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Matching User Preferences with Learning Objects in Model Based on Semantic Web Ontologies

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Abstract: *The e-learning contained many educational resources are generally used in learning systems like Moodle, It's free open source software packages designed and flexible platform to create Learning Objects (LOs) and users' accounts. The author demonstrates how to use semantic web technologies to improve online learning environments and bridge the gap between learners and LOs. The ontological construction presented here helps formalize LOs context as a complex interplay of different learning-related elements and shows how we can use semantic annotation to interrelate diverse between learner and LOs. On top of this construction, the author implemented several feedback channels for educators to improve the delivery of future Web-based learning. The particular aim of this paper was to provide a solution based in the Moodle Platform. The main idea behind the approach presented here is that ontology which can not only be useful as a learning instrument but it can also be employed to assess students' skills. For it, each student is prompted to express his/her beliefs by building own discipline-related ontology through an application displayed in the interface of Moodle. This paper presents the ontology for an e-Learning System, which arranges metadata, and defines the relationships of metadata, which are about learning objects; belong to academic courses and user profiles. This ontology has been incorporated as a critical part of the proposed architecture. By this ontology, effective retrieval of learning content, customizing Learning Management System (LMS) is expected. Metadata used in this paper are based on current metadata standards. This ontology specified in human and machine-readable formats. In implementing it, several APIs were defined to manage the ontology. They were introduced into a typical LMS such as Moodle. Proposed ontology maps user preferences with learning content to satisfy learner requirements. These learning objects are presented to the learner based on ontological relationships. Hence it increases the usability and customizes the LMS. In conclusion, ontologies have a range of potential benefits and applications in further and higher education, including the sharing of information across e-learning systems, providing frameworks for learning object reuse, and enabling information between learner and system parts.*
Keywords: *Semantic Web, Ontologies, Moodle, E-learning.*

I. INTRODUCTION

E-learning is an alternative concept to the traditional teaching system and offers new possibilities in learning. Thus, a student can get immediate feedback on solutions to problems; learning paths can be individualized, and so on. E-learning is a growing knowledge. Thus, the number of organizations working on online learning and the number of courses available on the Internet is growing rapidly. [1].

The Semantic Web is the emerging landscape of new web technologies aiming at web-based information and services that would be understandable and reusable by both humans and machines. It wills predictable the Semantic Web technologies influence the next generation of e-learning systems and applications. And Ontologies are a major component of the Semantic Web, generally defined as a representation of a shared conceptualization of a particular domain. To take the development and widespread e-learning contents of semantic Web applications a step further, we have developed a Learning Management System (LMS) based on an infrastructure entirely designed using the technologies made available by the semantic Web, namely OWL, SPARQL[2]. LMSs are becoming increasingly popular now. Well-known LMSs include Moodle, whose focus has centered on distance education opportunities. Typically, Moodle includes a variety of functionalities, such as class project management, registration tools for students, examinations, enrolment management, test administration, assessment tools, and online discussion boards [3].

The most serious problems are caused by the semantic evaluation process. There is a great variety of LMS. As far as evaluation is concerned, current platforms may be helpful to acquire tacit knowledge in organizations, but they do not solve the problematic of doing automatic semantic information. Thus, cooperative cognitive processes are not efficient and not found matching between LOs and student information. In fact, Moodle lack for these properties. Thus, the augment of students per LOs can dedicate to each student. This makes the learning process to be impersonal, and not many users can keep track properly of their students' progress.

By bringing together the previous statements and the need for a good way in the cooperative learning, we spot the need for tools supported by intelligent techniques. A possible solution might include ontology components of semantic web technologies to deal with this issue. Some authors [4] utilize ontology based semantics to improve the analyses of information in unstructured documents. The domain ontology plays a central role as a resource structuring the learning content [5]. One of the key challenges of the LOs construction process is to identify the information abstract domain within which that will exist. The tutor has to describe the main terms and concepts from which a learning object is to be constructed.

The author has developed is part of the Moodle and explores the use of ontologies to develop an innovative Semantic Learning Management System (S-LMS). The S-LMS provides complete information and management solution for users and LOs. Our focus and main objective is to automate the different procedures involved when students enroll or register for class courses. Managing a large course it's a complex undertaking. Many factors may contribute to this complexity, such as a large number of students, the variety of rules that allow students to register for a particular course, students' background, and students' grades.

II. METHODS

The idea of learning object context emerged as a part of our efforts to facilitate learning objects' reuse and advanced levels of personalized learning. We define learning object context as a specific learning situation, determined by the learning activity, the learning content, and the (group of) learners involved. We conducted a small-scale observation of online educators' current practices and requirements. We included instructors and designers from one Sudanese universities, a well-known group of developers, researchers, and instructional designers from around the country. Most participants completed the survey, each providing highly informative comments. Among other important findings, all observation for participants reported a lack of matching between a learning object and learners' preference. We consider feedback to be information about observed learners' interactions either with learning content or with other participants in the learning process. We determined three levels of feedback based on the responses we received from the observation:

1. Detection of content that was hard for students to comprehend.
2. Identification of student difficulties at a topic level.
3. Identification of frequently discussed topics.

