ORMEE

Observatory on Rights Management for eLearning in Europe

Agreement N° 2003-4727/001-001 EDU ELEARN

WORKPACKAGE 2
T2.4
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Best practices in dealing with Learning Objects

AIE - Associazione Italiana Editori, Italy
BolognaFiere, Italy
FEP - Federation of European Publishers, Belgium
Research Center for Network Technologies and Multimedia Applications Technical University Berlin (TUB),Germany

Summary

1. What is a Learning Object?

Learning Objects are the elements of the computer-based instruction grounded in the object-oriented paradigm of computer science. Object-orientation highly values the creation of components (called "objects") that can be reused in multiple contexts. Therefore, Learning Objects can be defined as small instructional components that can be reused a number of times in different learning contexts.
In the educational environment, beside the term Learning Object, we often find also courseware, meant as an aggregation of instructional content designed as a structured learning process, and educational resources, usually digital additional content to be used as integration to the traditional learning experience or to printed textbooks. As we have seen in the T2.2 study *DRM solutions addressed to eLearning environment* developed within the OrmeE project, this latter type of digital content (educational resources) seems to be the most widespread in the educational publishing industry, therefore we have comprised it in our analysis on business model, considering them "a kind of" learning Object. However, here in the analysis of best practices in dealing with Learning Object, we will restrict our survey to what is being actually defined "Learning Object".

1.1 The LTSC definition

According to the Learning Technology Standards Committee a Learning Object is "any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning".
This definition has been criticised by David Wiley who focused his remarks on the following topics:

- "Non-digital", as the LTSC definition would in fact virtually include any existing object (physical things, events, persons), therefore being too broad and undefined.
- "Used", as this means that a LO as defined by the LTSC, could be used even just for one time, therefore shrinking the meaning of reusability.
- "Referenced", see remarks on the Non-digital topic.
- "During", as the LTSC definition implies that nothing more than contiguity of an object's use and the occurrence of learning is sufficient, excluding therefore the need of the LO to enhance the learning process.

1.2 Wiley's definition

According to David Wiley a Learning Object is "any digital resource that can be reused to support learning."
This definition includes anything that can be delivered across the network on demand, be it large or small. According to his criticisms to the LTSC definition, Wiley aims at defining a reasonably homogeneous set of things: reusable digital resources. Wiley's definition therefore rejects non-digital and non-reusable resources. Moreover, it rejects also the "during" topic of the LTSC definition replacing it with the verb "to support" which connect the use of LOs to learning.

1.3 Metadata

Metadata, literally "data about data", are descriptive information about a resource. For example, the card catalogue in a public library is a collection of metadata. In the case of the card catalogue, the metadata are the information stored on the cards about the Author, Title, and Publication Date of the book or resource (recording, etc.) in question.
As the purpose of eLearning and LOs is to let the most broad audience access to the educational resources, combine LOs to build a new educational resource etc. this means that LOs have value only if they can be easily searched for and found. This implies thy have been stored somewhere (for the definition of Repository see T 2.2). In order to be retrieved from a repository, LOs must have been described in their key features, so that the "user" will be able to find objects by searching, as opposed to browsing the entire digital library and can understand if the LOs he finds suit his needs. This is exactly what metadata do.

What are metadata used for?

First, as we have already discussed, metadata allows LOs to be searched for and retrieved from the huge amount of educational resources stored in a (or more) repository on the Internet. By means of metadata, it is possible to have a sort of identity card of each Learning Object, that is to say: it is possible to know almost everything about a learning object (for example who has created it, which is the pedagogical objective, which medium and format has been chosen, who's the rights owner on the content, and so on) the richer the metadata are, the most accurate the information on each LO will be. Knowing everything about each LO also implies that it is easier to choose which LO best fits with another, to combine them in order to build a new educational resource with instructional sense, or in instructional design terminology, "sequencing" the learning objects. Of course, in order for a computer to make sequencing or any other instructional design decisions, the computer must have access to instructional design information to support the decision-

making process. Therefore metadata should also integrate information on sequencing. At this point of the discussion we can try to define a learning object as a combination of two main components: content and metadata. Further information about metadata are to be found in section 2 of this study dedicated to LOM and SCORM standards.

1.4 Granularity

Talking about granularity means asking oneself: how big should a learning object be? Granularity is the term to define the minimum size a learning object can have without loosing its core features and its pedagogical effectiveness and thus enabling its reuse, reassembling and the creation of bigger instructional units from smaller pieces. However, it's self evident that the higher the granularity level is (more LOs), the harder the work on metadata will be (each LO has to have its own associated metadata). In other words, the decision regarding learning object granularity can be viewed as a trade-off between the possible benefits of reuse and the expense of cataloguing.

In order to explain what granularity actually means we can refer to the metaphors that the international learning community has used since the birth of the studies on eLearning: the LEGO metaphor and the atom metaphor. According to the first, each Learning Object can be compared to a LEGO block to underline its behaviour in relation to other LOs (or LEGO blocks if we stick to the metaphor); therefore as:

- any LEGO block is combinable with any other LEGO block;
- LEGO blocks can be assembled in any manner;
- LEGO blocks are so fun and simple that even children can put them together;

What instructional designers should do by working with Learning Objects is to create small pieces of instruction (LEGOs) that can be assembled (stacked together) into some larger instructional structure (castle) and reused in other instructional structures (e.g., a spaceship). Although the LEGO metaphor seems to be very clear and appropriate, according to David Wiley – who strongly criticised it – it hides some dangerous mistakes: Wiley thinks that "a system of learning objects with these three properties [the LEGO properties cited above] cannot produce anything more instructionally useful than LEGOs themselves can", that is to say Learning Objects do not have any instructional meaning themselves therefore it doesn't matter how they are combined (or sequenced) one with another. Wiley proposed therefore a different metaphor, comparing LOs to atoms: first of all not every atom is combinable with every other atom, as atoms can only be assembled in certain structures prescribed by their own internal structure (this means each LO has its own instructional meaning).

According to Wiley, the atom metaphors allows to better answer to the question “what degree of granularity is the most appropriate for instructionally effective Learning Object combination?” that answer is: the level of aggregation at which the learning objects display this structural bonding characteristic.

1.5 Taxonomy for Learning Objects

Saying that a learning Object is a chunk of digital instructional content that can be reused in different educational contexts is just providing an overall description of what a LO could be and can do. Of course not all LOs are alike, they have indeed common features but they also differ one from the other in terms of structure, interactivity level, difficulty, complexity, for example. Therefore it’s necessary to build a taxonomy for Learning Objects. For the purpose of this study – that is to highlight best practices in dealing with learning objects – we will consider the characteristics listed in the LOM metadata scheme that refers to the inner structure and to the pedagogical efficiency of learning objects, in order to point out which types of LOs could actually be created and with are each type’s pros and cons for the purpose of reuse and of creating a real sustainable and effective market for educational digital content.

