# TRENDS IN THE IMPLEMENTATION AND MANAGEMENT OF THE LEARNING DESIGN UNDER THE IMS LEARNING DESIGN STANDARD

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**Abstract**

After having published an educational modeling methodology based on the IMS Learning Design standard, this paper intends now to promote the application of this methodology by introducing a prototype of Learning Units Repository which strictly follows the aforementioned standard. It also includes a preliminary work on the conception of a domain specific language for educational modeling, which will serve to train the teaching staff in the design of their didactic plans; as well as to generate said Units of Learning (UoL) in a formal, systematic and simpler way than the applications that currently exist. By producing the UoL in a generic and well-founded way, the teaching staff will have improved their teaching work at the same time that they will be able to feed the repository and thus share their learning designs globally.

**Keywords:** Educational Modeling Language , IMS Learning Design, units of learning , repository of learning units.

## 1. Introduction

The need for a bridge between basic learning research and educational practice has been discussed for a long time. The functional value of this type of bridge would be its ability to translate the relevant aspects of learning theories into optimal instructional actions (Ertmer

and Newby, 1993). As described by Reigeluth (1983), the field of Instructional Design performs this function. This paper aims to show the processes of production and management of UoL when designing and implementing a prototype of a Learning Units repository, including some elements of instructional design such as the preparation and selection of teaching and learning activities, educational materials related to the actors of the process and its realization in the classroom and even its possible use in the Learning Management Systems (LMS) such as Moodle (Dougiamas, 2003), Canvas (Instructure Inc., 2019) or Blackboard (Blackboard Inc, 2019). The above implies knowledge that will be acquired by knowing and understanding the distance learning standard IMS Learning Design (IMS-LD). It is also mentioned how educational modeling is carried out following the IMS-LD standard with existing software and how it is planned to generate UoL through the design and elaboration of a Domain Specific Language (Hudak, 1998) for Educational Modeling, of which we already have some advances, which will serve to help the instructional designers or teachers of technological superior education or the personnel in charge of making the learning or didactic designs, in general to the personnel involved to develop didactic plans and that they will put into practice in the classroom or move such planning to any LMS. The Educational Modeling Language (EML) (Koper, 2000, pp. 19-25) that we have planned to design and develop should be easier to operate than the current systems that exist to generate UoL and that have not been very successful in using them, but In turn, it should allow modeling the learning design as detailed as the standard requires and generate the UoL under the IMS-LD standard (Global Learning Consortium, 2003).

Until now, a methodology has been published in congress to generate UoL with tools that already exist (Arroyo et al., 2013). Now we have already implemented a repository that accepts UoL generated with this methodology, however we want to go further; proposing to implement an EML that helps to develop the teaching-learning designs in a more automatic and simple way, without ceasing to be, therefore, valid and formal planning. This work is briefly described below. In the section 2 some aspects of the EMLs are provided, in the section 3 several characteristics of the IMS-LD standard are specified, later in the section 4 it is mentioned what is a DSL and some examples of these. Before concluding, the advances in the implementation of the DSL for educational modeling (DSLEM) and how the implementation

of the repository of UoL was made are briefly described in the section 5; which is publicly available on the Internet, finally we give some conclusions and mention, as a possible work in the future, the actions to be carried out to develop the DSLEM which would fully consolidate this project.

## 2. Educational Modeling Language

Originally Koper (Koper, 2000, pp. 19-25) defined, in a simple way, an Educational Modeling Language (EML, for its acronym in English) as: *The notation method for education in electronic learning environments*, he also called it as: *A system of notation for units of study* where that system of notation has some of the following basic assumptions:

(a) *Formalization*, must formally describe the units of study

(b) *Pedagogical flexibility*, should allow to describe units of study based on different educational philosophies.

(c) *Explicit instruction method*, must explicitly record the structure of the didactic components.

(d) *Completeness*, must be able to fully describe a unit of study, including all content and all activities of all students and staff members. And regardless of whether these aspects are for face-to-face education or distance education.