III. E- LEARNING SYSTEMS

The most typical form of e-learning systems on the Web today is through Learning Content Management Systems (LCMS), such as Moodle. It is a widely adopted technology that enables setting up online courses and managing the students' activities. In particular, LCMSs provide instructors with substantial support for numerous activities indispensable for securing high quality e-learning processes, such as preparation of learning content, structuring and organization of the content in accordance with the chosen teaching strategy, interactions with coordination of students' activities using online communication tools, that allows learners to collaboratively create and share knowledge, by adding highlights, tags and notes in learning content. The information coming from peers, for instance, how other students have tagged or commented a piece of learning content, is seen as an important factor in increasing students interest in course topics [6].

Even though state-of-the-art LCMSs successfully support a huge set of online teaching/learning activities, their support for adaptation of learning courses is very rare. This is due to the fact that support for adaptation of e-learning materials is much trickier and less straight forward; hence widely used LCMSs enable only simple content editing features for this purpose. However, instructors need much better support since they have to almost constantly adapt their courses both in terms of the included materials and the applied instructional design. When doing this, instructors have to take into account students' performance and interaction with learning content in order to better address the specific needs and requirements of each particular students group, and thus secure students' high performance and learning efficiency levels.

Learning control needs the comparison between the learner's knowledge base, which is modified as the learning process evolves, with the course domain knowledge base. It requires for powerful and interoperable tools of knowledge representation and analysis. A structured information representation is then required. For it, semantic domain information can be used as they provide for flexible and extendable properties to knowledge management systems. The motivation for developing reusable atomic learning components and to capture their characteristics in widely-accepted, formal metadata descriptions will most probably attract learning object providers to annotate their products with the accepted standards.

The goal of the early software tutoring systems was to build user interfaces that provide efficient access to knowledge for the individual learners. Recent and emerging work focuses on the learner control over the learning process such as learner exploration, design and construction. For it, adaptive systems are used as tools [7]. With the application of more and better computer techniques in education and the involvement of more adults in software tutoring systems, the learner control strategy has become more appreciated than tutor or program control.

An important component of e-learning is students' knowledge and LOs preference. One of the main problems for the creation of matching systems is interoperability, i.e. the opportunity to reuse this knowledge in different processes. To organize knowledge exchange between various events, it is necessary to create some universal format of knowledge's preservation and their processing instructions. An important requirement for this format is that it should be platform independent. Standardization of educational technologies and, in particular, formats of match data preservation is being worked out all over the world.

A. Moodle

Moodle is an open source Content Management System (CMS) in which activities are at the heart of the system. Moodle was designed on base of social constructivism. Constructionism asserts that learning is particularly effective when constructing something for others to experience. The students could be considered as actively engaged in making meaning. Teaching with that approach looks for what students can analyze, investigate, collaborate, share, build and generate based on what they already know, rather than what facts, skills, and processes they can parrot. Moodle has modular design that makes it easy to create new courses, adding content that will engage learners. This modular object-oriented dynamic learning environment possess intuitive interface that makes it easy for teachers to create courses. Teachers and students require only basic early acquired from Internet browser skills to begin learning, which makes last one very simple and user-friendly platform [5]. Moodle has been applying in the universities to allow the use of new methods of E-learning and encourage the self-learning. This application allows the generation of a specific space in which students and teachers can interact in order to:

- Exchange experiences and the generation of debate forums about any topic of the subject.
- Resolve problems and exercises along the course.
- Allow an early evaluation of the teacher.
- Self-evaluate their own works.
- Set out new problems and obtain the collaboration of the community.
- Access to activities of any subject in any moment in base to its availability.

The student can also have some tools to assess its level of knowledge through quizzes, exercises. In order to encourage the collaborative work, the possibility of generating forums, wikis or workshops exists [8].
In this paper we are going to focus on student's knowledge and Learning Objects (LOs) because it is in that part where we apply the concept of the ontology.

IV. THE SEMANTIC WEB ONTOLOGY

The ontology is one technologies of the semantic web, it can be described as an explicit specification of a shared conceptualization, which can be taxonomically or axiomatically based [9]. Ontologies can be based around a single taxonomy or several taxonomies and their relationships [10]. Taxonomies consist of concepts and relationships that are organized hierarchically and whose concepts can be arranged as classes with subclasses.

The structure of an ontology should be based on a taxonomy that allows for the modeling of a system based on certain functional descriptions [11].

The ontology can formulate a representation of the learning domain by specifying all of its concepts, the possible relations between them and other properties, conditions or regulations of the domain. The development of the ontology is similar to the definition of a set of data and their structure. In this way, the ontology can be considered as a knowledge base that is used further for extracting useful knowledge and producing personalized views of the e-Learning system [12].

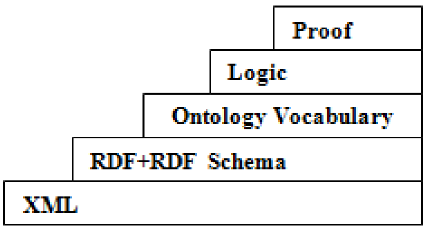

Fig. 1. Layers of the Semantic Web Architecture [13]

A. Ontology and e-learning:

Ontology is a specification of a conceptualization [13]. Ontology consists of concepts, properties, constraints on their usage and relationships between the concepts. Ontologies have a wide application scope.