Already David Wiley had proposed a taxonomy for Learning Objects in his early studies, which we think worth to consider here, before taking into account the LOM perspective. Wiley’s taxonomy in fact, however non-standardised, helps us to understand the general principles that have led the different international authorities to develop their standard and metadata.
Says Wiley: “Learning Objects have certain qualities. It is the difference in the degree to which (or manner in which) they exhibit these qualities that makes one type of learning object different from another”. Wiley taxonomy differentiates between five Learning Object types (we report Wiley’s original definitions):

Fundamental - An individual digital resource uncombined with any other, the fundamental learning object is generally a visual (or other) aid that serves an exhibit or example function (Wiley & Nelson, 1998). For example, a JPEG of a hand playing a chord on a piano keyboard.
Combined-closed - A small number of digital resources combined at design time by the learning object's creator, whose constituent learning objects are not individually accessible for reuse (recoverable) from the Combined-closed learning object itself. For example, a video of a hand playing an arpeggiated chord on a piano keyboard with accompanying audio.
Combined-open - A larger number of digital resources combined by a computer in real-time when a request for the object is made, whose constituent learning objects are directly

accessible for reuse (recoverable) from the Combined-open object. For example, a web page dynamically combining the previously mentioned JPEG and QuickTime file together with textual material “on the fly.”
Generative-presentation - Logic and structure for combining or generating and combining lower-level learning objects (Fundamental and Combined-closed types). Generative-presentation learning objects can either draw on network-accessible objects and combine them, or generate (e.g., draw) objects and combine them to create presentations for use in reference, instruction, practice, and testing. For example, a JAVA applet capable of graphically generating a set of staff, clef, and notes, and then positioning them appropriately to present a chord identification problem to a student.
Generative-instructional - Logic and structure for combining learning objects (Fundamental, Combined-closed types, and Generative-presentation) and evaluating student interactions with those combinations, created to support the instantiation of abstract instructional strategies (such as "remember and perform a series of steps"). For example, an EXECUTE instructional transaction shell (Merrill, 1999), which both instructs and provides practice for any type of procedure, for example, the process of chord root, quality, and inversion identification.

According to Wiley’s point of view, each type of Learning Object show a different degree of the same characteristics which are typical of a LO.
These characteristics are (we always report Wiley original definition):
Number of elements combined – Describes the number of individual elements (such as video clips, images, etc.) combined in order to make the learning object.
Type of objects contained – Describes the type of learning objects that may be combined to form a new learning object.
Reusable component objects – Describes whether or not a learning object’s constituent objects may be individually accessed and reused in new learning contexts
Common function – Describes the manner in which the learning object type is generally used.
Extra-object dependence – Describes whether the learning object needs information (such as location on the network) about learning objects other than itself.
Type of logic contained in object– Describes the common function of algorithms and procedures within the learning object
Potential for inter-contextual reuse – Describes the number of different learning contexts in which the learning object might be used, that is, the object's potential for reuse in different content areas or domains
Potential for intra-contextual reuse – Describes the number of times the learning object might be reused within the same content area or domain.

The following Table summarises Wiley’s taxonomy, making clear the key features of each Learning Object type. We will see in the section dedicated to LOM metadata how Wiley’s

suggestion is somehow similar to the taxonomy we can derive by analysing the values of the requested LO metadata.

Wiley taxonomy of Learning Object types

	Fundamental Learning Object	Combined-closed Learning Object	Combined-open Learning Object	Generative-presentation Learning Object	Generative-instructional Learning Object
Number of elements combined	One	Few	Many	Few - Many	Few - Many
Type of objects contained	Single	Single, Combined-closed	All	Single, Combined-closed	Single, Combined-closed, Generative-presentation
Reusable component objects	(Not applicable)	No	Yes	Yes / No	Yes / No
Common function	Exhibit, display	Pre-designed instruction or practice	Pre-designed instruction and / or practice	Exhibit, display	Computer-generated instruction and / or practice
Extra-object dependence	No	No	Yes	Yes / No	Yes
Type of logic contained in object	(Not applicable)	None, or answer sheet-based item scoring	None, or domain-specific instructional and assessment strategies	Domain-specific presentation strategies	Domain-independent presentation, instructional, and assessment strategies
Potential for inter-contextual reuse	High	Medium	Low	High	High
Potential for intra-contextual reuse	Low	Low	Medium	High	High

Source: David A. Wiley, Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy *(2000)*

"This taxonomy is not exhaustive in that it includes only learning object types that facilitate high degrees of reuse. Other types of learning objects that hamper or practically prevent reuse, (e.g., an entire digital textbook created in a format that prevents any of the individual media from being reused outside of the textbook context), have been purposefully excluded".

What type of Learning Object educational publishers produce? If we stick to the results of T2.2 study, we realise that digital educational content publishers put on the market (pdf files attached to textbooks, complementary resources etc) are hard to define Learning Objects even in Wiley's perspective. At least they could be considered LOs of the first two types…

2. Standard and LOs

If Learning Objects have to be used and reused, if new educational content has to be created (let's begin to say "packed") collecting LOs from different sources, this means that a mechanisms for people to be able to find and use the content is needed.
Standards will enable to find the right materials on the right time and place. In order to work on this purpose standards requires LOs to be indexed with consistently constructed metadata that should provide not only basic bibliographic information about the object but also information on both pedagogical uses of the object.
Learning objects and their associated metadata will than be searchable and this reuse of content will result in tremendous cost savings and time efficiencies that will further add to the cost effectiveness of eLearning
Standardization enable therefore instructors and learners to create, find, evaluate, reuse and share electronic content and therefore is essential to the long-term success of eLearning.

Why is standardization so important for the digital educational content market?

Standards describe the necessary conditions for content created by different organizations to be interoperable with delivery systems created by different technology companies. Standards therefore enable the growth of a market for educational digital content. In other words, the adoption of standards as far as educational digital content is concerned, offers content providers – and therefore educational publishers – appealing revenue opportunities such as the possibility to penetrate new markets by creating flexible content for each granular market segment, to accommodate multiple channels, since content is stored independent of delivery logic and format and it can be delivered via print, web, and mobile devices and finally to avoid content piracy, thanks to DRM systems. (Sustainability of the market has been discussed in T2.2 research *DRM solutions addressed to the eLearning market* developed in the framework of the OrmeE project)
To sum up, standards increase the value of digital content, assuring:

- Accessibility: the ability to search, identify, access, and retrieve content that is widely distributed;
- Adaptability: the ability to tailor instruction to individual and organizational needs;
- Affordability: the ability to increase efficiency and productivity by reducing the time and costs involved in delivering instruction

- Interoperability: the ability to use content developed by one organization on a given platform with one set of tools at a completely different organization on a different platform with another set of tools;
- Portability: the possibility to move or copy Learning Objects from one repository to another and access them through any delivery system that conforms to the standard (for example SCORM specification);
- Usability: the ability to navigate and use content in an intuitive way, as content architectures are standardized through industry- or community-based metadata models and taxonomies;
- Reusability: the flexibility to reuse content objects for multiple purposes, in different applications, in different products, via varying access devices, for numerous markets;
- Durability: the ability to transcend technology (platforms, tools, access devices, products, vendors) changes or evolution without costly redesign, reconfiguration, redevelopment or recoding.
- Information currency: the possibility for customers to get the latest, most up to date information, since the use of standard makes it easier and more economical to revise and update content in real-time (without having to republish the entire collection).