(e) *Reproducibility*, must describe the units of study so that its repeated execution is possible.

(f) *Reusability*, should allow to identify, isolate, decontextualize and exchange useful components, and reuse them in other contexts.

(g) *Interoperability*, should allow to isolate between the standards that are used to specify the units of study and the technique used to represent the units of study.

Koper (Koper, 2001, pp. 3-12) also offers the concept of unit of study as the smallest unit that offers learning events for learners, which satisfies one or more interrelated learning objectives, where this unit of study is the result of an instructional design process and this one

should consider some of the following characteristics:

- the roles (*roles*) of the teaching staff and students in the learning process
- the learning objectives and target group
- the prerequisites of the learners
- other characteristics of the student (learning styles, environmental circumstances, etc.)
- el dominio del aprendizaje (por ejemplo, las matemáticas son diferentes de las ciencias sociales)
- the domain of learning (for example, mathematics is different from social science)
- the assessment of learning

It is truly complex because for the design of a study unit it must be considered that each activity has a role associated, that is, it must be done by the student or by someone from the teaching staff, the environments can include learning objects, exams, investigations, presentations, etc., Ortiz (2011) offers a more concrete concept of the Unit of Learning (UoL), also referring it as a unit of study, *to the smallest unit that provides educational events to students, satisfying one or more interrelated educational objectives*.

On the other hand, Rawlings Rawlings et al. (2002) cited in Ortiz (2011) define an EML as: *Model of semantic and binding information, which describe the content and process within a Unit of Learning from a pedagogical perspective to allow its reuse and interoperability*. In the same paper Rawlings offers another definition of an EML developed by the Open University of the Netherlands (OUNL-EML) as: *A semantic specification, based on a pedagogical meta-model, which describes the structure and processes of a learning unit* (Rawlings et al., 2002). That *method of notatio*n or *system of notation* to which Koper refers and the *Model of semantic information* mentioned by Rawlings, from our point of view, can be summarized as the *pedagogical meta-model* that is specified in the OUNL-EML; since if we consider a UoL as the basic element of a didactic design which is a specific instance of a *pedagogical model* (by objectives or competences) and in turn it is an instance of a *pedagogical meta-model* (Ortiz, 2011, pp. 33-34); then an EML is a *model of pedagogical models* used to formalize the

teaching-learning processes.

It might be easier to use an Instruction Design Editor, such as Reload LD Editor (Milligan et al., 2005), instead of creating and using an EML. Reload LD Editor generates UoL according to the IMS-Learning Design standard (Global Learning Consortium, 2003) however the use of this editor has not been generalized, so we want to offer an alternative that can be easier to use but equally formal and valid to generate the UoL.

# 3. IMS-Learning Design

IMS Learning Design (IMS-LD) is defined as a specification of a model to represent and codify structures and learning methods for the different actors of the learning process (Burgos et al., 2007). IMS-LD is a formal specification that aims to standardize learning processes in order to be reused, which involves the different actors, activities, environments, methods and contents, which forces a formal structuring of the learning processes generating UoL (Arroyo et al., 2013). Technically IMS-LD involves a formal specification in Extensible Markup Language (XML) (W3C, 2008), so any learning design can be validated according to this specification (Global Learning Consortium, 2003). IMS-LD has the advantage of being able to represent a great variety of proposals and educational theories so that the teacher adapts its resources and didactic instrumentations to virtual or face-to-face classes in a completely flexible way. IMS-LD not only shows activities sequentially or as a list of learning objects, rather, this model offers diverse characteristics to generate adaptive, dynamic and personalized learning by describing different roles, activities, environments, methods, properties, conditions and notifications (Burgos et al., 2006). According to IMS-LD, a method can include one or several representations (plays), a representation consists of one or several acts, each act can be constituted of one or more roles, either of learners or of the teaching staff, a role can be perform one or more activities—teaching or learning—, and in turn each activity may contain a learning environment with objects or learning services.