And domain ontology, detailed description about an application specific domain is definitions of concepts, entities, attributes and processes related to a given application domain [14]. In this paper, our domain is e-Learning systems.

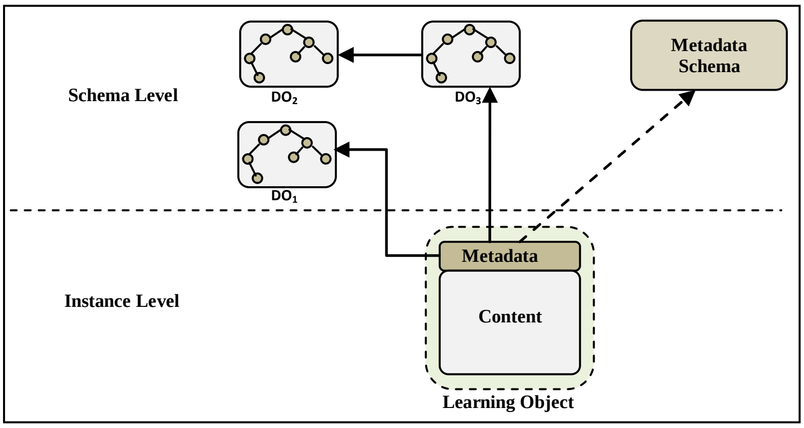

Fig. 2. Different ontological levels of learning object metadata and domain ontologies (DOi)

B. SCORM and Learning content Metadata

The three main metadata standards defined are, IEEE Learning Object Metadata (LOM), Dublin Core metadata and SCORM metadata [15]. Out of them SCORM has the widest scope [16] and it consists of 49 student metadata elements.

This paper used only a subset of SCORM metadata, which can be extended. These belong to the learning state of domain objects. We expect to extend the usage and number of metadata in the course of future implementation and learner identification. The metadata what have been utilized in the ontology are, title, identifier entry, content type, content status, intended end user role, aggregation level. (Constraints were defined on them).

V. PROPOSED ONTOLOGY AND IT'S IMPLEMENTATION

A. Moodle Platform Architecture

We have taken the proposed ontology as a part of a typical Moodle platform. In this architecture (figure 3) the component, user & course manager is responsible for capturing user interests, giving access to learning objects for learners, matching user profiles with the learning content and selecting the learning content satisfying the user interests. The assets and SCO manager is used by the authors to create SCOs using assets and other SCOs by the teachers to create new units and courses, the ontology manager is used by the author or administrator to update and improve the ontology.

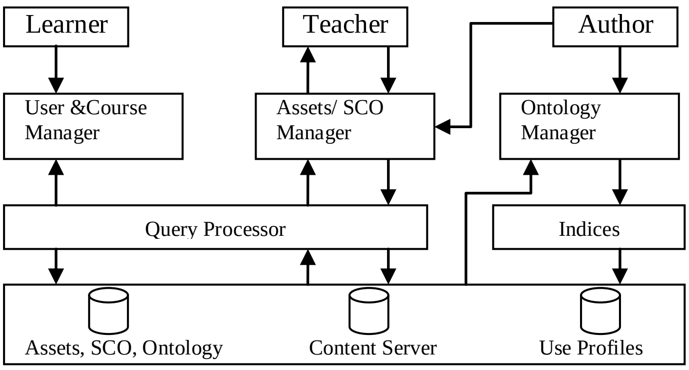

Fig. 3. User Oriented Ontology Based proposed Moodle architecture

The query processor helps to pass queries coming from the learners and teachers to the learning repository and to retrieve results of queries and pass them back to learners. Indices are defined on metadata to increase the efficiency of queries.

B. Proposed Learner and Courses Oriented Ontology

The proposed ontology consists of e-learning objects and their relationships (figure 4). Therefore via these ontological relationships the required learning resources can be located and their metadata can be retrieved. Then matching of user profiles and learning resource metadata can be done to ascertain the relevance of them.

This ontology can be extended according to the changes to user profiles and learning content.

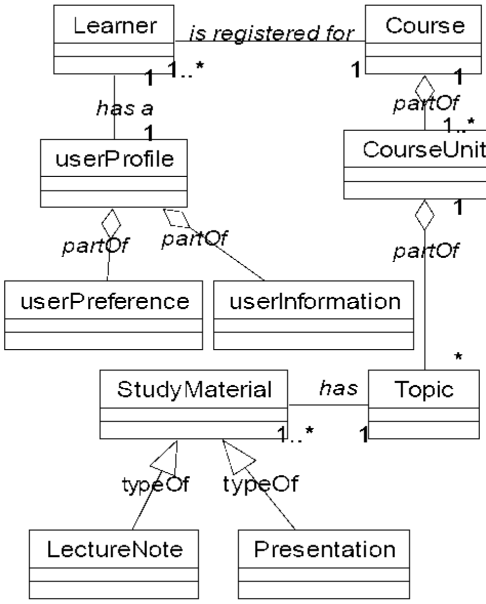

Fig. 4. a part of ontology as a class diagram

C. Learner Preference Ontology

The learner preference ontology presents personal preferences and learning characteristic of the learner which has interaction with the system. The information is updated according to the learner's interactions with the content. The updated information is used by the adaptation model to make adaptation decisions. Figure 5 illustrate the graphical representation of the user model. The information is available for the system to adapt the learning content presentation and navigation for the learner.