From this point of view it's almost impossible, and actually a non sense, to talk about best practices in dealing with learning objects without taking into account the standard issue and in particular LOM and SCORM. This issue, as a matter of fact, seems to be crucial from a double perspective:

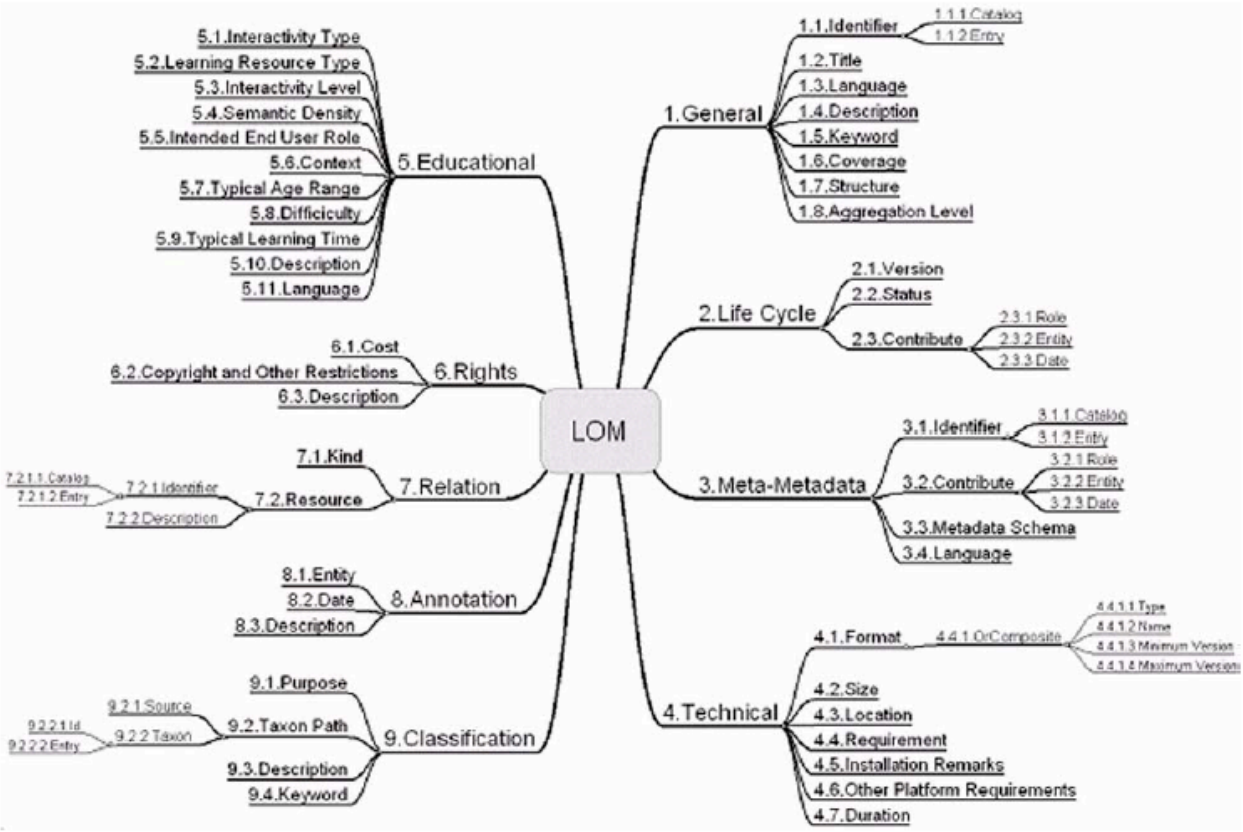
- In the eLearning environment nowadays a best practice can't avoid facing with standards which grants interoperability and scalability of LOs, therefore, being LOM and SCORM the most updated and internationally widespread standards, we could mean as best practices in dealing with LOs experiences that are LOM or SCORM compliant.
- LOM and SCORM (that is LOM based as far as metadata are concerned) allow to highlight the core features of a learning object being it a real learning object (and not just a piece of digital educational content), as the metadata they require focus on pedagogical, structural, technical but also legal (copyright) and economical aspects of a LOs based eLearning system.

2.1 LOM – Learning Object Metadata

For LOM, a metadata instance for a learning object describes relevant characteristics of the learning object to which it applies. Such characteristics may be grouped in general, life

cycle, meta-metadata, educational, technical, educational, rights, relation, annotation, and classification categories.

- The General category groups the general information that describes the learning object as a whole.
- The Lifecycle category groups the features related to the history and current state of this learning object and those who have affected this learning object during its evolution.
- The Meta-Metadata category groups information about the metadata instance itself (rather than the learning object that the metadata instance describes).
- The Technical category groups the technical requirements and technical characteristics of the learning object.
- The Educational category groups the educational and pedagogic characteristics of the learning object.
- The Rights category groups the intellectual property rights and conditions of use for the learning object.
- The Relation category groups features that define the relationship between the learning object and other related learning objects.
- The Annotation category provides comments on the educational use of the learning object and provides information on when and by whom the comments were created.
- The Classification category describes this learning object in relation to a particular classification system.



For the purpose of this study, we don't want now to provide an exhaustive analysis of the LOM metadata scheme, which could be easily retrieved at http://ltsc.ieee.org, but to underline what in the LOM metadata could be useful to build a taxonomy for Learning Objects and therefore to provide some reference models to discuss the best practices which are at the core of our research. Metadata are not an extemporary creation, on the contrary they reflect (and help to put them into categories) the characteristics of LOs, therefore it is easier to start from metadata requirement in order to extract LOs features than analyse LOs in order to find common qualities to describe. We must also remember that the LOM metadata scheme is at the basis of the SCORM reference model, therefore it could be regarded as "the" standard for Learning Objects metadata.

2.1.1 General (1)

2.1.1.1 Structure (1.7): underlying organizational structure of the Learning Object.

- atomic: an object that is indivisible (in this context).
- collection: a set of objects with no specified relationship between them.
- networked: a set of objects with relationships that are unspecified.

- hierarchical: a set of objects whose relationships can be represented by a tree structure.
- linear: a set of objects that are fully ordered. Example: A set of objects that are connected by "previous" and "next" relationships.

