

LSI Dept / TR-2002-01
Universidad Nacional de Educación a Distancia



Technical Report

PALO Language Overview

Draft version

Miguel Rodríguez-Artacho

*LSI Dept.
UNED University
miguel@lsi.uned.es*

The Universidad Nacional de Educación a Distancia (UNED), is similar to other Spanish public Universities.

It awards the same qualifications, which are equally valid and it is run under the same general legislation. However, the special features of UNED make it different from most other Spanish Universities. This is due to the fact that it is nationwide in scope, uses different methodology, and has a wide social influence. The University Reform Law in Spain ensures UNED the same degree of autonomy as the rest of Spanish universities. The law states that UNED is to provide distance education throughout the country. It is UNED's teaching methodology, what actually makes it special within the spectrum of Spanish higher education. The keystones of this methodology are printed and audiovisual teaching material, tutorial teaching, and an ever-increasing use of new information and communications technologies. UNED is going to commemorate the 30th anniversary of its foundation. The University is fully consolidated and recognised by both Spanish and international educational fields. The Statutes of UNED describe its various functions as follows:

- a) To provide preferential access to university and further education for all those who, while capable of pursuing higher studies, are unable to attend on-campus classes for working, financial, residential or any other similar reasons.
- b) To set up and develop programmes for further education and for cultural and professional improvement.
- c) To use the most appropriate techniques and experience for distance teaching and to try out new educational models, with the purpose of serving both students and any Universities or Institutions with which it holds cooperation agreements.
- d) To create a wide and varied university community based on scientific and cultural knowledge, that will serve to unite and to encourage progress and solidarity in the towns and regions of Spain.

e) To carry out scientific research in all fields and at all levels.

f) To promote continuing education and to update and promote university teaching, research, administrative and service staff.

UNED has its buildings located in four different areas in Madrid:

The Government and Administration building is located on *Bravo Murillo, 38*, and contains the following offices: Rectorate, Vice-Rectorates, General Secretariat, International Relations, Institutional Relations, Financial Departments, CSI (Computer Centre). It also houses the following Sections: Student Service, Grants and Financial Aid, Information Coordination, Student Participation, COIE, Continuing Education, Study Centres (Overseas Students and Prisons), Research, Sales, Registration, Public Information and the University Bookshop.

UNED currently has three buildings on the Madrid University Campus (*Ciudad Universitaria*): the Faculty of Psychology, the Higher School of Industrial Engineering and the Centre for the Design and Production of Audiovisual Materials (CEMAV).

The other four buildings are on *Senda del Rey*. One of these is the Science building which contains the Faculty of Science and the *COU-Selectividad Section*.

The second building is the Humanities Building and houses the Faculties of Philology, Philosophy and Educational Science, Geography and History and Political and Social Science, as well as the Foundation course for over 25 years-old, and the University Institute of Distance Education. The third is the Library building and the fourth houses the Faculty of Economics and Business Studies.

The offices of the Open Learning, Teacher Training and Physiotherapy and Nursing certificate recognition Programmes are located in *Conde de Peñalver, 38, 3rd floor*.

LSI Dept/TP—2002—01
Universidad Nacional De Educación A Distancia



Technical Report

PALO Language Overview

Draft version

Miguel Rodríguez-Artacho

*LSI Dept.
UNED University
miguel@lsi.uned.es*

January 2002

Acknowledgements

STEED Project and the development of PALO Language was supported by the Spanish Ministry of Science and Education.

PALO compiler was originally developed by M. Y. Calero thanks to a grant from the Comunidad de Madrid

Available from:

Dept LSI - UNED
Ciudad Universitaria s/n
28040 Madrid
Spain

This report is also available in electronic form at <http://sensei.lsi.uned.es/palo>

Contents

INTRODUCTION.....	3
DESCRIPTION MODELS OF AN EML: THE PALO APPROACH	5
Information Model.....	5
The Semantic Model	5
Classification of the entities of the information model	6
Layer 1: Educational content	7
Layer 2: Task and collaborative level	7
Layer 3: Structure Level.....	8
Layer 4: Scheduling and sequencing level	8
Layer 5: Management level	9
AN INSTRUCTIONAL TEMPLATE OF PALO LANGUAGE	11
Information Model.....	11
Level 1: Educational Content.....	11
bd_element	12
bd_relation	13
glossary.....	13
explanation.....	14
as_is.....	14
Level 2: Task level	14
task.....	15
essay.....	16
questionnaire.....	17
Level 3: Structure Level	17
Chemical lab	18
module	19
part.....	19
subpart.....	20
Level 4: Scheduling level	20
deadlines.....	20
prerequisites	21
Level 5: Management level.....	21
Object and Task DB.....	21
Metadata	22

Introduction

Educative Modeling Languages are a new paradigm to create educational material that provide an abstraction layer in the description of the content and learning processes within a course or unit of study. Recently, the EML-PT group at CEN/ISSS¹, has agreed with a general definition of an EML as *“A semantic rich information model and binding, describing the content and processes within ‘units of learning’ from a pedagogical perspective”*.