The top class of the learner preference ontology is the *User* class, which is a superclass to *PersonalInformation*. The *PersonalInformation* class has metadata to current the basic individual information such as user's name, gender, email, etc. also that the system can identify the user. A subclass of the *User* class is the *Learner* class, which represents information about learners. The *Learner* class is a central concept as it includes all the properties of a learner [17]. Containing of learner's ability, preference, knowledge, feedback and learning style, these five classes are related to association through *hasPreferences*, *writeFeedback* and *hasLearningStyle* properties. These aspects are considered important to describe the learning characteristics of the learner.

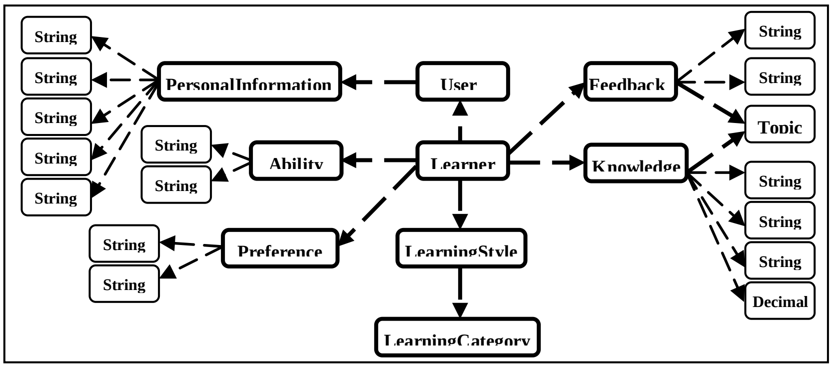

Fig. 5. The graphical representation of the user model

The learner's preferences in different stages of the learning process are kept in the instances of *Preferences* class to obtain the fluctuation of preference during the learning process. The following examples show *Preference*s class keeps learners' preferences with regards to information, and language. These two

features are used to provide adaptive presentation. An instance of *Preferences* class is shown in the following example:
<owl:NamedIndividual rdf:about="="&UserModel;Preferences_student1">
<rdf:type rdf:resource="&UserModel;Preferences"/>
<UserModel:hasLanguagePreference rdf:resource="&UserModel;English"/>
<UserModel:hasinformationPreference rdf:resource="&UserModel;Exactinfo"/>
</owl:NamedIndividual>

The example show that the language preference of student1 is "English" and also it shows that his/her information preference is "Exactinfo".

Furthermore, the *learningStyle* class holds information about the learner's learning style (*hasLearningStyle*) is associated with the *LearningStyleCategory* class. There are different models about the learning style and learning methods of learners. *LearningStyleCategory* class represents these different learning models.

a. User Profiles and attributes:

When learners access the Moodle, captures their profiles (interests and preferences), which will be stored in the learning repository. These user profiles are more descriptive. So in this paper we capture them into a compact representation space in a digital format [18].

We have used a set of attributes to represent user profiles. They are, name, age, gender, occupation, education level, language, topics of interest, education type and education format. These are helpful in the matching process and in creating user communities.

The user can, unwittingly, be the source of some information for the ontology, if we tell the program where to look. There are two specific places we can look the names and metadata of the files that the user uploads, and the relationships that can be inferred from the user's interactions with artifacts.

For example, if the user submits a file with certain metadata, and places that artifact such that it develops certain relationships within the ontology, and later uploads another file with similar metadata; we can then infer that perhaps we should create relationships for this new artifact, as well (it should be noted the user does not have to create this metadata, the external system that submits it to the student may do much of the work both files may be marked "IT 101" submissions by the submission system, for example). The more similarly named or placed artifacts the user uploads, for example, the better we can become in helping the author by creating some relationships for them.

b. Learner Preference:

We discuss that in order to provide personalization in e-learning systems, it is necessary to store the learner's characteristics (e.g. abilities, performances, prior knowledge, and learning style) in the learner preference. Some of these characteristics are static whereas others are dynamic. Static features are initialized in the registration period, and they usually remain unchanged throughout the learning process such characteristics are learner's email, preferences, etc. On the other hand, dynamic features are updated during learning process based on the interaction of learner with the system, for example, learner's information, abilities and knowledge.

Learner preference allows the system to personalize the interaction between the learner and learned content. To achieve this goal, the system should predict the needs of the learner based on the information in the learning preference in order to then offer the content in a way that the learner can understand. There are several techniques for modeling the learner and refining this way. Ontologies have been proving to be an effective means for presenting knowledge within a specific domain in a semantic way [19]. Consequently, we propose an approach where an ontological model is used to present the learner's characteristics. This model is described in the following.

