

LEARNING OBJECT. DEFINITION AND CLASSIFICATION

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Abstract

The current trend in higher education includes competencies in the curricula. This integration can be done through the competency-based learning. The competence is acquired through various learning objects to be achieved. In this paper different dimensions to define a learning object (LO) and different classifications associated to them have been proposed. An analysis and synthesis of the results obtained have been presented.

Keywords: Innovation, Learning objects definition, learning object classification.

1 INTRODUCTION

To acquire competences, certain learning outcomes are established, which must be met. The way to transmit knowledge to fulfil these learning outcomes is through learning objects [1].

The competences defined at the Universitat Politècnica de València (UPV) aim to synthesize the competence profile acquired by students of UPV, also guaranteeing cover the framework of some degrees with regulations or specific recommendations.

The competency-based learning requires an effort that depends not only on teaching strategies, but also to know how to select and apply appropriate resources for their achievement. On this basis, should be proposed resources aimed at developing skills, helping to adequate recovery and reuse of these resources [2]. To develop the skills needed in each competition, it is important that teachers have access to appropriate learning resources, which can adapt to the different educational needs of students.

The objective of this paper is to clarify the learning object (LO) definition and its classification.

This paper is structured as follows, in the section 2 LO definitions found in the literature are reviewed by first identifying the dimensions to define the LO and then analyzing definitions based on the dimensions identified. Section 3 presents different ways to classify LO. In section 4 the conclusions are included.

2 LEARNING OBJECT DEFINITION

In existing literature various researchers have attempted to define a Learning Object (LO). However, a review of this literature shows a lack of consensus in the terminology used as well as in the dimensions addressed during its definition. In this section, different dimensions to define a LO are proposed based on the literature review made. These dimensions have allowed to carry out a structured analysis of the different LO's definitions. Then, a synthesis of the results obtained is presented.

2.1 Dimensions to define LOs

From the study of the different LO's definitions in the literature and their integration, it can be concluded that some of the following dimensions are addressed:

What is? Through this dimension authors identify LO with existing teaching elements.

How is it supported? The material and technology support is covered through this dimension.

How is it? Relevant properties of LO are described in this dimension.

How it is used? It is interesting to know for what, when and where the use of LO is appropriate.

2.2 Analysis of LO definitions based on LO Dimensions

Table 1 shows the analysis of different LO definitions formulated during the last 15 years structured according to the four dimensions previously proposed. From Table 1 some conclusions can be drawn from the different dimensions:

- What is? The vast majority of definitions identify a LO with an entity, atom, piece of Lego, building blocks, learning units or resources. An underlying concept of an independent and minimal element that can form part of bigger ones is underlying.
- How it is supported? Though some definitions do not specify the support in a very important number of definitions LO are restricted only to digital support. More recent definitions include the requirement of being identifiable through metadata. However, there are also several authors that consider LO in non-digital support even in whatever support.
- How is it? Although different adjectives have been proposed to describe Los, the most frequently used is the “reusability”. The rest of features can be integrated in self-meaning, independency, technical compatibility, adaptability, and durability.
- How it is used? it is a consensus about that LO should support learning in a multiple educational, teaching and technological contexts based on the different actors’ objectives, in an active manner and in one sitting.

Authors (year)	What is?	How it is supported?	How is it?	How it is used?
[3]	Resource	Digital	that can be reused	to support learning
[4]	Piece of Lego or Atom		Not all atoms can be combined with every other atom Atoms can only be assembled in a certain structured manner determined by the internal structure of the atom itself Special training is needed in order to assemble atoms	
[5]	Entity	Digital or Non-digital		that may be used for learning, education or training
[6]	Chunk of relevant information, Atom		Share-ability and reusability Like an atom that has smaller components (electrons, protons, and neutrons), the LO also would comprise of several smaller components	that learners can access and internalize in one sitting
[7]	Entity	Digital or Non-digital	which can be used, reused or referenced	during technology supported learning
[8]				To contribute to the understanding of concepts and processes and the development of skills
[9]	Components of high quality, technology-mediated instruction	Multimedia		Learning objects allow the student to use the content learned in a particular part of a course