Using this approach, we can abstractly extend the description of learning material to larger units of study rather than individual learning objects or content packages, and incorporate the instructional methods for the unit.

Consequently, learning environments are reshaped as a collection of components that can be *modeled* and described by mean of an abstract information model that would consider its pedagogical features and properties. The information model can be bind into any syntactical notation, but mark-up languages like SGML and XML have provide an excellent bind due to the great amount of available tools, editors and parsers.

PALO² language is an open proposal of EML developed at the Department of Languages and Computer Systems at UNED University that provides an useful and maintainable representation for open web-based courses at UNED. At the same time, PALO is a main contribution to the work of CEN/ISSS Workshop on Learning Technologies and to the Project Team on EML.

This document describes the information model of PALO based on a five layer representational framework and a cognitive approach for modeling a given learning domain.

¹ <http://www.cenorm.be/isss/workshop/LT>

² <http://sensei.lsi.uned.es/palo>

Description models of an EML: The PALO approach

A learning material including content and processes can be fully described by an information model and the semantic interpretation of its entities.

An EML is a bind of this information model along with the appropriate tools to interpret and configure the formal description based on it, into a specific delivery format.

Information Model

We are used to view learning environments as computational systems, with a system architecture of software components and—occasionally— a reusable repository of content that is delivered to the learner. However, when describing learning systems as computational systems, there is a lack of abstraction to identify and describe system components from a pedagogical or an instructional point of view, rather than from a software perspective. In fact, the pedagogical and instructional features of that environment are commonly embedded in the architecture and hardwired as software logic.

Nowadays, a very important effort has been made to model and describe learning material and learning environments. However, learning material is not only a collection of passive learning content but, more extensively, a collection of pedagogical components, which includes the definition of learning processes, activities, and structure of content, thus making explicit the processes and the pedagogical features of the environment and considering learning content—as a passive content package— only one of the many kind of components of learning material.

Educational Modeling Language proposals come to solve this problem establishing a formal layer of abstraction to describe learning environments from a pedagogical point of view in the shape of an information model that could be bind into a description format like XML, SGML, among others.

Such a model needs firstly by a previous process of conceptualization in order to identify the elements of a learning environment based on a ontology of learning content and tasks.

The Semantic Model

An EML information model is a description, but not an implementation of a learning material. This information model—describing components and processes of the learning unit— is a collection of formal components that describe a meaningful behavior of a learning environment with the shape of a functionality, a tool, a chunk of learning content or a feature.

The implementation of an element of the information model in terms of a computational subsystem is carried out by mean of a process of *interpretation* or *compilation* of it, according to their semantics. As a consequence of this interpretation, an element can then be turned into a

variety of technologies or delivery formats. This interpretation is defined by the semantic model of the EML.

Thus, an EML has to consider both the information and the semantic model in order to firstly express and describe the learning unit and, secondly interpret that description in terms of a pedagogical/instructional functionality of the modeled element in the final delivery format. Also, where the information model is explicit and can be bind in a variety of representations —i.e., an SGML or an XML file—, the semantic associated to each one of the modeled elements is provided by the software logic of the PALO interpreter, compiler or processor.

Pedagogical model is provided in PALO by mean of a variety of arrangements of the different elements of the information model called *instructional template*. Different instructional templates provide a collection of features that creates an specific pedagogical aim for the PALO description file.

Authoring process in PALO has therefore a first stage based on the selection of the appropriate instructional template, and secondly, a stage of creation of the PALO description according to it.

Classification of the entities of the information model

Learning environments are composed by a variety of components with different pedagogical meaning and behavior.

According to this, their corresponding elements of the information model can be, at the same time classified or scaffold in a certain number of *categories* of elements or entities called *layers*.

A layer expresses information about a certain kind of components, processes or functionalities of a learning environment, and provides at the same time a coverage of all the aspects involved in describing a learning environment.

At the moment, the PALO approach considers the following layers:

- **Layer 1:** Educational Content
- **Layer 2:** Activity and cooperative model
- **Layer 3:** Structure
- **Layer 4:** Sequencing and Scheduling
- **Layer 5:** Management

Each layer, for a given template will contain a selection of elements from the information model. Whether to create elements of the information model for all these categories or not, depends on the template.