D. Learning Objects (LOs)

The broad definition of "learning object" reflects the two very different communities who have an interest in reusable learning resources. Learning objects (LOs) enable and facilitate the use of educational content online. Internationally accepted specifications and standards make them interoperable and reusable by different applications and in diverse learning environments. The metadata that describes them facilitates searching and renders them accessible [20].

a. Learning Object Content Ontology Model(LOCOM)

Having looked at several content models (e.g. Learnativity, SCORM content aggregation model) we decided to use the LOCOM. The LOCOM was designed to generalize all of these content models, to provide an ontology-based platform for integrating different content models, and to enable semi-automatic reuse of components of LOs by explicitly defining their structure [21]. In this paper we refer to the ontology built on top of a LOCOM. Actually, we use a revised LOCOM ontologies divided into two different parts:

- *Content Structure* ontology enabling a formal representation of LOs decomposed into components;
- *Content Type* ontology defining the educational role of LOs and their components.

Both ontologies are developed in OWL [22]. The Content Structure ontology distinguishes between content fragments (CFs), content objects (COs) and learning objects (LOs). CFs are content units in their most basic form, like text, audio and video. These elements can be regarded as raw digital resources and cannot be further decomposed. COs aggregate CFs and add navigation. Navigational elements enable sequencing of content fragments in a content object. Besides CFs, COs can also include other COs. LOs aggregate COs around a learning objective. In Figure 6 we show the top-level ontology concepts. Note also that the ontology defines aggregational and navigational relationships between content units.

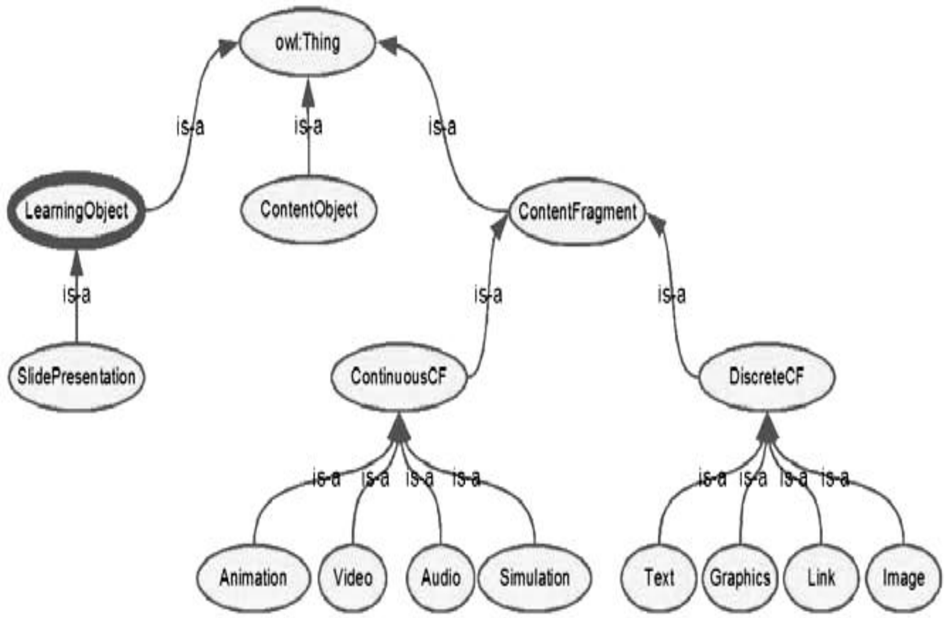

Fig. 6. The top level concepts of the Content Structure ontology

The content type ontology is also rooted in the abstract LO Content Model and has CF, CO and LO as the basic, abstract content types. However, these concepts are now regarded from the perspective of educational/instructional roles they might have. Therefore, concepts like Definition, Example, Exercise, Reference are introduced as subclasses of the CO class, whereas concepts such as Tutorial, Lesson, Test are some of the subclasses of the LO class. The development of this ontology was mostly inspired by a thorough examination of existing LO Content Models [23].

Note also that both the parts LOCOM ontologies are organized as extensible infrastructures that can be further extended with new LO types or content structure elements. Another beneficial point for using that parts is an extensive development of tools able to represent widely accepted formats of LOs (e.g. slide presentation) using LOCOM ontologies. We have information about LO components, the same LO can be better personalized according to the learners' specific needs, preferences and styles (e.g. learning using examples rather than formal definitions) when using the same learning design.

```
<owl:Ontology rdf:about="">
<rdfs:comment rdf:datatype= "http://www.w3.org/2001/XMLSchema#string">
An ontology to define learning object LOM metadata records</rdfs:comment>
<rdfs:isDefinedBy><oc:IntelligentAgent rdf:ID="User_LO1"/></rdfs:isDefinedBy>
<rdfs:isDefinedBy><oc:IntelligentAgent rdf:ID=" User_LO2"><rdfs:comment rdf:datatype= "
http://www.w3.org/2001/XMLSchema#string">http://localhost/moodle/mysystem  </rdfs:comment>
<rdfs:comment rdf:datatype=
"http://www.w3.org/2001/XMLSchema#string">http://localhost/moodle/mysystem
</rdfs:comment></oc:IntelligentAgent></rdfs:isDefinedBy> </owl:Ontology>
<owl:Class rdf:ID="Learning_object">
<rdfs:subClassOf><owl:Restriction><owl:onProperty><owl:ObjectProperty
rdf:ID="hasResource"/></owl:onProperty>
<owl:allValuesFrom><owl:Class><owl:unionOf rdf:parseType="Collection"><owl:Class
rdf:ID="web_content"/>
<owl:Class
rdf:ID="Imsld_content"/></owl:unionOf></owl:Class></owl:allValuesFrom></owl:Restriction></rdfs:subCl
assOf>
<rdfs:subClassOf><owl:Class rdf:ID="ResourceDescription"/></rdfs:subClassOf></owl:Class>
<rdf:RDF><owl:Ontology rdf:about=""><owl:imports rdf:resource="http:// localhost/moodle/mysystem
/LOCO"/>
<owl:imports rdf:resource="http://www.owl-ontologies.com/alocom-core.owl"/></owl:Ontology>
<owl:Class rdf:about="http:// localhost/moodle/mysystem  /LOCO#LearningObjectContext">
<owl:equivalentClass rdf:resource="http:// localhost/moodle/mysystem
/LOCO#Learning_object"/></owl:Class>
<owl:ObjectProperty rdf:about="http:// localhost/moodle/mysystem  /LOCO#hasLearningObject">
<rdfs:domain rdf:resource="http:// localhost/moodle/mysystem  /LOCO#LearningObjectContext"/>
<rdfs:range rdf:resource="http://www.owl-ontologies.com/alocom-core.owl#LearningObject"/>
</owl:ObjectProperty></rdf:RDF>
```