Authors (year)	What is?	How it is supported?	How is it?	How it is used?
[10]	Knowledge element, learning resource, and instructional component	Online material	Three parts: (1) a learning objective, (2) a learning activity, and (3) a learning assessment	
[11]	unit of learning content		independent and self-standing that is predisposed to reuse	in multiple instructional contexts
[12]	Processes or strategies, such as object-oriented instructional design	Digital	as discrete, addressable, and adaptable units to achieve fine-grained accessibility and improved reusability	to support active learning strategies (case-based learning, problem-based learning, generative learning, collaborative learning, etc.) rather than treating them as collections of static lessons.
[13, 14]	Minimal learning content units	Formed by interactive and multiple format information packages, identifiable through metadata	Their outstanding features were self meaning, reusability, technical compatibility, adaptability, and durability.	Designed to reach a single learning objective, integrating learning content, assets, activities and evaluations.
[15]	Entity	Digital or Non-digital	which can be used, reused or approached	during the learning process supported by technology
[16]	One or more files or modules of learning material	Digital	Reusable in multiple settings and for multiple purposes accessible from digital repositories	potentially usable in classrooms as components of units of work accompanied by digital and non-digital materials
[17]	Learning units		Small reusable These LOs are then assembled and/or aggregated in order to create greater units of instruction (lessons, courses, etc)	
[18]	Building blocks	can be presented through a variety of media, including text, graphics, animations, audio and video	They can be combined in a virtually infinite number of ways They can be as small as an explanatory paragraph or as large as a complete tutorial	To construct collections that may be referred to as lessons, modules, courses, or curricula.
[19]	entity	Digital or Non-digital	can be used, re-used or referenced	during technology support learning

Authors (year)	What is?	How it is supported?	How is it?	How it is used?
[20]	Learning resources		Sharable and reusable	reusability, meaning the effective use of a learning object by different users in different technological environments and in different educational contexts
[21]			<p>It can be independently used because its content is self-contained;</p> <ul style="list-style-type: none"> - It is reusable and can be used in different contexts and for different purposes; - It is associative and can be grouped in a large collection of objects, including regular or traditional course structures; - It contains information that describes its content, its discovery being easier. 	The proper use of learning objects can lead to flexible dynamic adaptation solutions of instructional content related to the individual learning needs in real time
[22]	the minimal unit of learning,	Digital Format	<p>Pedagogical purpose Interactive Content It is indivisible and independent of other learning objects, so: It must make sense in itself and be self-contained. It cannot be broken down into smaller parts. It is reusable in educational contexts other than that for which it was created. It can be reused and sequenced</p>	Integrated and integrating elements of the teaching-learning process, offering students the opportunity to improve their performance and satisfaction.
[23]	Composition or a scene with a set of blocks.		Blocks have learning content in small parts, consisting of learning content (text document) and a set of atomic learning content (document, text, figures, pictures, video, audio, animations, questions and answers)	The central objective is to achieve the possibility that students and teachers can adapt the training resources in accordance with their training goals and learning, their interests, needs and styles learning and teaching.
[24]	Content component	Digital	Flexibility, independence and reuse of content	in order to deliver a high degree of control to instructors and students
[25]			It can enhance maximum reuse, without leaving a minimum instructional design, to ensure their use as self-contained resource, that is, an educational resource with the necessary elements for reuse in other areas and disciplines	

Authors (year)	What is?	How it is supported?	How is it?	How it is used?
[26]	Resource	Digital	To provide a modularised model, based on the standards that enhance flexibility, platform independence, and reuse of the learning content, as well as providing a higher degree of control for teachers and learners	
[27]			Need for reusability has at least three components: Interoperability, Flexibility in terms of pedagogic situations, modifiability to suit a particular teacher's or student's needs, reusability of LOs	

3 LEARNING OBJECT CLASSIFICATION

The online information revolution has spawned the LO, the cyber equivalent of earlier shareable resources for education and training. Lecture handouts, textbooks, test questions, and presentation slides can all be considered LO's. The online versions of these, together with interactive assignments, cases, models, virtual laboratory experiments, simulations, and many other electronic resources for education and training further add to the pool of LO types [10].