At the same time, the utility of this classification is also to provide a framework to compare different EML proposals.

Layers are described in the following sections.

Layer 1: Educational content

This level describes the elements of the information model referred to the insertion of educational content. This content can be any chunk of knowledge of any kind but without associated processes or context. Pedagogical context will be provided by specific attributes or by mean of other aspects of the description at a different layer.

A text, a description, an external reference, a document or a learning object can be considered learning content.

Examples of types of learning content elements are:

1. A chunk of plain text or formatted text
2. A package of learning content described with any standard format like IMS
3. A learning object retrieved from an external source or repository (ARIADNE)
4. Learning content retrieved from a Domain Model of a given matter

Other types can be also considered depending on the granularity of the learning content, that at the same time compromises the degree of reusability and interoperability. In the example of the types provided, type 1 is the only one that is not reusable —as it is not labeled or retrieved—, which should not imply that is not a valid type of learning content that could be turn in a reusable type if that is the case. At the same time, types 2 and 3 correspond to a bigger granularity level than 1 and 4.

EML's in general, must provide flexible mechanisms to incorporate these kind of learning content, and any others. In order to be interoperable with existing standards, some of these mechanisms must consider existing proposals.

Layer 2: Task and collaborative level

Learning processes are a central issue in learning environments. The main contribution that EML's can do in this respect is to provide a representational framework for a variety of activities from a simple quiz to a complex activity within a collaborative process.

From the PALO point of view, a task involves more than a description of the work to do, but covers other aspects of the process like the definition of the available resources and the tools provided to carry out the activity.

Abstract representations of an activity can be considered. Thus, for example, the abstract notion of activity from the social-cognition point of view provided the definition of the Activity Theory.

Other simpler reference frameworks can provide an useful format to describe individual activities.

From a collaborative perspective, the information model must provide a way to describe a collaborative learning activity along with its working community and a set of features, tools and resources. This information model can be based in a known theoretical framework like the one pointed above, or in any other.

Actual PALO implementation considers activities as individual tasks, but a representation framework of Activity Theory is been developed.

Layer 3: Structure Level

Structure level provide hierarchical decomposition of the learning environment.

This level provides an explicit description of the table of contents that can be incorporated to the information model. The utility of this hierarchy is that each one of these elements can have associated pedagogical properties in terms of:

- Establishing pedagogical dependencies between different parts of the environment (i.e. prerequisites)
- Associate assessment (some parts could be assessed separately from others)
- Usability (Facilitate access to some parts of the environment)
- User Interface (. i.e. the navigational model of an HTML delivery format is defined by the hierarchical structure of the EML)

To illustrate this definition, a learning environment structure could be a *course* that is composed by one or more *units of study* composed as well by one or more *parts* or *themes*.

Layer 4: Scheduling and sequencing level

This level consider time restrictions and pedagogical dependencies associated to certain components of the learning environment.

Scheduling consider information related to:

- Dependencies between the different parts of the components: This is the case of certain part or element to be prerequisite of some other component of the description. These properties are usually associated to the structure entities, but could also be associated to activities.
- Deadlines or any other schedule over the components
- Timing of an activity or an structure element.

All these consideration could be useful to configure the behavior of an environment. In some cases they could not be necessary, but some fields like experimental environments (i.e. chemical learning environments) could need these kind of restrictions.

Layer 5: Management level

This level consider the information necessary to manage the description in order to create a learning environment in a certain delivery format.

Management information is handled by the processing tool of the EML and is related —but not limited— to:

- Location of the repositories, resources or tools described
- Metadata

At the same time, this level could refer to the data models used during the exploitation of the environments. This would include for example the type of DBMS and the DB associated to the data model that would back-up the use of the system

An instructional template of PALO Language

PALO is an Educative Modeling Language designed to provide a definition level for open courses at LSI Department at UNED University, and to provide a high level of reusability and maintainability in the authoring of the academic material for the Computer Science Technical School.

PALO pedagogical model is based in the use of instructional templates, a set of elements of the PALO language that provide an specific functionality and a pedagogical schema.

Information Model

The information model presented here is the corresponding to an instructional template designed to describe an experimental environment for chemistry.