2.1.1.2 Aggregation Level (1.8): the functional granularity of the Learning Object.

- 1: the smallest level of aggregation, e.g., raw media data or fragments. If the learning object is a digital picture of the Mona Lisa, 1.7:General.Structure=Atomic and 1.8:General.AggregationLevel=1.
- 2: a collection of level 1 learning objects, e.g., a lesson. If the learning object is a lesson with the digital picture of the Mona Lisa, 1.7:General.Structure=Collection or Networked (since there are two descriptions of the same type of Structure) and 1.8:General.AggregationLevel=2.
- 3: a collection of level 2 learning objects, e.g., a course. If the learning object is a course on the Mona Lisa, 1.7:General.Structure=Linear if the documents are intended to be viewed linearly and 1.8:General.AggregationLevel=3. If the learning object is a collection of lessons on the Mona Lisa from different sources, 1.7:General.Structure=Collection and 1.8:General:AggregationLevel=3.
- 4: the largest level of granularity, e.g., a set of courses that lead to a certificate. Lastly if the learning object is a set of courses with a full history, description, interpretation, etc. of the Mona Lisa, 1.7:General.Structure=Linear or Hierarchical and 1.8:General.AggregationLevel=4.

A LO with Structure="atomic" will typically have 1.8:General.AggregationLevel=1. A learning object with Structure="collection", "linear", "hierarchical" or "networked" will typically have 1.8:General.AggregationLevel=2, 3 or 4.

These two qualities of Learning Objects provide us with a first “quantitative” taxonomy that reminds of Wiley’s. Learning Object are in fact divided into categories according to their structural complexity, that is a way to answer to the granularity problem. According to LOM there are 5 types of LOs (as 5 were Wiley’s, even tough Wiley’s taxonomy contained more qualitative characteristics, that we find in other sections of LOM metadata), each type (with the exclusion of the atomic type) can have different aggregation levels (if we only crossed Structure X Aggregation Level we would have 13 types of Learning Objects. Anyway, as said these features give us only an idea of what LOs could be, not of what LOs can do, from the educational point of view.
Therefore we need to refer to the Educational subset of metadata provided by LOM, which help to explain in depth the “nature” of LOs: interactivity.

2.1.2 Educational (5)

2.1.2.1 Interactivity Type (5.1): predominant mode of learning supported by the Learning Object.

- "Active" learning (e.g., learning by doing) is supported by content that directly induces productive action by the learner. An active learning object prompts the learner for semantically meaningful input or for some other kind of productive action or decision, not necessarily performed within the learning object's framework: simulation (manipulates, controls or enters data or parameters); questionnaire (chooses or writes answers); exercise (finds solution); problem statement (writes solution).
- "Expositive" learning (e.g., passive learning) occurs when the learner's job mainly consists of absorbing the content exposed to him (generally through text, images or sound). An expositive learning object displays information but does not prompt the learner for any semantically meaningful input: video (views, rewinds, starts, stops); graphical material (views); audio material (listens, rewinds, starts, stops); hypertext document (reads, navigates, as activating links to navigate in hypertext documents is not considered to be a productive action)
- “Mixed” interactivity occurs when a learning object blends the active and expositive interactivity types: hypermedia document with embedded simulation applet.

2.1.2.2 Interactivity Level (5.3): the degree of interactivity characterizing the Learning Object. Interactivity in this context refers to the degree to which the learner can influence the aspect or behaviour of the Learning Object .

- very low
- low
- medium
- high
- very high

Learning objects with 5.1:Educational.InteractivityType="active" may have a high interactivity level (e.g., a simulation environment endowed with many controls) or a low interactivity level (e.g., a written set of instructions that solicit an activity).
Learning objects with 5.1:Educational.InteractivityType="expositive" may have a low interactivity level (e.g., a piece of linear, narrative text produced with a standard word processor) or a medium to high interactivity level (e.g., a sophisticated hyperdocument, with many internal links and views).

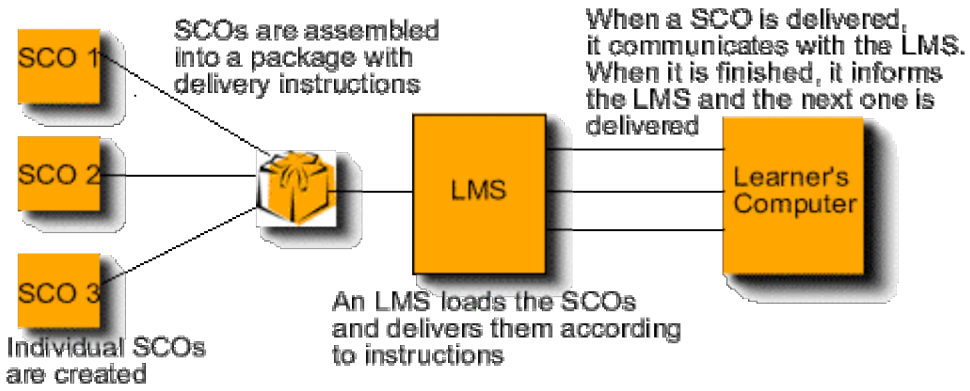
These two characteristics (interactivity type and interactivity level) seems to point out the key feature of LOs and the added value of the eLearning experience: the possibility for the learner to affect somehow the content behaviour or at least to take active part in the

instructional process. This is no doubt a “qualitative” aspect of LOs; there is however no judgement, no preference ranking between active or expositive LOs: they both have a kind of interactivity as we are used to understand it. This remark should tell something to educational publishers willing to produce and market digital educational content: to have a LO it’s not enough to have a piece of digital content, it has to have certain characteristics and one of the most important is of course to stimulate the active participation of the learner.

2.2 SCORM

SCORM, Shareable Content Object Reference Model, is a specification that provides a model to address the fundamental issues of interoperability and reusability of learning content. SCORM has been developed by the Advanced Distributed Learning initiative (ADL). SCORM therefore is not properly a standard but a reference model to create, aggregate and deliver educational content (SCOs, Sharable Content Objects, the LOs for SCORM) using standardised procedures: it defines an aggregation model for packaging learning content (SCORM has adopted a content packaging format from the IMS Global Learning Consortium) and defines an API (Application Programming Interface) to enable communications between learning content and the system that launches it (that is a LMS, Learning Management System). Besides, SCORM defines also a set of navigation and sequencing rules enabling SCORM conformant content to be sequenced through a set of learner-initiated or system-initiated navigation events (that is to say, to enable a LMS to interpret sequencing rules as defined by the author or packager of the content).

The following Figure shows the workflow of SCORM compliant content.



As said, SCOs could be regarded as Learning Objects, in the meaning we have given since now; therefore it is not a nonsense to provide some additional information on SCOs as further specification for the outline of best practices, which is the purpose of the present study.