Regarding metadata, the basic elements associated to LO's have been described by the Institute of Electrical and Electronic Engineers like the Learning Object Metadata or LOM [28]. This standard, conceptually compatible with the well-known Dublin Core Metadata Element Set [29], organizes its conceptual metadata schema in nine categories: general, lifecycle, meta-metadata, technical, educational, rights, relation, annotation and classification.

The "Classification category" serves several different purposes, including stating the objectives of the LO, the prerequisites of the learner and the overall classification of the contents inside taxonomical schemes or ontologies.

From a point of view of this "classification" category, the diversity in types of LO's is especially indicated by the three properties [10]: aggregation level, interactive type, and resource type.

In the Aggregation Level property:

Level 1 refers to the most granular or atomic level of aggregation, e.g. single images, segments of text, or video clips.

Level 2 refers to a collection of atoms, e.g. an HTML document with some embedded images, or a lesson.

Level 3 refers to a collection of level 2 objects, e.g. a set of HTML pages linked together by an index page, or a course.

Level 4 refers to the largest level of granularity, e.g. a set of courses that lead to a certificate.

For the Interactive Type property:

Expositive: information flows primarily from the object to the learner for and includes text, video and audio clips, graphics, and hypertext linked documents

Active: information flows from the object to the learner and from the learner to the object for learning-by doing including, simulations and exercises of all sorts

Mixed: a combination of expositive and active

In the Resource Type property:

Resource types could include: exercise, simulation, questionnaire, diagram, figure, graph, index, slide, table, narrative, text, exam, experiment, problem, and self-assessment.

The research reported in the article of [10] tested a process designed by the authors for the evaluation of LO's. For this process they use the Learning Object Review Instrument (LORI). LORI (version 1.3) measures ten separate qualities of LO's so the LO's could also be classified according to these ten qualities:

1. Presentation: aesthetics
2. Presentation: design for learning
3. Accuracy of content
4. Support for learning goals
5. Motivation
6. Interaction: usability
7. Interaction: feedback and adaptation
8. Reusability
9. Metadata and interoperability compliance
10. Accessibility

The presence of each quality is measured with a single item using a rating scale consisting of five levels: absent (0), weak (1), moderate (2), strong (3), and perfect (4). A descriptive rubric is provided for each level.

In the work of [30] can be consulted another adaptation of the LOM, where the aim of category "Classification" is "to describe where the object is focused in a specific classification system". Each classification assigned to an object is described using four information elements, as shown below.

The LOM classification category Number Item Description are:

9.1 Purpose: The purpose of classifying this LO. Value space: discipline, idea, prerequisite, educational objective, accessibility, restrictions, educational level, skill level, security level, competence

9.2 Taxon path: A taxonomic path in a specific classification system. Each succeeding level is a refinement in the definition of the preceding level. Each path is described as a pair (Source, Taxon), where source is a reference to the name of the classification system and taxon is a reference to one or more particular terms within a taxonomy. A taxon is a node that has a defined label or term, and an ordered list of taxons creates a taxonomic path

9.3 Description: A unique description of the LO relative to the stated purpose

9.4 Keyword(s): Keywords and phrases (zero, one or more) descriptive of the LO relative to the stated purpose

The LOM classification model is flexible and enables classifying using well-known public taxonomies as well as taxonomies created for a specific purpose. However, in terms of the research described in the [30] article, category 9 Classification should be extended in two dimensions:

1. Classification with regards to pedagogical design is not considered explicitly in any label of the value space recommended in the standard. An obvious extension is to include a generic purpose like "design rationale".
2. Several classificatory scales do not use nominal scales (sets of values) since classification is rough or fuzzy to some extent and thus it has a specific degree. This degree can be specified using ordinal labels or real/integer numeric scales.

[30] describes a case study that evaluates the general pedagogical dimensions proposed by [31] to classify learning resources.