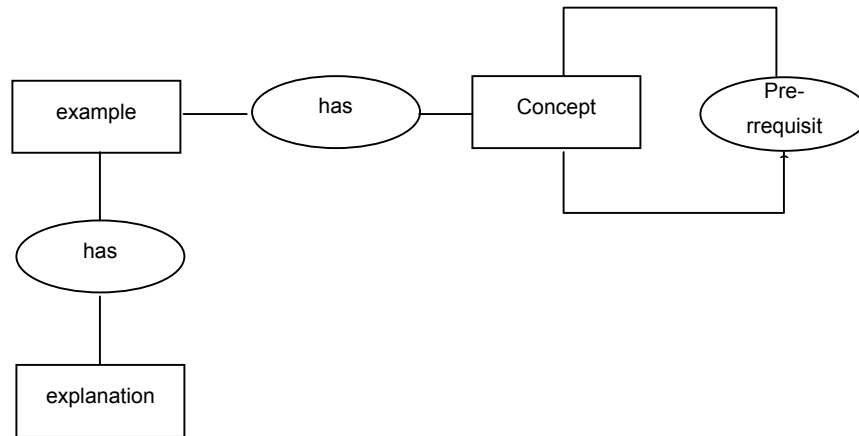
The elements of the template are described using a W3C schema representation derived from the DTD, along with the cardinality and composition of the different elements at each level of the description

Level 1: Educational Content

PALO has a content model based on a cognitive approach, which means that rather than encompassing a set of local or distributed "knowledge objects", PALO instead involves creating a course-specific repository of semantically linked material. For example, it is possible to assemble "concepts", "problems" and "solutions" for the domain of study and then link them together, so that you can provide "problems associated with concept x" or "solutions for problem x" in the unit of study.

In PALO, the construction of this themed knowledge base is a core aspect of course development. Thus, a previous work of conceptualization and definition of an *ontology* to describe the content matter must be carried out, in order to obtain a domain knowledge that describe the content and also the semantic relationships between the elements. These repositories have in PALO a common structure based in domains, entities and relationships to describe a basic matter ontology.

For example, considering a scientific/technical content, we could have a basic domain composed by *concept*, *examples*, *explanation* and *prerequisites*. Figure below shows these elements and their corresponding relationships. Access to this specific domain is performed by mean of three elements of the content layer to access entities, relationships and to create a glossary.

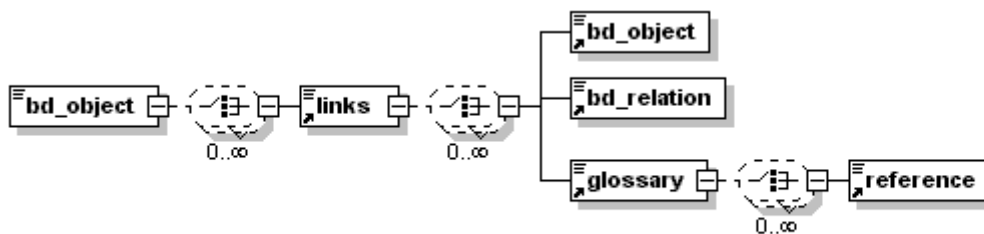


A basic ontology

Among them, elements of this layer used to access knowledge domains are `bd_object`, `bd_relation` and `glossary`.

bd_element

The `bd_object` element can retrieve an element from the domain located in an external repository. Objects are retrieved by identifying its domain, object name and category.



bd_object schema

The declaration of an object is recursive to allow nested access. This feature is implemented by mean of a `links` declaration. Once inside a link scope, the same structure apply to provide again a set of possible objects, relationships and glossary.

A `bd_object` declaration retrieves a concrete object of the domain.

bd_relation

A relation collects one or more objects semantically linked by mean of a relation of the domain ontology.

Following the example above, a *prerequisite* relation could be used to retrieve all the prerequisites of a given concept, as for instance, “examples of concept x” etc.

```
What are the
<RELATION NAME="Prerequisite" DOMAIN="Didactic"
  SUBJECT="catalyze" CATEGORY="Concept"> prerequisites
</RELATION>
of this concept?
```

As shown above, a *relation* is used to provide access to the prerequisites of concept “catalyze”. The word **prerequisites** will provide a link to access to the list of prerequisites.

glossary

A glossary is a collection of all the entities of a given category.



glossary definition

A “glossary of concepts” could be defined as:

```
<GLOSSARY
  CATEGORY="Concept"
  DOMAIN="Conceptual"
  ATR-LABEL="Name"
  ATR-CONTENT="Content"
  ORDER="alphabetical">
glossary of concepts
</GLOSSARY>
```

The phrase **glossary of concepts** will give access to a list of all elements of the domain that belong to the category *concept* ordered alphabetically.

A more complex form of glossary is provided for the case of involving relationships. For example having for each one of the concepts, a list of all the examples related to it. This can be done using the *reference* definition, which makes possible to involve a relationship (*has*) in order to create a second nested level.

explanation

An explanation is a word or phrase that give access to a chunk of plain or formatted text



An explanation schema

An explanation provide a mechanism to encapsulate an explanation or any chunk of content that has not been modeled or stored in terms of an external domain.