Fig. 5. OWL/XML definition of the Learning_object class and linking LOCO ontologies

b. Ontologies are User-Repository Interfaces for the Application Domains

Ontologies serve as user-repository interfaces that provide views of learning objects in various perspectives to enhance the learning objects repository usability for diverse application domains [24]. The ontologies are envisaged as knowledge structures that fit the individual application domains. For instance, a learning objects repository can have two different views: learners' view and instructors' view. An ontology for the learners articulates general interactive learning processes, while an ontology for the instructors describes a scheme of educational development.

Ontologies have been with us for a quite long time. For instance, an ER (entity-relationship) chart is a general type of ontology for relational databases. In comparison with ER charts for relational databases, ontologies for learning objects repositories are complicated due to the complex properties of learning objects and the richness of semantics in the learning and instructional context.

More importantly, ER charts are basically used only for database designers, but ontologies for learning objects must be used for all creators of learning objects, as well as end-users of learning objects, for the knowledge sharing purpose. Hence, an ontology of learning objects acts as the interface between all users and the learning objects repository.

c. Ontology vs. Meta-data of Learning Objects

Meta-data standards of learning objects intend to generalize taxonomies and vocabularies for learning objects repositories for all disciplines (Convertini, Albanese, Marengo, & Scalera, 2006; Dublin Core, 2007; Friesen, 2005; IEEE LTSC, 2007; IMS, 2006; Yordanova, 2007).

There is a tacit ontology behind a meta-data standard. Such a tacit ontology is too complicated to present because the semantic relationships between all learning objects are hard to be standardized. Specifically, the taxonomies can never be exhaustive for all disciplines, and vocabularies can be interpreted in a variety of ways depending upon the disciplines. Without the support of ontologies, tagging all types of meta-data and relevant keywords to every learning object could be prohibitively expensive and will eventually make any search engine practically powerless. On the other hand, an ontology of a specific domain for a learning objects repository serves as a map and suggests paths for retrieving candidate learning objects to reach a certain objective of learning or teaching. The use of ontology does not exclude the use of meta-data. When the learning objects repository is huge, standardized meta-data are still useful for searching learning objects through ontologies.

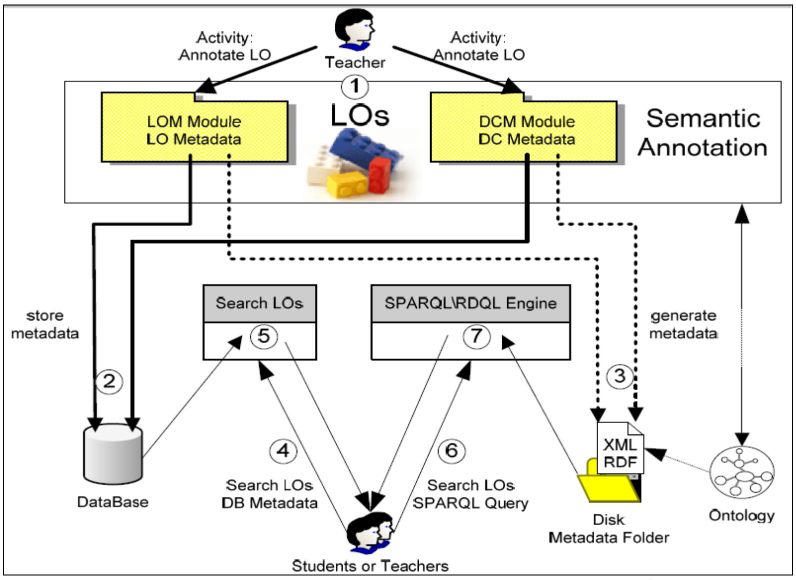

Fig. 7. Semantic Web Technologies in Moodle platforms

VI. MATCHING USER PREFERENCES WITH LEARNING OBJECTS

When we try to satisfy learner requirements we need to match the user preferences with the learning objects in the system. However, a direct matching between the learning objects and user preferences is not efficient enough and it will take a lot of memory. Therefore it is done in this paper by referring to metadata retrieved through the ontological relationships. Therefore it becomes efficient.

