularity of the learning sequence- literally they are statistic measures, which are rapidly changing and could be articulated in another functionality of the repository. Technically the purpose is to inform the stakeholders of the statistics of the repository (number of downloads, number of previews, etc.). This is actually the case in the dspace repository (http://dspace.eap.gr/dspace/statistics instance at the Hellenic Open University), a popular open source institutional repository worldwide.

Moreover, we carefully examined whether inter-relationships and dependencies between data elements exist in the way we built the AP. That is, whether the value space[1] in a field imposes or depends on the value of another and even if there are contradictions between them. If that would be the case then we needed to explicitly define those relationships and cope with the contradictions. We concluded that there are no such restrictions.

In the second phase of the implementation of the MAP, we have focused on best practices of metadata which include the use of (local) controlled vocabularies to describe their value space –where this is applicable and advisable, i.e. it conforms with the 'nature' of the element -, the assignment of the size/ cardinality (multiple values allowed or not) and finally the decision about obligatory submission i.e. which of these will be filled optionally by the submitters or not. The results are shown in Tables 2 and 3 below.

[1] In this context, the value space defines a limited choice of words or phrases (i.e a restricted or controlled vocabulary) that the metadata elements shall derive their value from.

Table 3: The MAP elements and their basic characteristics

a/n	*Name of the MAP element*	*Controlled vocabulary*	*Size (One value, Multiple values)*	*Obligation (Mandatory or Optional)*	*Comments on the usage of the element*
1	**Sequence (title)**	no	one	Mandatory	The title of the learning sequence
2	**Description**	no	multiple	optional, but highly recommended	A textual description of the context of the learning sequence
3	**Keyword**	no	multiple	Mandatory	The topic of the learning sequence
4	**Subject**	no	multiple	mandatory	The curriculum or learning objective to which the learning sequence conforms to
5	**Audience**	no	multiple	optional, but highly recommended	The typical kind of learners. Examples may include: "elementary school students", "4th-5th grade", "secondary science" etc
6	**Delivery Mode**	yes , from the local vocabulary	multiple	optional, but highly recommended	The principal environment within which the learning and use of this learning object is intended to take place. Local vocabulary: { *"online", "offline" "synchronous", "asynchronous", "group", "individual", "classroom", "computer lab" , "other"* }
7	**Run Time**	no	one	optional, but highly recommended	Approximate or typical time it takes to work with the learning activity
8	**Outline of Activities**	no	multiple	optional, but highly recommended	Comments on how the resource is to be used, including ways of presenting learning objects or conducting learning activities, patterns of learner-to-learner and learner-to-instructor interactions, and mechanisms by which group and individual levels of learning are measured. Instructional methods include all aspects of the instruction and learning processes from planning and implementation through evaluation and feedback.
9	**Date of creation**	no	one	Optional	The date of creation of the Learning sequence (current version)
10	**Date of submission**	no	one	automatically generated by the system	The date of the submission of the Learning sequence in the system (current version)
11	**Authored by**	no	yes	Mandatory	The name of the author(s) of the Learning sequence
12	**Submitted by**	no	one	automatically generated by the system	The name of the submitter of the Learning Sequence to the system
13	**Resources/References**	no	yes	Optional	This category defines the relationship between this learning object and other learning objects, if any.
14	**Comments**	no	yes	Optional	This category provides comments on the educational use of the learning sequence. This category enables educators to share their assessments of learning objects, learning sequences, suggestions for use, etc.
15	**LAMS Version**	no	no	Optional	The minimum version of LAMS that a learning sequence is being used
16	**License**	yes , from the local vocabulary	no	Optional	This category describes the intellectual property rights and conditions of use for this learning sequence Local Vocabulary: *{"LAMS recommended", "Creative Commons Attribution 3.0 Unported", " Creative Commons Attribution- No Derivative Works 3.0 Unported", "Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported", "Creative Commons Attribution- Noncommercial 3.0 Unported", "Creative Commons Attribution-Noncommercial-Share Alike 3.0 Unported", "Creative Commons Attribution-Share Alike 3.0 Unported", "other"* }
17	**Support Files**	no	yes	Optional	Any learning material that this Relationship references.

Conclusion and Future work

We are suggesting a flexible MAP for the needs of the LAMS community. As seen in Table 2, there exist 4 categories of metadata in our MAP. Mandatory, optional but highly recommended, optional of lesser importance and finally those elements that are automatically generated by the system.

The semantics of the fourth category is obvious. The actual meaning of the first three categories is: i) Required. A value must be supplied (mandatory); ii) A value should be supplied unless there is a reason not to. **(**optional, but highly recommended**)**; iii) A value may be supplied if desired (optional). Only four (4) metadata fields are mandatory: "Title", "Keyword", "Subject" and "Author(s)". These comprise the 'digital ID' of every digital object. If every digital object was accompanied with its 'digital metadata id' the procedure of indexing through the chaos of the available resources would be more easy and efficient

The metadata that are optional, but highly recommended are: "Description", "Audience", "Delivery mode", "Run time" and "Outline of activities". We consider these to be less significant than the previous category, but important to be filled in order to keep up with the educational profile of the LAMS repository. These are the actual educational metadata, which are very helpful to the majority of the people using and/or submitting learning material from the LAMS repository, namely: the educators.
The optional metadata elements are: "Date of creation", "Resources/References", "Comments", "LAMS Version", "License" and "Support Files".

In this point, we should clarify that these are only suggestions concerning our view towards the comparative importance of the metadata elements. Each metadata element has its value, but a long list of mandatory elements would reduce the usability and flexibility of the MAP. As stated in IMS (2006) implementers should evaluate whether an element is critical to the implementation or whether it is just "nice to have".

Finally, the last category is the fields that are automatically generated by the system (in its current state of functionality). These are: "Date of the submission", "Name of the submitter".

According to IMS, *"while the development of AP provides the opportunity for implementer communities to meet their local needs, balancing interoperability with local requirements can be a significant challenge"* (IMS, 2006). We tried to keep this balance. Finally, there should be noted that a complete application profile defines not only the conceptual model (Data profile) for the metadata elements but also the XML or RDF binding (which is called 'Bound Data profile'), that is binding a conceptual model such as the LOM conceptual data schema to an XML schema . In fact, this could be one of the future work directions, in order to actual integrate this MAP in the LAMS repository application.

The added value of this work is not only that it promotes interoperability through the mappings of the suggested MAP with both LOM and DC elements, but also proposes a MAP especially designed for LAs, something that was missing from the educational technology field.

A future work we plan is to study which metadata from the MAP could be added by authors in sequence (except license) and therefore automatically generated by the system in a LAMS Repository.

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