The explanation can provide plain text or formatted text content. Nested structures are possible by using the *content_explanation* element.

as_is

This element provide a mechanism to include formatted text into the learning material. Options available in PALO are LaTeX, SMILES and XHTML.

LaTeX provides a powerful formatting mechanism to embed scientific notation, tables and other complex structures into a learning content. SMILES is an extended chemical notation to provide graphical rendering of chemical formulae.

A mechanism to embed XHTML is also provided, but should be used with care in order to maintain integrity of the PALO description.

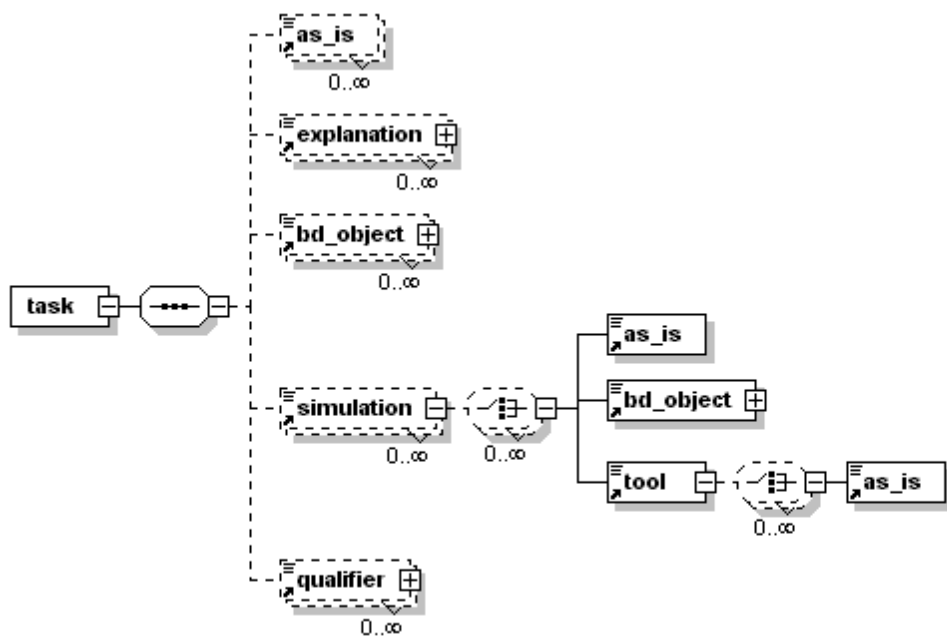
Level 2: Task level

Task level is defined by mean of *tasks*, *questionnaires*, and *essays*.

task

A task in the scope of a learning material must be understood as a learning process in which there are a set of components and actors. PALO provides a simple definition of task based in an individual learning approach that can be extended to a more complex activity definition based on a cooperation model.

Tasks in PALO assumes two actors: student and teacher (assessment) and a set of simple implicit tools provided within the scope of the task. At the same time, the task can have a description for which elements of the content layer are provided.



Task schema

An example of a task in PALO is defined below. User is asked to comment the result of a simulation stored in the domain model.

```
<TASK NAME="Task_001"
  TOOL_TYPE="text"
  LABEL="Comment" ASSESSMENT="yes">
  <SIMULATION NAME="simulation">
```

```
<ELEMENT DOMAIN="Experimental" NAME="s011"
  CATEGORY="Simulation" />
```

```
Perform this simulation
```

```
</SIMULATION>
```

```
Comment the above result. Why that hexogen reaction is produced?
```

```
</TASK>
```

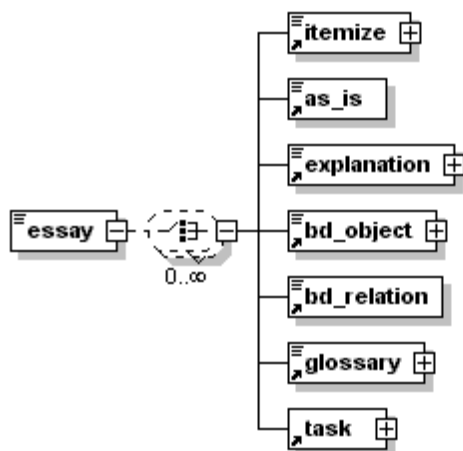
In the definition above, **Task_001** proposes to carry out a comment of a previous chemical process. Implicit tool provided by the task is a text editor (*text* value of TOOL_TYPE attribute) but could also consist in a quiz (*test*), or a file upload dialogue (*file*), among others.

When attribute *assessment* is toggled to *yes* the task is supposed to be assessed, thus providing additional functionalities in term of its semantic interpretation. When this is the case an optional *qualifier* element provides help to during the assessment process, including comments to the teacher about important topics that should be included in the student answer.