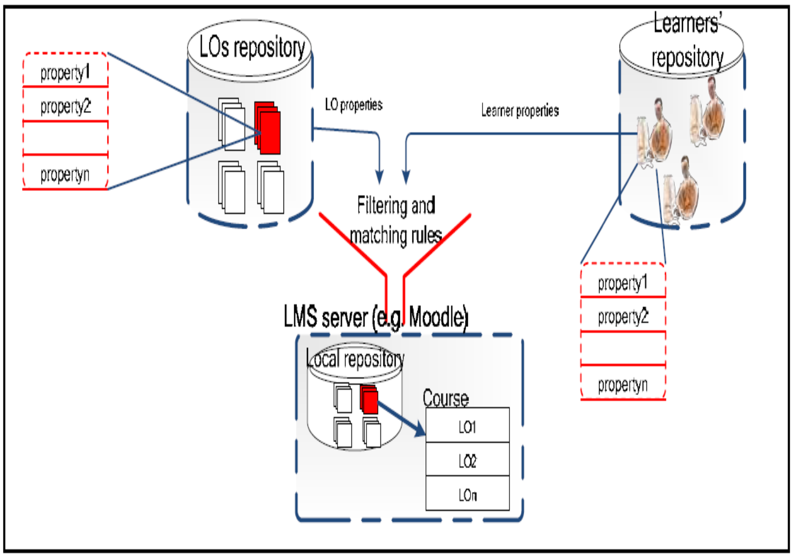

Fig. 8. LOs repository filtering and matching with the learners' repository in Moodle platforms:

A. Use of Proposed Ontology with an Existing Moodle

The ideas we have presented in this paper have been implementing by modifying the open sourced LMS "MOODLE" . Two new APIs called profile API (profile.php) and ontology API (onto.php) has been added including the required functions, classes and variables.

VII. DISCUSSION AND RELATED WORK

A number of works have been published about the use of ontology in the e-learning, such as [25]. However, a strong computational approach is noticed in the suggested solutions. Furthermore, some works like the one presented by [26], allow the reuse in a closed environment. Only the contents created in the system are considered for reusing and the resulting course should be performed in a property system that makes the access difficult for a large amount of people. In order to minimize these problems, ontologies presented in this paper were created through OWL in Moodle, so that any system can reuse and store new information. Still aiming to facilitate the ontologies acceptance to matching LOs with the learner's preferences, the choice was to use properties defined in a standard of metadata already existent like LOM. In a stage further than the ontology development, a system that uses ontology to generate user preferences and LOs described according to SCORM standard was developed, which allows it to be used by students through any LMS with the support of the chosen standard.

A. Related Work

Learner's model contains learner's characteristics which are essential for adaptive learning. A typical learner's preference includes most important features of the learner that affects his/her learning, such as current knowledge, background, interest, goals, learning style and preferences [27]. A flexible approach in student modelling is presented in [28]. This user model is used in DEPTHS (Design Pattern Teaching Help System), which is an intelligent tutoring system for learning software design patterns. DEPTHS make use of a knowledge assessment method based on fuzzy rules to update students' preferences during the learning process.

Recent developments in semantic web technologies have informed research on applying these technologies for developing adaptive e-learning systems. Several attempts have been made to implement ontology-based educational systems, one of the most important components in these systems is the learner preference [25,29]. Some of these researches focus on proposing ontology-based approach for sharing student profiles between different learning systems [30,31] . For instance, ADAPT2[30] is an Advanced Distributed Architecture for Personalized Teaching & Training. It employs a high-level mechanism for enabling interoperability between ontology-based user preferences in adaptive Web-based systems. The main idea of the ADAPT2 approach is the use of an ontology server to exchange user preferences. The ontology server seems like the most appropriate place to store user preferences in this system. Moreover, some researchers attempt to propose the usage of ontologies and rule-based methods for developing learner preferences. For example, a rule-based solution for developing the user profile in an e-learning system is presented in [32]. In the proposed solution, a two layers user preference (competences and interests) is designed through ontological constructs. The user preference provides personalized functionalities, especially with recommendations on potential collaborators for the users of an e-learning system. Correspondingly [33] proposed the usage of ontologies and rule languages for building learner preferences in Moodle system. This approach is used for implementing adaptation in web-based Programming TUtoring System (Protus) where the learner preference is updated as a result of firing the semantic rules.

An ontology-based learner preference expresses the learner's characteristics in an abstract way. But, it only expresses learner's characteristics which is essential to support the system's needs. For example [34] proposed a learner preference for adaptive learning system based on Semantic Web. This learner model mainly includes study style, cognition level, interest and hobby. The authors depended on Solomon Study Style to obtain learner's learning style. The learner preference ontology is defined using Moodle and it is updated through metadata. While [35] proposed an ontology-based learner preference to describe three aspects of learner's characteristics namely learner's basic information, preference, and performance. The authors calculate semantic similarities between learner‘s preference ontology and LOs ontology to recommend effective learning resources based on learner's needs.