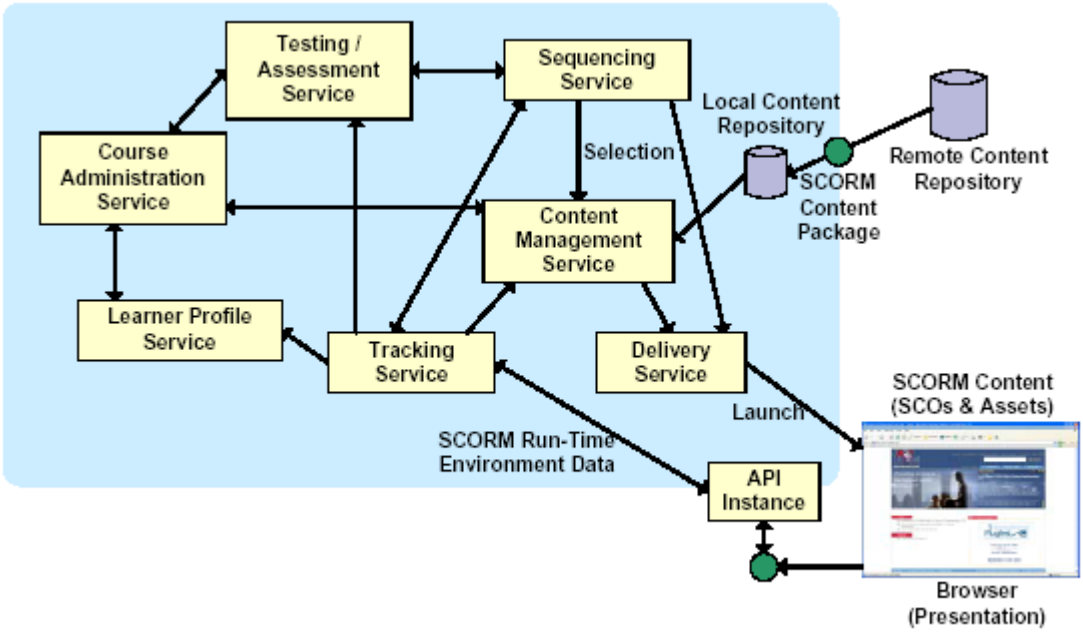
As remarked, SCOs are self-contained units of learning that can be used as building blocks to create packages of SCOs, but cannot be broken down into smaller units. In other words, they are Learning Objects. In order to create a larger unit of learning from SCOs and thus make SCORM work, SCOs must be found and organized into a structure; instructions must tell an LMS which SCO comes after which and SCOs and instructions must be bundled into a portable package.
This process is called content aggregation.
It is clear that at the core of this process stay the metadata as they facilitate the search and discovery of the components across systems. Moreover a LMS uses the metadata to give the learner information about the content organization (i.e., course, lesson, module, etc) and they can also be used at run-time to help in the decision of what content model component to deliver to the learner.
SCORM has a place for metadata in every SCO and in every content package; they can be collected in catalogues, as well as directly packaged with the learning resource it describes.
The SCORM metadata directly reference the IEEE 1484.12.1-2002 Learning Object Metadata (LOM) standard, though LOM provides roughly 64 metadata elements – more than would be practical for everyday use. However, other metadata schemes may be used.

2.2.1 What does SCORM actually enables?

SCORM seems to have gained a certain fortune in the eLearning community, since it is regarded as THE standard for the future growth of the educational digital content market. If it were only a collection of procedures and standard metadata as set in the LOM scheme, there would have been no reason for all those enthusiasm. Actually, being SCORM a interoperable reference model, it offers valuable market opportunities:

- a Web-based LMS can launch content that is authored using tools from different vendors and exchange data with that content
- Web-based LMS products from different vendors can launch the same content and exchange data with that content during execution
- multiple Web-based LMS products/environments can access a common repository of executable content and launch such content

The following Figure shows the architecture of a LMS in the SCORM model



The LMS merely processes the externally defined rules bundled with the learning content in the content packages and itself has no knowledge about how the content is organized except through the interpretation of rules. In other words: rules and navigation is kept separate from the content (although packed together) so that the content may be reused in new and different ways.

For a better understanding of how SCORM works, refer to the SCORM books, which can be found at www.adlnet.org. The following Table provides an overview of the SCORM books structure:

SCORM Book	Concepts Covered	Key SCORM Technologies Covered	Areas of Overlap
Overview	High-level conceptual information	Introduction to numerous high-level elements of SCORM terminology.	Covers areas of the CAM, RTE, and SN books at a high level.
Content Aggregation Model (CAM)	Assembling, labeling and packaging of learning content.	SCO, Asset, Content Aggregation, Package, Package Interchange File (PIF), Meta-data, Manifest, Sequencing Information, Navigation Information	SCOs and manifests. SCOs communicate with an LMS via the RTE. Manifests contain Sequencing and Navigation information.
Run-Time Environment (RTE)	LMS's management of the RTE, which includes launch, content to LMS communication, tracking, data transfer and error handling.	API, API Instance, Launch, Session Methods, Data Transfer Methods, Support Methods, Temporal Model, Run-Time Data Model	SCOs are described in the CAM book, are content objects which use the RTE.
Sequencing and Navigation (SN)	Sequencing content and navigation.	Activity Tree, Learning Activities, Sequencing Information, Navigation Information, Navigation Data Model	Sequencing and Navigation affects how content is assembled in a manifest.

3. Rights Management and Learning Objects

As stated in the T2.2 study *DRM solutions addressed to eLearning environment* the key issue to enable the creation of a sustainable market for educational digital content is to give shape to an environment where digital content is secured and copyright protected: that is content must be an autonomous, identifiable, researchable digital object, and it must also "embed" the idea of "rights".
In other words we have to make DRM and LOs talk to each other.
We have seen in the previous pages which are the standards used to describe and to pack Learning Objects and we have seen that the metadata provided supply a set of information to enhance interoperability and make LOs talk to other technological applications, as for example Learning Management Systems.

On the other side, DRM is based on rights expression language such as the Open Digital Rights Language or the Extensible Rights Markup Language, which provide language concepts and vocabulary for the composition of electronic agreements over the usage of learning resources.
In order to prompt the interoperability, share and reuse of learning resources, to protect copyright, to reward rights owner and to create therefore a real market we need to understand how rights and LOs can be combined. And standards help us once more.

Learning Objects standards provide themselves – in their metadata – some hints regarding rights and copyright protection: LOM contains a rights category (6) that describes the intellectual property rights and conditions of use for this learning object. This category, however give just a core set of elements and needs therefore to be extended or implemented in order to be effective from a DRM point of view; LOM indeed defines:

- Cost (6.1): whether use of the learning object requires payment;
- Copyright and Other Restrictions (6.2): whether copyright or other restrictions apply to the use of the learning object;
- Description (6.3): comments on the conditions of use of the learning object.

SCORM not only includes metadata but also now includes a sequencing specification that instructs learning delivery systems in what order and under what conditions to deliver specific learning assets. If a system is to respect the rights associated with a learning asset, which may preclude or restrict its delivery or form of delivery, information on rights need to be processed together with sequencing information.