Simulation and tools provide additional elements to the task. A simulation is an internal or external process that has a result that can be obtained by *performing* the simulation. Simulations could also be performed by external tools or be part of the domain knowledge repository.

essay

An essay is a composition of heterogeneous tasks grouped in a single process to be assessed together.

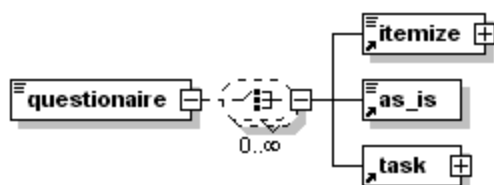


Essay schema

For the purpose of the instructional template used here, this grouping element provides an useful abstraction for a chemical environment.

questionnaire

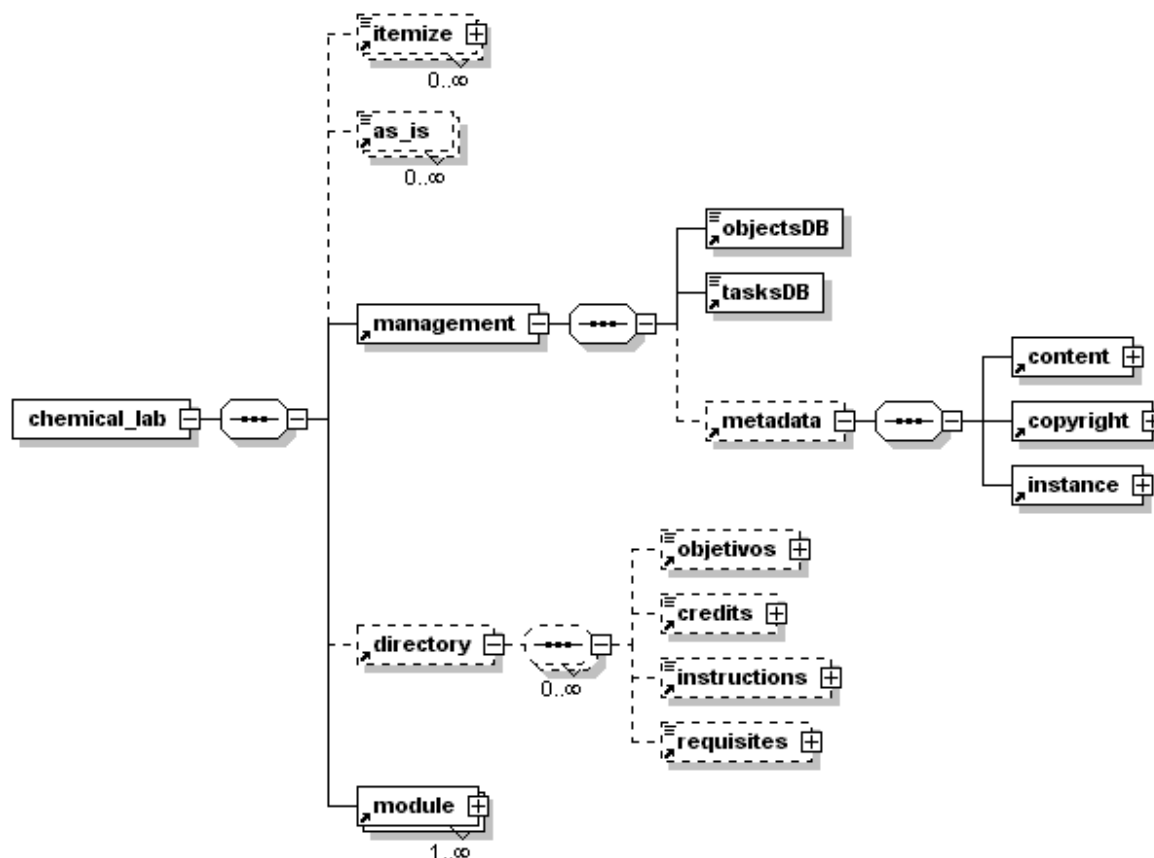
A *questionnaire* group a set of similar tasks, usually quizzes. A quiz is defined in each one of the tasks using the appropriate attribute set to *test*.



Questionnaire schema

Level 3: Structure Level

Structure level define elements to structure the learning material and provide a hierarchical model in the resulting learning environment.



