

LOs Instructional Design based on an Ontological Model to Improve their Quality

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Abstract. The purpose of this paper is to provide an awareness of the elements that should be considered in the quality learning objects instructional design for e-learning systems. According to this, we propose our own LO definition taking into account aggregation level number 2. On this basis we analyze cognitive theories to promote learning as well as we explain issues relating to the LOs characteristics that help to improve their quality for a suitable management. To achieve this we propose an instructional design based on an ontological model, which explains relation between the instructional design elements and a specific classification to improve their management.

Keywords: Learning Objects, Instructional Design, Ontology

1 Introduction

The challenge of defining the type of information to manage for e-learning is a topic that has led to the emergence of new concepts for resource development. One of these concepts is the learning object, which considers resources as independent units that can be re-used for new educational situations.

Due to the big quantity of LOs definitions, we propose our own LO definition which is directed to LOs with aggregation level number 2. In this way it is possible to take clear what we understand for LOs and what kind of LOs we are managing for instructional design. Nowadays, specifications and standards are in development, which allow for interoperability of these objects on diverse platforms. However, the ability to interchange learning objects is not a synonymous of a good quality result. At this time there are a lot of researches directed to achieve LOs interoperability without taking into account some instructional design.

As stated before, the purpose of this paper is to provide an awareness of the elements that should be considered in the quality LOs instructional design for e-learning systems. Taking into account some classifications to improve their management. To achieve this in section 2 we suggest some issues to take into account

to achieve a good LO design. In this section we analyze cognitive theories to promote learning as well as we explain issues relating to the LOs characteristics which help to improve their quality for a suitable management. Section 3 shows the relation between LOs instructional design components through an ontological model proposing some classification that could be considered for an application profile in order to improve LOs management.

2 LOs Instructional Design

E-learning systems based on reusable LOs means the possibility of accessing specific content according to the learners' needs. To avoid interoperability problems there are some organizations that are working to develop standards and specifications to manage resources for e-learning systems.

Nowadays a lot of LOs definitions exists [5], [8], [9], [11]. In order to manage them for e-learning systems, it is important to respond what we understand for LOs. We define a LO as a "unit with a learning objective, together with digital and independent capabilities containing one or a few related ideas and accessible through metadata to be reused in different contexts and platforms" [7]. According to this our proposal is directed to LOs that has a level of aggregation number 2, for example a lesson [5].

In order to apply some design for contents it is necessary to consider some methods depending of learning situations, it is possible through instructional design. Different kinds of learning theories exist to explain how the learning occurs. About this concept [10] explains that instructional design is a theory that offer an explicit guide about how teaching to learn.

Instructional design theories are related with the kind of information to try depending on what and how to teach. About LOs some instructional design theories exists. One of this Merrill [6] proposes the instructional transaction theory directed to mechanized process. According to his definition "is an attempt to extend the conditions of learning and component display theory so that the rules are sufficiently well specified to be able to drive automated instructional design and development". This theory describes knowledge in terms of three types of knowledge objects: entities, activities, and processes. Also it identifies a lot of things like interrelationships among knowledge objects including: components, properties abstractions, and associations between entities, activities, and processes.

However Merrill [6] theory has been criticized about their excess structure because it doesn't facilitate the content developers work and to put it into practice.

Based on Merrill theory [6], Cisco Systems [3] suggests a guide for reusable learning objects creation. This guide proposes specific structures for any kind of specific learning object. Also provides a help guide and examples for their classification. To ensure solid structures for multi-courses Cisco Systems [3] provides five levels of hierarchy: course, module, lesson, topic, sub-topic. Each one of these levels has specific elements to structure them. The general structure is composed by: *Course*: introduction, module, lesson, topic, sub-topic, practice, evaluation; *Module*: Overview, lessons, summary, practice and evaluation; *Lesson*: Overview, topics

(concept, Fact, procedure, process, principle), summary, practice and evaluation;
Topics: contents related with concepts, facts, procedures, process and principles.

Cisco LOs structure [3] is shared by Moreno and Bailly-Baillière[8], however they add some changes. They propose to group contents into three kinds of them: data and concept, procedure and process and finally reflection and attitude. In this way it is possible to simplify the content developers work covering other related type of contents. They also suggest adding sequenced activities after summary and self-assessment for each topic.