Reusability of LO is thus dependant on the quality of their metadata records. Metadata enables software agents or software systems to select LO from global repositories for some given search criteria. One of these criteria is the classification of the resources into one or several classificatory frameworks. The above mentioned paper focuses on the classification of LO according to their pedagogical properties. Pedagogical classification is understood here as tagging the LO's with schemes that characterize them according to the pedagogical standpoint that was used to create them, or to the actual pedagogical orientation of their constituent learning contents and activities.

Pedagogical frameworks or toolkits are useful tools that support the development of pedagogically driven approaches to e-learning. These tools can be used also as an instrument to classify LO's, supplementing criteria of a different nature.

With regards to learning activities design, one the most detailed toolkit is the one described in [31]. The classification ranges of [31] for learning activities design can be considered as a kind of "ordered categorical" scale, or better, as a type of Likert scale, if we consider that the qualifying scale of each component is a set of levels separated by a same distance. The toolkit used as the basis for the study considers six components to determine criteria on the nature of the LO's. These criteria enable the evaluation and are the following:

1. A LO has individual nature if the individual is the main object of the learning.
2. A LO has social nature if the learning is carried out by means of the interaction between the student and other people, like a tutor or other students.
3. A LO is of reflection nature if conscious reflection exists on the educative experience, by means of which the experience is transformed into learning.
4. A LO is of non-reflection nature if the learning is explained by means of processes like the agreement, the pre-conscious learning, memorization, or learning of capacities or abilities.
5. A LO is based on information if there is an external body of information (text or other elements) that conform the base of the experience and the fundamental material for the learning.
6. A LO is based on experience if the learning is reached by means of the direct experience, the practical application and the development of activities.

The authors of the toolkit provide classifications for a number of theories or approaches to learning design, along with concrete criteria for the design. However, the classification of LO's is not explicitly addressed in their work.

To define the different types of LO, [25] using the four levels of granularity proposed in IIIIE LOM [28].

These authors, referring to skills development, mention the importance of the use of educational resources and classify them into resources for learning: a) data and concepts, b) procedures and processes, and c) attitudes and values. For each of these types of resources are listed related capabilities, examples or types of related resources and types of activities.

[32] includes the definition of a new class of learning design objects that combine two types of knowledge: (1) reusable knowledge, consisting of theoretical and practical information on education design, and (2) knowledge of reuse, which is necessary to describe the reusable knowledge using an extended LO metadata language.

Moreover, [33] propose a categorization of LO based on the Purpose sub-element of Classification, using values of idea, prerequisite, educational objective, educational level, and skill level values. These values are likely to be words that are already used by lecturers and teachers in the course of their teaching. There can only be one each of these values per Purpose element, but every value does not have to be used.

- i. The idea value of the Purpose relates to the concept contained in the resource.
- ii. Prerequisite refers to the knowledge or skills necessary before the learning resource is attempted.
- iii. The educational objective relates to end goal of the LO.
- iv. Educational level is the cognitive or grade level for which the resource is intended.
- v. The skill level value has no recommendations in any of the Learning Object Metadata profiles.

[34] also identified the IEEE LOM categories, to be related with competence properties of learning resources: the Educational Category via the Difficulty element and the Classification Category via the Purpose element.

More specifically, the IEEE LOM Classification category describes a LO in relation to a particular classification system. In sub-element Purpose (Nr 9.1) they use the "competence" value to state that the purpose of the classification is defining the competence that is the intended outcome of the LO. This element contains a specific vocabulary (prerequisite, accessibility, etc.) that must be updated with the "competence" value.

4 CONCLUSION

This paper depicts a literature review in order to gather the terminology used as well as the dimensions addressed during the definition of the LO. The literature review shows a lack of consensus in the terminology, in this sense, different dimensions to define a LO have been proposed: What is?, How it is supported?, How is it? and How it is used?

Regarding the classification, the growing use of internet in the field of education is promoting the creation and use of LO's of all types: cases, models, virtual laboratory experiments, simulations, and many other electronic resources.

There are several researchers who propose ways to classify these LO's but one of them seems to have greater acceptance; the used in the LOM [28] in the "Classification category". From a point of view of this "classification" category, the diversity in types of LO's is especially indicated by the three properties: aggregation level, interactive type, and resource type.

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