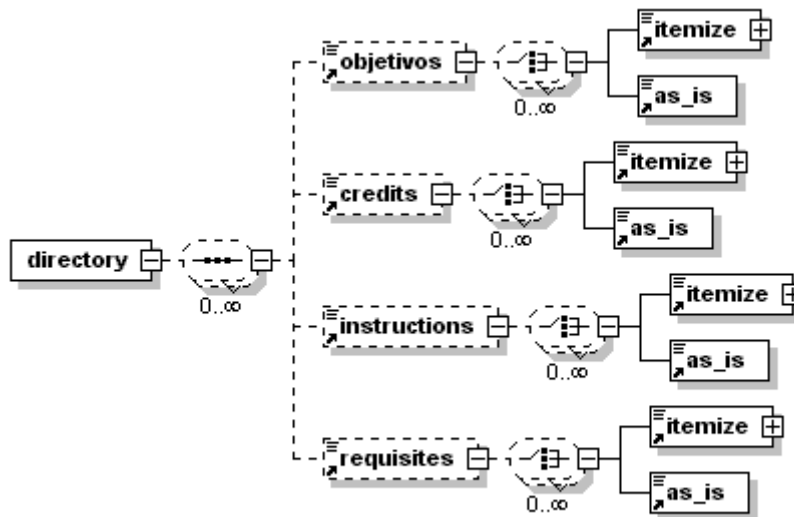
PALO templates provide a variety of structure elements, but a similar interface composed by fixed elements (*directory* and *management*) and one or more *module* elements.

Chemical lab

Top-level element of PALO in this template is *chemical_lab*, composed by management information related to the management level and a directory (optional) to guide the user within the learning material.

Directory is composed by the following items:

- Objectives: aim of the learning environment described
- Credits: Acknowledgements and author information
- Instructions: Instructions for using the environment
- Requirements: Technical requirements, previous background and administrative information



Directory schema

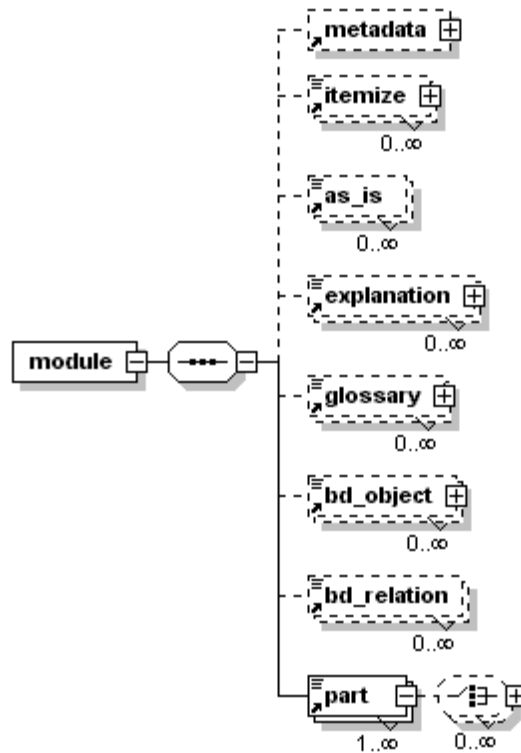
Finally, the main element of the template is the *module*. The PALO description define the document to be divided into one or more modules, each one divided into one or more *parts* and another hierarchy is provided as *subpart* element.

These elements are described in the following sections

module

A module defines the concept of minimal unit of study to be coursed by a student and assessed by the teacher. The definition follows the schema shown in the figure:

Module schema

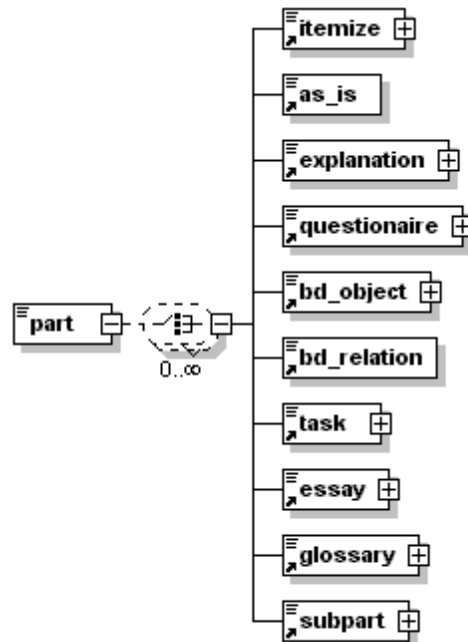


The module can contain a variety of learning content plus one or more *parts*. It provides the possibility of having its own metadata schema associated to it, but as an optional element.

The module element is interpreted as a unit of learning, containing a consistent group of tasks and learning content. It has been featured to contain scheduling information that will be explained later.

part

A part is a second level hierarchy with a simpler structure than the module, but containing processes in the shape of a task or group of tasks.