Nowadays, LOs instructional design is a topic that is highly discussed. However according to mentioned above there are some things that must be considered to ensure a quality LOs instructional design.

LOs are individual units of learning or modules which needs to be enabled with other ones to build the largest units (didactic units, courses, etc.), it's mean they are part of the whole, but each one of LOs must be useful to be reused by itself in other didactic units. According to this in order to complete a LO as a quality unit of learning and to compose didactic units (DU) with them, we think it is necessary to consider the following issues.

- **Overview:** According to [3] and [8] a didactic unit needs a general vision in which may be explained general objectives and introduction about the LOs content. Introduction is an important element for any kind of content because as well as their informative function about the contents, establish the purpose of the topics and orient learners to what they are expected to learn. By other side it is a motivation element that aims to engage the students letting them know why the subject is important for them.

An overview must provide a LOs objective too. As we explain in LOs definition according to LOs reusability characteristics ideally an objective must be simple with one or few related ideas. We suggest that an objective must be directed to learn one kind of content because in this way all the instructional design would be targeted to achieve this specific objective.

Other important things that must be included in a LO overview are: Their own title and the title of the unit of learning in this way students can know what part of a whole they are trying; the list of topics that aim to know their sequence; the number of hours to be available to achieve the objective that aim to organize the learning and finally keywords that aim to know students what related areas involved with the LO content.

- **Contents:** In general any kind of content must have some quality characteristics taking into account different issues. From a pedagogical point of view contents must be in line with logic and psychologic meaningful. That's mean by one side discipline logic (content sequence, methodology, kind of activities, etc.) and by other side users suitability (level of difficulty, user interests, etc.). Other issues related with any kind of content are the information veracity, correct data, good redaction and orthography, suitable size, colour and kind of letter, etc.

However taking into account the LOs characteristics it is important that contents doesn't mention something about the time for example, this week or this semester... because it could to delay its reusability for other educational situations. The same thing must be taking into account for the audience, so phrases like "dear engineering students..." must be avoided.

Ideally contents must be presented in a multiple formats in order to attend different cognitive skills and learning styles e.g. videos, animations, graphics, etc.

- **Activities:** Activities may be directed to promote new knowledge acquisition and prepare users for a final assessment. Activities may be included into any kind of content during all teaching and learning process. They help users to know if they must to take the next lesson or a content feedback.

Some authors [12], [4] promotes constructivist learning environments for Learning Objects. They emphasize that activities must be most diverse as possible to attend different kind of users: case studies, to resolve problems, collaborator work, reflect about situations etc. We are agree with the necessity of this kind of activities, however we think a deep reflection about them is necessary before their applications to LOs.

First, activities are too related with the kind of contents. This issue may affect the kind of activity to employ, for example if LOs contents are just talking about basic concept, fact or data the kind of activities may be directed to reinforce them, for example relating the correct concepts, checking true or false, etc. Probably another activity like “study case” does not needs to be employed at this level of complexity.

According to this, to respond to different complexity levels contents and cognitive domains, we suggest taking into account three kinds of activities: Initiation, Re-Structuring and Application.

Initiation activities are designed to teach basic content for a specific subject. An example of this is a quiz. Re-Structuring activities classification may be directed to promote new knowledge acquisition, such as activities that promote questions, investigation, etc. Finally, applying classification activities may be directed to promote students’ experience in order to achieve their new concepts acquisition. An example of this activity is a study case.

Didactic Unit is composed by a group of individual LOs. Due reusability characteristic some authors [3], [8] recommend to made some activities at the end of for DU, it is because to avoid consistency problem with new LOs adaptation in order to attend the whole of each one of individual LO content.

- **Summary or Conclusions:** As whatever kind of teaching and learning process, it is advisable a summary after contents review. For a suitable summary it is important to point out the principal ideas and relation between them, in this way it is possible to reinforce the contents and learner progress. Also it is important to relate the contents with another knowledge areas by diagrams, schemas, conceptual maps, etc.
- **Assessment:** An evaluation must take into account each one of learning objectives. So they must be directed to any kind of content and their level of difficulty. Evaluation may be doing as activities, however it is very important that students can know what activities will be evaluated. Clark [2] promotes activities of practice and activities of evaluation. The first one has to support students to acquire new knowledge providing feedback, pointing out the most important information, and to prepare them for a final evaluation. The second one must be a final experience together with an approbation or not degree. They be use to verify if the objectives were achieved or not.

