Semantic Web and e-Learning:
A pedagogical ontology of an e-learning platform

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Abstract
From its initial preoccupations : learning content layout and management, e-learning now concerns the whole process of knowledge transmission between distant people, e.g. taught resources and dependencies between them need to be described, educational activities must be planned, learners must be modelled and acquired knowledge must be qualified and quantified. Normalization institutes now provide sets of metadata that help these modelings. Using such standardized metadata as ground terms for an ontology of e-learning, we propose to enhance the capabilities of an existing e-learning platform, translating tasks in educational engineering, content management and learner tracking into inferences on the ontology.

1 Introduction

E-learning platforms integrate tools that contribute to the development of online resources, communication between learners and teachers, and the synchronous or asynchronous follow-up of learners. However, the quantity of online resources makes the task of organizing material into relevant pedagogical tracks more difficult. Now e-learning is a whole process with many actors -not physically present at the same place, but rather interacting with each other across the Internet: students, educational engineers, tutors, and teachers. This brings the need for new capabilities for e-learning systems: learner tracking, validation of knowledge acquisition, accurate presentation of contents to learner and learning management.

In the same time, the success of e-learning has introduced the scalability of the process as a central concern. The study which will be presented here implies 600 students, 40 teachers and about 10 gigabytes of teaching material, but the whole objective, for the University of Nantes, is to support 8,000 students, most of them being outside of the University's walls. Students, teachers and people with expertise in education or computers, organized in workgroups, supervised by national or international normalization institutes, have defined models for the e-learning process. These mainly take form of metadata models and models of relations between these metadata. Thus, to address the e-learning systems scalability issues and to meet the new requirements of understanding e-learning as a whole process, we propose to bring it to the Semantic Web by defining a RDF/OWL binding to learning metadata and by mapping educational procedures into inferences on the ontology.

2 Representation of the model

The e-learning platform P@D of the long-life training department of the University of Nantes, involves:

Actors of four types: _learners_, _tutors_, _teachers_, _managers_. Theirs models are standardized by IMS LIP [1] and PAPI [2]. PAPI defines several categories to represent personal data, relations and bonds between the different users, access control management, users' preferences, performance evaluation and parameters of this evaluation, and experiment tracking. In this paper, we will focus on personal data and performance evaluation.

Learning object: The learning object is a central concept in the e-learning. Several definitions can describe what a learning object is. Quoting the IEEE LTSC[3]'s one which considers that a learning object can be defined "*as any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning* ". It must be comprehensible by a machine and exploitable by tools, software, intelligent agents[1]. P@D uses the CanCore metadata fields [4] to describe the learning resources. The CanCore metadata standard is based on the LOM[2] standard, which corresponds to the IMS LRM[3] specification. It defines 9 categories to represent teaching resource characteristic, lifecycle of the object, metadata (data on metadata), technical requirements, educational (teaching characteristics), rights, relation (bonds between teaching resources), annotation, classification (classification system where can appear the teaching object).

Performance and teaching activity: The descriptor used to define the performance elements and the teaching activity is resulting from the *performance* category of PAPI specification [2]. This profile makes it possible to express the parameter setting informations of the teaching activity and of the learner's evaluation: date of the beginning and the end

[1] Tim Berners-lee «Metadata is machine understandable information about web resources or other things »
[2] LOM Learning Object Metadata
[3] IMS LRM Information Management System Learning Object Metadata

of the training experiment, type of the teacher's notation coding ([A-E],[0-20],…) and the learner's results (measurement value).

3 Ontology

From metadata to knowledge

This standardization effort brings a real improvement compared to a bare content management system. It gives an homogenous and explicit representation of the informations that were widespread on each actor's own. However, the possibilities of a new global vision upon the e-learning process raises new needs for knowledge representation and management, reporting and decision making from this knowledge, and for the automation of various tasks in education. RDF [5] is an answer to these needs.

The P@D platform's data being represented as both a relational schema and XML, and most and the standard metadata having XML bindings, is isn't too difficult to get RDF terms and statements to describe our process.

However, we used a top-down process to be sure that the produced ontology will correctly solve the targeted tasks. Thus, we defined OWL [6] classes of terms, relations between these classes and defined properties for the terms and the relations. All the properties are expressed as OWL terms. The terms and relations of our model are built from our platform model, using the standardized metadata.

Figure 1 shows a part of this model, associating learners' data with performance evaluations and learning objects. The diagram results of the ezOWL visualization plug-in of the ontology editor and knowledge framework protégé [7].

Edition of the model in the form of ontology

The structures XML and the approach RDF provide a support to the semantic Web without, however, being enough to express all the properties related to the data. OWL [6] is a response to the need for an ontology language for the Web; it adds more vocabulary to describe the properties and classes: relation between classes (disjunction), cardinality, characteristics (symmetry, transitivity…).

Figure 1 represents the diagram corresponding to the platform model studied previously. It's a representation resulting from the plug-in visualization ezOWL available under the ontology editor and knowledge-base framework Protégé [7].