3.1 Rights-Enabled Learning Objects

As seen, rights information provided by these standard alone are not enough. Another class of metadata should therefore be attached to the LO in order to control the way the LO can be used and must be respected to ensure appropriate use along the whole lifecycle of the LO. Of course the languages used for the new rights related metadata must be interoperable with the standard used for LOs. Rights languages as ODRL or XMrL (see Annex to T2.2) may be used to express permissions, constraints, obligations, etc. as far as a LO is concerned.
Therefore we talk about Rights-Enabled Learning Objects (RELO). [Source: Iannella, R. *Digital Rights Management (DRM) Architectures*, D-Lib Magazine, Volume 7 Number 6, June 2001]

Let's think to apply rights metadata to a LO: the first think we could think of is to integrate LOM metadata with the new set of rules managing rights. But if we take the SCORM perspective, we notice that the basic principle of content packaging allows to combine more than one LO, from different sources to give birth to a new Learning Object. In this case, rights metadata have also to refer to the new combined LO and to be therefore included in the metadata element of the package. In this way rights metadata are delivered together with the LO.
It is otherwise possible not to embed rights metadata in the metadata of the LO, but to separate them and store them in a License repository (or produced live to deliver to the customer).
Design of DRM-enabled Learning Object model depends on granularity, application scenarios and e-commercial model. In general, DRM-enabled Learning Object model for combined delivery has light protective ability, and the model for separate delivery is more flexible and more secure.

4. Open questions

Although the standard and metadata issue seems to be quite a consolidated practise, thanks to the LOM scheme and the SCORM reference model, there are certain questions that are still unresolved and that will be discussed in the following sections: that is a shared taxonomy for Learning Objects types and a common vocabulary enabling metadata entry to be filled in according to shared principles.

4.1 Taxonomy for Learning Objects types

If we keep in mind the core feature of a Learning Object is its instructional value (its pedagogical objective) it is clear that a taxonomy for Learning Objects types can't avoid taking into account the scope for which a Learning Object has been produced. This means that the taxonomical approach proposed in the previous pages has to be considered as a general framework on which the educational aspects have to be embedded, facing the needs of the educational community in its daily work. In order to understand the use of LOs in the praxis we can start considering the type of Learning Objects as listed in the LOM scheme.

4.1.1 LOM taxonomy

The taxonomy proposed within the LOM scheme is more a kind of taxonomy of learning activities than of Learning Objects, moreover the range of possible values is quite limited and in the praxis it needs to be elaborated to form a comprehensive scheme. It seems to be more a question of vocabulary, i.e. of naming of things, but we will look inside the topic later on these pages. We wish to point out since now, as it will be functional to our dissertation in short time, that the vocabulary terms used to identify the different types of LOs are defined as in the OED:1989 and as close as possible to the use by educational communities of practice.

4.1.1.1 Learning Resource Type (5.2): specific kind of learning object. The most dominant kind shall be first:

- ordered exercise
- simulation
- questionnaire
- diagram

- figure
- graph
- index
- slide
- table
- narrative text
- exam
- experiment
- problem statement
- self assessment
- lecture

Anyway if we look to the taxonomies proposed for Learning Objects by different organizations or communities dealing with projects concerning LOs, we notice how the so called taxonomy includes both quantitative, qualitative perspectives combining them with the educational objectives of each LO itself. The taxonomy created by the CELEBRATE initiative could be en exhaustive example of this approach.

4.1.2 CELEBRATE Taxonomy

Context eLearning with Broadband Technologies (CELEBRATE) was a large-scale 30-month demonstration project (ending in Nov. 2004) co-ordinated by European Schoolnet and supported by the European Commission's Information Society Technologies Programme (IST). It addressed all parts of the educational content value chain and involved 23 participants including Ministries of Education, universities, leading educational publishers, content developers, VLE vendors and technology suppliers from 11 countries. 1350 Learning Objects have been developed within the project and evaluated by 319 schools and 775 teachers in six countries.
In order to be able to catalogue in an efficient way the LOs produced within the Project, CELEBRATE has listed a taxonomy of Learning Objects types, combining learning activities and learning scope. The list of LOs typo follows (in one case the description of the objectives is reported), but for any other detail, refer to http://celebrate.eun.org.

- Assessment: Learning Object represented by assessment and evaluation instruments including exams and tests. Essentially any LO whose primary purpose is the evaluation of the user's actions or input or which supports teacher design or development of such materials. Used e.g. for assessing learner performance or self-assessment.
- Drill and practice
- Exploration
- Glossary

- Guide
- Information resource
- Open activity
- Tool

4.1.3 Other taxonomies

Anyway if we browse the web in search of Learning Object repositories or of studies and projects dealing with LOs, we realize that it does not still exist a shared and unique taxonomy for Learning Objects. As already pointed out each learning community tend to develop its own taxonomy, often the vocabulary used is different (the words, the naming is different) while the definition, the content describing each LO type (the meaning of the vocabulary term) is exactly the same. The following list provides an example of the variety of typologies which are to be found in different learning contexts (beside the LOM and CELEBRATE's): lesson, article, case study, research, research project, role play, simulation, problem solving, guided exercises, on line labs, assessment test, open answer test, etc.
It is easy to understand that the multiplication of taxonomies (not of LOs types, as we've seen) is a very crucial problem if we remind that LOs should be reusable and therefore interoperable. This is exactly the topic we are going to analyse in the next section of the study.

4.2 Vocabulary

What we understand here with the term "Vocabulary" (or thesaurus) is a list of recommended values (words) to define certain "things" related to Learning Objects and their characteristics. As we have seen in the previous section of this study, even the nature (taxonomy) for LOs is somehow a question of vocabulary more than of content. The problem however is more urgent if we think about all the values required in the LOM metadata entries. It is clear that if we want LOs, and therefore their metadata, to be as interoperable as possible, we need a common set of possible values to enter in the metadata: their meaning has to be unique and shared: that's exactly what vocabularies are needed for.

4.2.1 Vocabulary Extension

LOM itself provides a minimum vocabulary (based as far as the meaning is concerned on the *Oxford Dictionary*) for the values required in the metadata, but – as we have seen – in the praxis of learning communities these vocabularies often need to be extended or are

even replaced by other self-made thesauri. These are option that LOM allows, as it defines provided vocabularies as follows:
“Vocabularies are defined for some data elements. A vocabulary is a recommended list of appropriate values. Other values, not present in the list, may be used as well. However, metadata that rely on the recommended values will have the highest degree of semantic interoperability, i.e., the likelihood that such metadata will be understood by other end users or systems is highest”. Anyway, new vocabularies “should not conflict with this Standard”.