Another important characteristic of the IMS-LD model is that it is formed by three levels, each level specifying functions to the UoL. Level A: provides methods, course, acts, functions, roles, activities and learning environments. Level B: provides properties, conditions,

calculations, control services, and global elements. Level C: adds feedback to Level B, which are notifications that are automatically executed in response to events that originate in the learning process. By instance, if a student submits a work to be evaluated, which could be uploaded to an LMS, at that time, automatically, it informs the teacher by means of an email (Burgos, 2008).

# 4. Domain Specific Language

A domain specific language (DSL) is a programming language designed for a particular application domain that allows raising the level of abstraction of a more complicated language. The characteristics of an effective DSL are: the ability to develop complete application programs quickly and effectively. Common examples of DSLs include LEXX and YACC to generate lexical and syntactic parsers, PERL for Text manipulation, VHDL for hardware description, TEX and LATEX for document preparation, HTML and SGML to specify document labeling rules. Tcl / TK to create graphical interfaces GUIs, VRML and OpenGL for 3D graphics, Mathematica and Maple to perform symbolic computation, AutoLisp and AutoCAD for computer-aided design (Hudak, 1998).

Historically, raising the level of abstraction of programming languages has been a common goal in all paradigms. The change in the level of abstraction allows to hide the difficult and complicated details closest to the machine, thus enabling non-expert programmers to build solutions. A simple method to raise the level of abstraction of programs, is producing interfaces that hide the low level of instructions, grouping them into modules and composing so-called libraries. Another more sophisticated method is to develop a new programming language that includes principles and abstractions in a consistent way; that is inspired by the domain of the application, which would imply writing a compiler that would be adequate but more delayed and laborious to implement. The so-called Domain Specific Languages (DSLs) provide a powerful solution for performing high-level abstractions (Arroyo, 2012, p. 154). Domain-specific languages allow users to directly express the concepts of particular domain in their programs and thereby eliminate the unexpected complexity that results from implementation details that are not convenient for that domain (Ratiu et al., 2012).

Inspired by the work of Arroyo et al. (2011) where they present a DSL, as a set of functions, to encapsulate the instructions of a language for computerized numerical control (CNC) machines; which allows them to raise the level of abstraction of the CNC language to develop CNC programs in a more friendly way; and be more productive with its library of functions that encapsulate many CNC instructions. In this project an educational modeling methodology was already published to generate UoL (Arroyo et al., 2013) in which its objective is to improve and strengthen the teaching and learning process in technological higher education in face-to-face, distance or blended mode; the methodology specifies how to model UoL applied to an educational system implemented in the Technical Institute of Querétaro called Remote Classroom Education (EPaD, for its acronym in Spanish), and clearly shows the procedure to generate UoL using the Reload LD Editor application University of Bolton (2008). The methodology is available at `http://www.cb-ciidet.com/garroyo/IMS-LD/`. Now, looking to fulfill the objective of training the teaching staff with little or no pedagogical knowledge, the following section exposes the design and implementation of a UoL repository prototype, as well as the preliminary work in a DSL language of Educational Modeling based in the specification of the IMS-LD standard.

# 5. Implementation of UoL repository

After publishing the methodology of educational modeling to generate UoL, we plan to continue with the development of DSL exclusive for educational modeling (DSLEM) that possesses a higher level of abstraction and that allows us to produce UoL in a more simpler, valid and formal way than the current tools to generate UoL under IMS-LD. This educational modeling language will couple the vast semantics of instructional design that IMS-LD implies with the limited knowledge of educational planning of many technological higher education teachers.