3. Instructional Design Based on an Ontological Model

In order to achieve a quality LOs instructional design it is important to define and relate their components. On this basis to manage them in a suitable way we think it is necessary to normalize them according to our definition and some instructional design issues to guarantee by one side a suitable degree of granularity and by other side pedagogical consistency. Figure 1 shows the components of our proposed knowledge model and the relationships between them. Following this model, we suggest the next steps.

1. *Define LOs components*: According to our LOs definition for LOs with aggregation level number 2 we suggest to define their components as we explained in section 1: Overview, Contents, Activities (practice and evaluation), Summary or Conclusions.
2. *Classify LOs components*: LOs can be classified for different purpose by “classify metadata element”. According to this it is possible to define some characteristic for them adding a vocabulary to metadata schema. To achieve a better LOs management we suggest the following LOs classification.
 - *Classify LOs objectives according to their cognitive domain*. In this way it is easier knowing about their compatibility for suitable new educational situations. Then, we suggest Bloom cognitive domain taxonomy [1] because it defines what and how to learn according to complexity levels: low level (knowledge, comprehension and application) and high level (analysis, synthesis and evaluation). To achieve this we propose the following metadata classification
 - 9.1 Purpose: Cognitive Domain
 - 9.2 Taxon path: A taxonomic path in a specific classification.
 - 9.2.1 Source: A specific classification e.g. Comprehension
 - 9.2.2 Taxon: An entry in a classification.
 - 9.2.2.1 Id: Taxon's identifier in taxonomic system e.g the number of an objective table
 - 9.2.2.2 Entry: Taxon's name or label (other than identifier) e.g. the value of an objective table (describes, explains...)
 - 9.3 Description: A textual description of learning object relative to its stated purpose. E.g In this cognitive domain, students are able to understand the information received and are able to describe, interpret and extrapolate the information.
 - 9.4 Keyword: Contains keyword description of learning objective relative to its stated purpose. E.g Comprehension
 - *Classify LOs into three kind of content*: data and concept, procedure or processes, and reflection or attitude. This classification aims to define the kind of content according to the learning objectives. This is an issue that may be important when teachers search LOs to structure their courses.
 - 9.1 purpose: Kind of Content
 - 9.2 taxon path: A taxonomic path in a specific classification.
 - 9.2.1 source: A specific classification e.g. Data and Concept
 - 9.2.2 taxon: An entry in a classification.

9.2.2.1 id: Taxon's identifier in taxonomic system e.g the number of a content table

9.2.2.2 entry: Taxon's name or label (other than identifier) e.g. the value of a content table (data, numbers, fact....)

9.3 description: A textual description of learning object relative to its stated purpose. E.g A group of objects, symbols, ideas or events that are defined by a single word or term.

9.4 keyword: Contains keyword description of learning objective relative to its stated purpose. E.g. "Internet History"