Here is reported the example for the vocabulary of the data element 5.2:Educational.LearningResourceType provided in LOM manual to better understand the vocabulary issue:

“If the value is just contained in the vocabulary, for instance "Questionnaire", then this would be represented as ("LOMv1.0", "Questionnaire"). This option is preferred if the values in the vocabulary can adequately express the intended meaning.
If the user wants to assign a value that is not part of the list given for 5.2:Educational.LearningResourceType, then the user may designate the value as, for instance, ("http://www.vocabularies.org/LearningResourceType", "MotivatingExample"). This option provides more flexibility to the indexer of learning objects, at the expense of semantic interoperability. Values defined in one community of users, or by an individual end user, will not be used consistently throughout a larger community”.
However, some of the vocabularies proposed in LOM are restricted, that is they should not be extended, others are regarded as best practices and therefore may be also extended.

Following some remarks by Daniel D. Suthers, of the Department of Information and Computer Sciences of the University of Hawai’i at Manoa, who led a Project of extension of LOM vocabularies:
“We found several of the LOM vocabularies for 5:Educational to be insufficient for our purposes. In one case, 5.2:Learning Resource Type, the vocabulary was open and the insufficiencies could be addressed via the extension mechanism. However, vocabularies for 5.1:Interactivity.Type (values: Active, Expositive. Mixed, or Undefined) and 5.5:Intended.End.User.Role (Teacher, Author, Learner, Manager) are restricted vocabularies, so cannot be extended in this way. We have made the recommendation that these be changed to open vocabularies until better consensus on an adequate term set can be obtained with the help of the various communities expected to be using the LOM. In some cases we felt that the vocabulary should be replaced with a structured description”.

As far SCORM is concerned, since the SCORM metadata are based on LOM, it is also recommended to adopt the use of vocabularies provided by LOM for each data element. However, if an organization has the need to use a different set of vocabularies, SCORM

permits the creation and use of an organizations own vocabulary. As mentioned above, this has the potential to decrease the semantic interoperability of the metadata and learning content and therefore it is recommended that vertical communities work to a consensus on building a set of interoperable vocabularies. “If there is a need in a vertical industry to create new sets of vocabulary tokens, it may be appropriate to work with others in that vertical industry to create an agreed upon vocabulary token set”. Anyway, as SCORM sets some vocabularies as “restricted vocabularies”, the process of implementation of specific vocabularies seems to be quite difficult in the praxis.

An example of an integrated attempt to build shared vocabularies for the cataloguing of learning resources (and the creation of LOs taxonomies) is given by the Living Taxonomy Project (http://livingtaxonomy.org) “an organization of educators, content publishers, and developers who are committed to improving the learning enterprise by making it easier for digital assets and print materials to be stored, retrieved, and distributed. Our taxonomies can be integrated into learning object repositories, LMS platforms, or other cataloguing systems to provide a common organization system for educators and students. The Project is aimed at creating a global set of open source, standards-based taxonomies for education. The purpose of these taxonomies will be to provide a free cataloguing structure for the collection and sharing of education materials around the world”.

5. Case studies

In year 2000 the investment banking firm W. R. Hambrect foresaw that:

"Online learning content development cycles are predicted to shorten by 20% every year to two or three weeks by 2004. This imperative will drive more template-based designs and fewer custom graphics. Learning objects will be created in smaller chunks and reusable formats. As a consequence, the industry will become more efficient and competitive…We are convinced that the move to defined, open standards is crucial to the continuing successful adoption of eLearning, especially as it begins to transition beyond early adopters into the rapid growth phase of the market. Authoring tools will need to operate across different platforms and communicate with other tools used to build learning systems. Content and courseware must be reusable, interoperable, and easily manageable at many different levels of complexity throughout the online instructional environment. Enterprise learning systems have to accommodate numerous and varied learner requirements, needs, and objectives. Corporate customers need to be able to easily track content created by multiple content providers through one training management system and search vast local or distributed catalogues of content to identify learning objects or modules on a particular topic. The race for education technology standards is on".

Where are we now, in 2005?

Generally speaking it seems likely to identify a couple of trend in the best practices in using Learning Objects in the publishing industry:

- There is an overall widespread consciousness of the need to work with open and interoperable standard;
- Almost every publisher knows what a Learning Object is, even though many tend to include in this definition each kind of educational resource in the digital format;
- The need for reusable content is very well known and the development of educational content seems to go in this direction.

However, It is unlikely that single publisher uses standards as LOM or SCORM to produce and identify its content on its own, let's say if not pushed by external factors: this latter case happens when for example a common platform for the delivery of contents or a gateway that stores metadata is created by a Ministry of Education or other public institution; usually these shared systems conform to international standards, therefore

content providers (publishers) are somehow pushed to adopt those standards themselves, in order not to be thrown out of the market.

5.1 Best Practices

We have decided to take in consideration some of the case studies, we have taken in account in the business models analysis, just to provide a selection of real best practices. As the reader will notice, most of the selected cases refers directly or indirectly to a broader initiative than the one of a single content provider.

5.1.1 Proquest

Contents delivered by ProQuest are SCORM compliant Learning Objects
Content is therefore described by two different sets of metadata according to the Platform from which they can be retrieved:

- Curriculum Online (see 5.1.8 for specifications on this application profile);
- Kaleidos (the scheme created by RM www.rm.com for their proprietary MLE).

5.1.2 Garamond

Content is made of Learning objects described according to DCMI (Dublin Core Metadata Initiative), while the LCSM platform is SCORM compliant.

5.1.3 SEI Educational system

As within the SEI system have been developed 530 multimedia lessons that are real Learning Objects and considering the need for content interoperability; the content packaging formats are based on XML and the content is packed strictly according to SCORM 1.2, based on the specifications of ADL. Metadata and vocabularies are therefore those provided by LOM.

5.1.4 Schoolbookextra

Schoolbookextra has developed an own metadata-specification based on IEEE LOM and Dublin Core, matched with the EUN schoolnet, http://elearning.bildung.at. The Schulbuchextra metadata include LOM metadata and Dublin Core metadata, in each of these cases the three required fields (or strings) are provided in order to make easy to understand the relations. In addiction to these common metadata, additional metadata are

requested, they are “service specific” metadata, that is information that helps users (human and machine) to identify and catalogue content (LOs) developed to be delivered on the Schoolbookextra platform.