Part schema

subpart

A subpart is the last structure level of this PALO template. It is similar to the previous one, but with no more sub-structure elements. As the *part* described above, the *subpart* can contain learning processes in the form of tasks or group of tasks.

Also as pointed before, all structure elements define the table of contents of the final learning material, be it in the shape of a hardcopy document or a navigational model in a web-based learning environment.

Level 4: Scheduling level

Scheduling level is defined by mean of attributes of the elements described in the previous levels.

There are two main scheduling mechanisms defined in PALO: deadlines and prerequisites.

deadlines

It is possible to associate a deadline to the whole document or to each one of its modules.

Deadlines are interpreted in terms of software functionality associated to the final learning environment.

Deadlines are extensive to *modules and tasks*, which allow to separate the course into a certain number of steps.

prerequisites

Modules and tasks are featured with a prerequisite attribute.

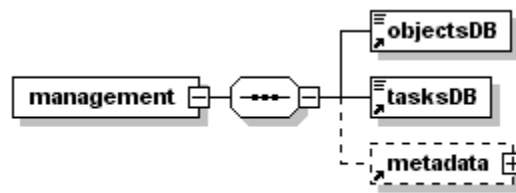
When defining a prerequisite for a module, it can be associate to the following conditions:

- Finalization of the previous module before its deadline
- Positive assessment of the previous module
- Complete one or more tasks of the previous module

In the case of a task, a prerequisite can be associated only to the completion of another (previous) task.

Level 5: Management level

Management level defines management information for the overall course or learning material described in the PALO file.



Management information schema

Object and Task DB

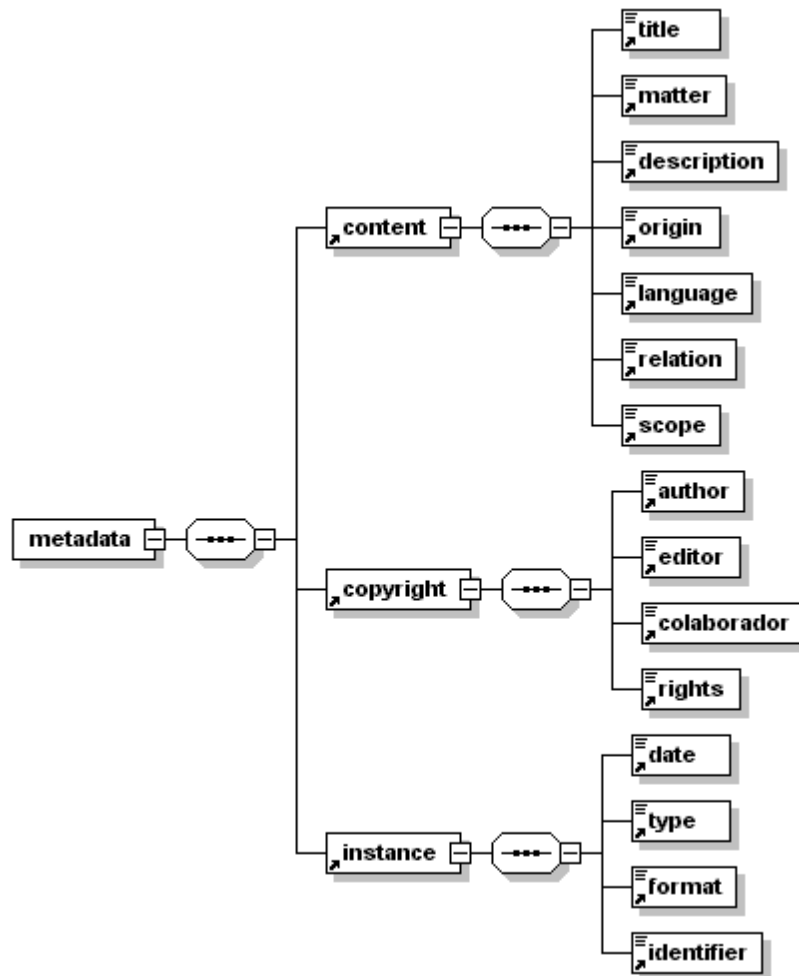
PALO considers two data models within the management information:

- Domain matter repository and learning objects database: This database contain the domain model repository of semantically linked material. One DB is allowed within the same PALO file
- Use and access database: This DB describes the management information of the final learning environment produced by the PALO compiler tools. PALO provides this element for this purpose only, and it should not be necessary in case the PALO file to be imported into an Integrated Learning Environment.

Metadata

Metadata information is associated to the course or unit of learning described in the PALO file.

PALO uses Dublin Core metadata schema. The resulting metadata fields are embedded in HTML META tags according to RFC2731 in the final learning environment.



PALO metadata schema