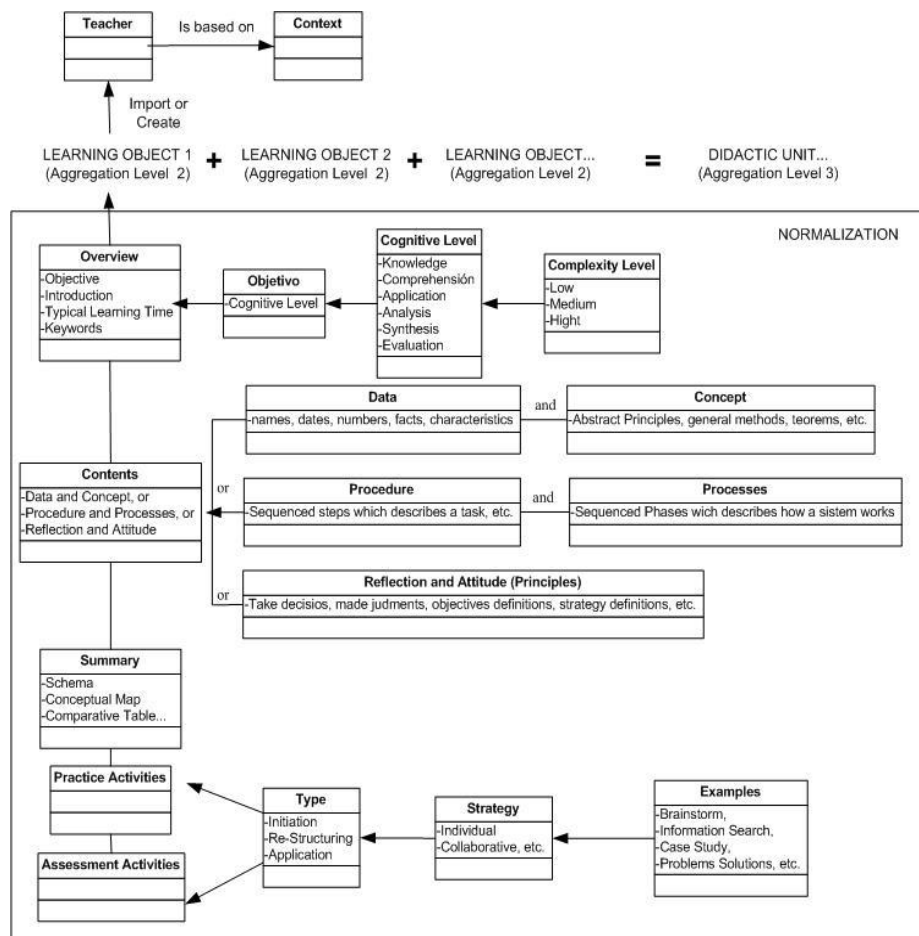


Fig. 1. An Ontological Model for Instructional Design

LOs classification suggested above is a way to facilitate LOs management according to instructional design characteristics. Cognitive domain aim to define what student skills to develop and what they are able to do. This information is important from a

pedagogical point of view to determinate their reusability in another educational context. By other side contents classification aim to decide if they are suitable for other educational objectives and aim to determinate the contents sequence because any kind of content define the specific type of content that LOs contain. This issue is useful to give students specific LOs content they needs.

According to knowledge model proposed, activities are classified by practice and evaluation as we explained in section number 1. Both have the same classification and strategy, however the last one must be evaluated to promote students to another learning stage.

LOs Normalization is a way to prepare LOs for their management and evaluation because in this way it is possible to uniform their characteristics promoting their quality criteria respond an important question for knowledge management: what to manage.

4 Conclusion

LOs is a subject which is highly discussed most of LOs proposals are directed to achieve a suitable LOs management from a technical point of view in order to guarantee their characteristics reusability, accessibility and interoperability for automatized process. Nowadays it is possible to find a lot of tools for help this task like metadata editors, e-learning platforms, etc. However in educational area LOs needs a special attention. According to LOs definitions they must be directed to teach a little unit of content. However to achieve this objective LOs must have a suitable instructional design that aim to achieve their educational objective.

About LOs instructional design we analyzed some of the most important proposals, all of them define some components that promotes educational goals. However in order to guarantee a quality LOs design it is important to consider quality criteria taking into account LOs and users characteristics, in this way LOs can be more useful and efficient

In order to improve LOs instructional design our knowledge model adds a clear and easy way to structure LOs elements with quality characteristics. The cognitive domain and kind of content classification is a way to guarantee a suitable LOs management. By one side the classification provided is useful for any context of use because a LO with aggregation level number 2 must have at least one educational objective and some kind of contents, then our proposal aim to define what a student is able to do and the suitable type of content to have. By other side, our proposal considers the metadata element “classification” which is part of an official metadata proposal, then it can be used for personalized applications profiles in order to classify LOs according to their particular educational needs.

LOs definition we are proposing applied to aggregation level number 2, aim to define some instructional design components, and quality criteria provided aim to create a valid and quality unit of learning. On this basis is easier to apply quality criteria for LOs because they have a uniform structure. According to this we are working on defining quality criteria for metadata information in order to promote a suitable LOs descriptions and their consistency with instructional design.

We want to emphasize that our proposal is directed to instructional LOs design. However it doesn't guarantee the quality LOs management for e-learning systems because it depends of many issues like platform capabilities, usability, accessibility, etc. which are out of this specific proposal. However this work proposes some ideas to improve LOs quality from an instructional design point of view that must be applied both, instructional design and metadata information.

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