The following list of metadata refer to the feature of the Austrian educational system, stakeholder of the Project:
Schulform (School Type)
List of school types existing in the Austrian educational system. The selected value is intended as the school type for which the Lo was originally developed.
Ausbildungsstufe (Educational Level)
Values from-3 to 99
Lehrplanabdeckung (Curriculum Coverage)

As the Schoolbookextra project focuses on digital extensions of printed schoolbooks, the following list of requested metadata provide information concerning the schoolbook to which the LO refers:
SBNR des dazugehörigen Schulbuchs (Schoolbook Number of related Schoolbook)
Schulbuchtitel (Schoolbook Title)
Kapitelzuordnung (Schoolbook Chapter)
Bezug zum Buch (Relationship with Schoolbook) - vocabulary provided

Being a Ministry funded Project, educational content must be “certificated” to be published on the Schoolbookextra portal. Therefore an additional category of metadata, developed on the basis of: Evaluation and Report Language (EARL) 1.0 (Working Draft), http://www.w3.org/TR/EARL10/, has been created in order to manage this particular issue:
Zertifizierung (Certification)
Description of the certification.
Zertifizierende Einrichtung (Certification Authority)
Who has certified the content: the Ministry of Education, regional government, the Church and so on.
Zertifizierungsdatum (Certification Date)
Zertifizierungsstatus (Status of Certification) – vocabulary provided
WAI-Kompatibilität (Web Accessibility Initiative compliance) – vocabulary provided

5.1.5 Kennisnet

Kennisnet is the Internet organisation for primary, secondary and professional education in the Netherlands creates virtual space for learning and educational processes and the technical framework for creating a market of digital educational content. In order to assure interoperability to the content delivered through the Kennisnet portal, two application profiles (one for professional education level and one for primary and secondary schools) based on LOM and on IMS metadata syntax: Content-zoekprofiel BVE v1.0.3

(professional) and Content-zoekprofiel PO-VO v1.0.1 (released in may 2005) a parallel version almost similar to the BVE instance except that it is aimed at primary and secondary schools and uses different vocabularies.
Content-zoekprofiel PO-VO v1.0.1 for example contains 57 metadata elements based on LOM, 18 of which are mandatory elements. Where required, vocabularies (in netherlandish is provided).

These metadata application profiles are not compliant to the SCORM metadata application profile.
In the fall this year Kennisnet intends to release a merged version of the BVE and the PO-VO strain. At this moment it is still uncertain if that version will be compliant to the SCORM metadata application profile, since one of the SCORM restricted vocabularies doesn't contain some of the required terms (Vocabulary of field IntendedEndUserRole – author, teacher, learner, manager)1

5.1.6 Sulinet

Sulinet Digital Knowledge Base is still in a start up phase, therefore many strategical decision concerning Learning Object, such as metadata scheme or content packaging have not been taken yet. Anyway the Sulinet aims at getting the highest degree of interoperability and compliance with the most widespread international standards (SCORM, IMS, LOM, Dublin Core) towards the enhancement of independence from the content-suppliers and the portability of the content.
The database, therefore, contains different reusable elements (pictures, texts, sound- and video files) ; these elements can be combined in different ways in order to create Los. Actually Los are displayed as web pages.
The reusable combinations of learning unites are stored in a central database. The multiple classifications and the technical and content metadata attached to the elements and units support the maintenance of the several data and substances.
Reusable elements classification:
Picture
Movie
Text
Simulation
Link
Sound
Chart
Quiz

Each element is described with a specific set of metadata. The following list shows the kernel of metadata common to all element types (excluding links):
Type/subtype (vocabularies provided for each type of element)

Title
Theme
Knowledge area/subject
Size
Author
Detail (relation whit a more general element)
Student work
Resource (original, if the content has been digitalized)

Other metadata as language or duration for example are of course media specific.
For now it's pretty difficult to foresee whether these metadata will be implemented in a standard scheme and which will be the development of the content packaging solution, anyway we suppose it would happen in the LOM-SCORM direction.

5.1.7 Bildung on line

www.b-o.de
Bildung on line is a catalogue of educational resourced (books, off line and on line materials) powered by VDS Bildungsmedien (once Schoolbook Publishers Association), therefore it just stores metadata on content, which publishers have to submit in order to feed the db. Criteria and list of required metadata is provided by Bildung on line.
Following the list of fields required to submit metadata to the b-o system. It is useful to see the system metadata requirements, as, since publishers have to export those information from their own systems, the fields should be as open as possible and compliant with the various metadata schemas publishers may use. Anyway, they should be compliant to the most widespread international standards.

<FILE>
<URL> URL where the content is actually to be found (web page of the publisher)</URL>
<PNR>Product number (ISBN or other identifier)</PNR> mandatory
<TITEL>Title</TITEL> mandatory
<UNTERTITEL>Subtitle</UNTERTITEL>
<REIHE>Series</REIHE>
<AUTOR>Author</AUTOR>
<ABSTRACT>Abstract</ABSTRACT>
<FACH>Subject</FACH> vocabulary provided, according to German curricula
<SCHULART>School Type </SCHULART> vocabulary provided, according to German educational system
<PRODUKT>Product type</PRODUKT> vocabulary provided
<MEDIUM>Product form</MEDIUM> vocabulary provided (ex. audio, book, software, download, video, etc.)
<FORMAT>File format</FORMAT>

<SYSTEM>Operating system</SYSTEM>
<KLASSE>Educational level </KLASSE> vocabulary provided, according to German educational system
<LAND>Region</LAND> vocabulary provided (German Länder)
<ANBIETER>Publisher's identifier</ANBIETER> mandatory and provided by b-o
<EDATUM>Initial date</EDATUM>
<XDATUM>Expire date</XDATUM>
<PREIS>Price</PREIS>
<RABATT>Discount</RABATT> test and launch period
<UMFANG>Number of pages or weight of a file</UMFANG>
<BERUF>Job</BERUF> vocabulary provided, according to German educational system
<SDATA>description for fulltext search</SDATA>
</FILE>

5.1.8 Curriculum Online

Curriculum Online is an online catalogue of metadata records that describe educational resources produced for the Uk market. Therefore suppliers of resources to Curriculum Online are required to provide metadata of their resources in a uniform format, for interoperability needs. It is clear that being Curriculum on line a highly widespread service, the metadata scheme required serve as a driver for publishers and content providers to adopt that scheme to identify their content.
The Curriculum Online metadata scheme is based on IEEE-LOM, of which it is a so called "application profile": this means that it has been defined which elements of IEEE-LOM are used and which are not and stated some rules on what values we are expecting for each element. In addition there are some elements which are included purely for compatibility with other systems which also use IEEE-LOM, but which aren't used for Curriculum Online (General – structure; Educational – semantic density; Educational – language).
Moreover some optional elements have been added that are "service specific":
Cost/price
This group of elements is used to give an indication of the cost of a product. The group of elements is made up of: Licence Model (vocabulary provided); Cost (of the licence model); Tax (VAT included or not)
Classification
All information required in the Classifications section (in LOM, the purpose of metadata referring to this section is to specify taxonomical characteristics of LOs) aim to add educational context specific to English schools based on controlled vocabularies generated by QCA, BECTa, etc.
Teaching subject (all core and non-core subjects taught in English schools) – vocabulary provided
Low level specifiers (key words that details teaching subjects) – vocabulary provided
Key stage (related to the Uk curriculm) – vocabulary provided

School year (education level) – vocabulary provided
Strategies (methodology of teaching or learning and goals to be achieved through the resource) – vocabulary provided
Cross-curricula (specify whether the resource refers to cross curricular skills) – vocabulary provided
SEN (special needs) – vocabulary provided
Attainment level (target audience) – vocabulary provided

As far as the Learning Resource Type vocabulary, Curriculum Online has adopted the CELEBRATE vocabulary (see section 4.1.2).