Haskell was used as host language, Haskell is a modern functional language, one of the best tools of the functional programming paradigm that exists today (Peyton-Jones, 2003). A library called HaXml was also used, written in Haskell, which has a collection of tools to analyze syntactically, filter, transform, and generate XML documents (HaXml, 2013). Firstly,

the formal IMS-LD schema, which is in XML language, was translated into a DTD type definitions file, later, with HaXml utilities and with some retouching to the DTD, the IMS-LD DTD was translated into Haskell types definitions; obtaining a very unfriendly definition system, as expected. It was considered directly to translate the formal IMS-LD scheme to Haskell types definitions, conceptually HaXml allows it, however the full translation has not yet been achieved.

It is necessary to work with the formal scheme of IMS-LD translated to Haskell and be able to program in this environment to model UoL with the level of abstraction required. According to the previous experiments it is determined that it is necessary to analyze, in conjunction with the creators of HaXml, the reason why such a tool does not allow the translation of the IMS-LD scheme to Haskell type definitions, when this is achieved, it will be possible to program the learning designs in this environment. At the moment that the UoL programming in Haskell is mastered, we will proceed to raise the level of abstraction generating function definitions that will be part of the new DSL of educational modeling, and even; at the end, translate these Haskell UoLs into the original XML language of IMS-LD. With which we will have achieved one of the objectives that is to generate the DSLEM; an educational modeling programming language that hopes to be simple and powerful to develop the UAs in a systematic way which will help to provide learning designs to the repository.

Parallel to the development work of the DSLEM; It was investigated the issue and the implementation of a repository of UoL in order to manage these UoL in a simple way. The repository allows above all to share the UAs, which is one of the objectives of the project. The work consisted first of knowing and understanding the IMS-LD standard, then generating UoL according to the published educational modeling methodology, this helped to better understand the IMS-LD standard. Later, and more technically, it was investigated on the XML technology to understand the formal specification of IMS-LD. To extract the information from the UoL, which is, in XML format; XMLDOM (W3schools, 2019) was used and XPATH (W3C, 2017b) was used to navigate between the XML design elements. The web application was developed using a local WAMP server (WAMPSERVER, 2019), then the web application was moved to a public web server where the development was continued. Other tools to design the repository are PHP (PHP, 2019), HTML (W3C, 2017a), MySQL (Oracle, 2019) and the

Web publishing service.

The repository has a database table consisting of the following attributes: a key, the name, description and metadata of the UoL; the names of the subject and the curriculum where this learning design is applied were added very aptly. Four views were created for the application: a welcome view to the repository, another to upload the generated UoL together with the necessary information, the third to search the UoL that have been uploaded in the repository and a fourth view where we can browse the information of the selected UoL to be reproduced. Other repository features are:

1. store the learning designs, this is to store the UoL
2. show the roles of the actors in the learning process of a UoL
3. show the learning objectives of the UoL
4. show the activities of the roles of that UoL

The web address of the repository is publicly available at `http://www.cb-ciidet.com/UAS/index.php`.

# 6. Conclusions and future work

The background of a modeling project of learning units has been presented which consists of a modeling methodology of learning units as well as the preparatory work of a domain specific language for educational modeling (DSLEM), in addition to a repository of units of learning. The methodology was already published in congress and allows to generate the learning designs based on an e-learning standard called IMS Learning Design (IMS-LD) using a free access software called Reload LD Editor and applied to an educational system implemented in the Technological Institute of Querétaro. Preliminary experiments have been carried out for the development of the domain specific language of educational modeling, with which it is hoped that it will be possible to generate the learning units in a more agile and systematic way, however this tool is not yet finished. On the other hand, the prototype of learning units has already been released and its use is publicly offered.

With the initial work of the development of the DSLEM, the problems and the actions to be followed to complete the project have been determined, it is necessary to perfect the tools of the translation software of the IMS-LD definition scheme; to a more complete, flexible and powerful language such as Haskell, which allows us to raise the level of abstraction of the original standard that involves IMS-LD. The drawbacks that are delaying this part of the project are well identified, which will focus the necessary resources to overcome this problem. Finally, having the three tools: the educational modeling methodology , the DSLEM and the UoL repository; the objective of training the teaching staff in the subject of learning design, also known as instructional design, can be met.

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