Process of inference - New knowledge

OWL makes it possible to formalize the properties associated with the relations. Thus, the relation *relation.kind* has the transitive property, which makes it possible to express the transitivity of the relations *requires* or *isPartOf* [4]:

```
<owl:ObjectProperty rdf:about="http://www.cancore.org#relation_kind">
        <rdfs:domain rdf:resource="#LOCC"/>
        <rdfs:range rdf:resource="#LOCC"/>
        <rdf:type rdf:resource="http://www.w3.org/2002/07/owl#TransitiveProperty"/>
 </owl:ObjectProperty>
```

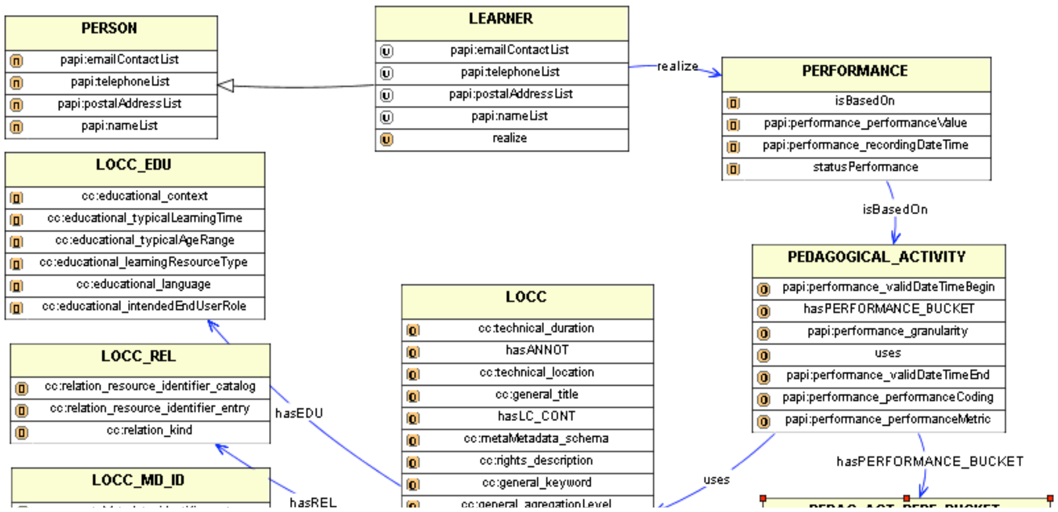
This property declaration gives a direction to deductive inferences, allowing, for example, to recursively determine the whole of the learning object requires. Thus, the following RDQL [8] query allows to interactively determine the learning object required by others and exploits the properties of this relation:

```
SELECT ?object ?requires  FROM < example >
WHERE (?object, < cc:requires > ,?requires),
USING cc for < http://www.cancore.org/>
```

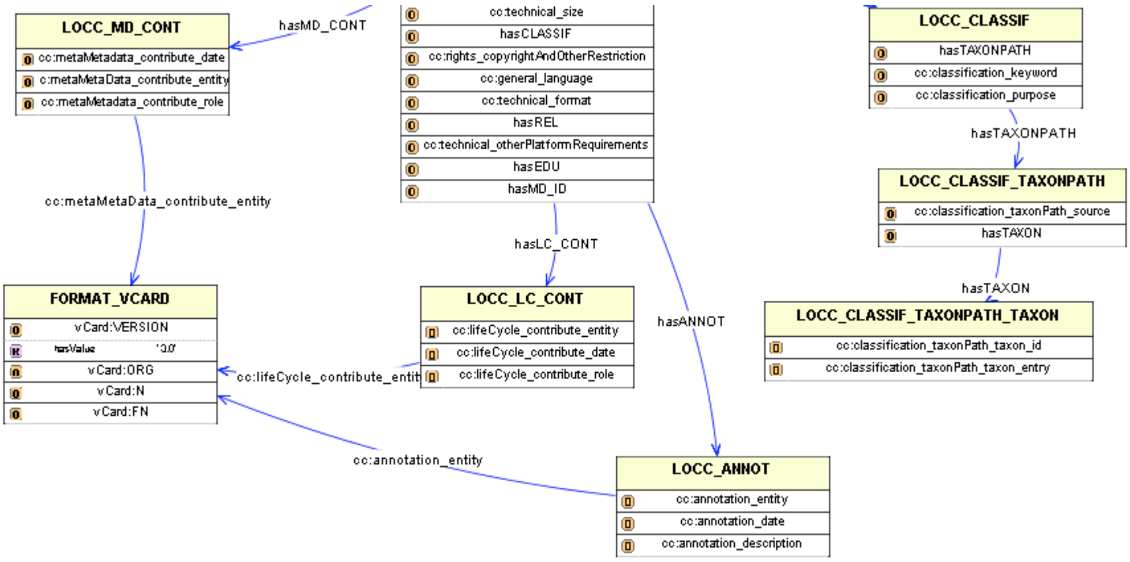
```
SELECT ?x ?z FROM < example >
WHERE (?x, < cc:requires >?y), (?y, < cc:requires >?z)
USING cc for <http://www.cancore.org/>
```

Conclusion

We approached, in this article, some interests of the knowledge representation in the context of an e-learning platform. In particular, we presented the use of standardized metadata languages, to form relations in RDF/OWL. Then, these descriptions can be used for educational engineering tasks. Today, for operational reasons, these inferences are realized from a relational data base. Our works in progress consist in exploiting this knowledge in RDF directly, by using specialized inference engines. At the same time, with this work, we also seek to formalize the knowledge obtained by learners, in order to connect the model of taught knowledge and the profile of knowledge actually acquired by learners.



[4] More precis



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