Most of the abovementioned systems concentrate on some learner's characteristics in providing adaptive functionality such as learner preferences or knowledge. However, learner's ability as an effective factor for implementing adaptation mechanisms is mostly neglected in referencing learners. Besides, those systems do not support the usage of different learning style preferences that improves the flexibility of learner preference. Structure of learner preference ontology supporting the personalization LOs process is described in this paper. Moreover, to obtain more precise estimation of learner's ability, the results of learner's responses to the matches are analyzed according to Item Response Theory.

REFERENCES

[1] Murray, T., Blessing, S., & Ainsworth, S. (Eds.), (2003). Authoring tools for advanced technology learning environments: Towards cost-effective adaptive, interactive, and intelligent educational software. ISBN: 978-1-4020-1772-8.

[2] Bossom (2005). Bossom engine for the semantic Web, http://projects.semwebcentral.org/projects/bossam/.

[3] Meinel, C., H. Sack, et al. (2002). Course management in the twinkle of an eye - LCMS: a professional course management system. Proceedings of the 30th annual ACM SIGUCCS conference on User services, Providence, Rhode Island, USA, ACM Press.

[4] Magnin, L., Snoussi, H., & Nie, J. (2002). Toward an ontology-based web extraction. In Proceedings of the 15th Canadian conference on artificial intelligence.

[5] Angelova, G., Kalaydjiev, O., & Strupchanska A.. (2004). Domain ontology as a resource providing adaptivity in e-learning, In Workshop on ontologies, semantics, and e-learning, on the move to meaningful internet systems (pp. 700–712).

[6] http://www.moodle.org

[7] Kay, J. (2001). Learner control. Journal of User Modeling and User-Adapted Interaction, 11(1–2), 111–127.

[8] Baños, J. Moodle Versión 1.8 – Manual de consulta para el profesorado.

[9] Gruber, T.R., (1993), Toward Principles for the Design of Ontologies Used for Knowledge Sharing, K.A. Publishers, Knowledge Systems Laboratory, Stanford University. Padova, Italy.

[10] Cottam, H, Milton, N., and Shadbolt, N., (1998), The Use of Ontologies in a Decision Support System for Business Process Re-engineering, Information Tech-nology and Knowledge Re-Engineering, Journal of the Austrian Computing So-ciety, Vienna, Budapest.

[11] Garbacz, P., (2006), Towards a standard taxonomy of artifact functions, Applied Ontology, 1/3:221-236.

[12] Markellou p., MousouroulI I., Spiros S, Tsakalidis A. (2005), Using semantic web mining technologies for personalized e-learning experiences, Proceedings of the web-based education, Grindelwald.

[13] N. F. Noy and D. L. McGuiness Ontology Development 101: A Guide to Create Your First Ontology, Stanford Knowledge Systems Laboratory Technical Report KSL-01-05 and Stanford Medical Informatics Technical Report SMI-2001-0880, March 2001

[14] A. De Nicola, M. Missikoff, Towards an Ontological Support for e-Learning Courses, OTM Workshops, LNCS 3292, pp. 773–777, 2004. © Springer-Verlag Berlin Heidelberg 2004.

[15] SCORM Content Aggregation Model (CAM) Version 1.3.1, 2004 Advanced Distributed Learning, http://www. adlnet.org/downloads/70.cfm

[16] Masood Ghaneh, System Model for t-learning Application Based on Home Servers (PDR), Broadcast Technology, no.19, Summer 2004, NHK STRL, pages 16-19

[17] Yarandi, M., Tawil, A. R., & Jahankhani, H. (2012). Ontologies for Personalised Adaptive Learning Paper presented at the Advances in Computing & Technology 2012, London,Uk.

[18] Eerika Savia, Teppo Kurki, Sami Jokela, "Metadata Based Matching of Documents and User Profiles", In Proceedings of Finnish Artificial Intelligence Conference, STeP'98, 1998, http://lib.tkk.fi/Diss/2001/ isbn9512256932/article1.pdf

[19] Snae, C., & Brueckner, M. (2007). Ontology-driven e-learning system based on roles and activities for Thai learning environment Interdisciplinary Journal of E-Learning and Learning Objects, 3, 1-17.

[20] ADL. (2005). Advanced Distributed Learning SCORM Specification, retrieved October 28, 2005 from http://www.adlnet.org/scorm/ index.cfm.

[21] Sheth, A., Ramakrishnan, C., & Thomas, C. (2005). Semantics for the Semantic Web: The Implicit, the Formal and the Powerful. International Journal on Semantic Web & Information Systems, 1 (1), 1-18.

[22] Bechhofer, S., van Harmelen, F., Hendler, J., Horrocks, I., McGuinness, D. L., Patel-Schneider, P. F., & Stein, L. A. (2004). OWL Web Ontology Language Reference, retrieved October 28, 2005 from http://www.w3.org/TR/owl-ref/.

[23] Verbert, K., Klerkx, J., Meire, M., Najjar, J., & Duval, E. (2004). Towards a Global Component Architecture for Learning Objects: An Ontology Based Approach.Paper presented at the OTM 2004 Workshop on Ontologies, Semantics and Elearning,October 25-29,2004,Agia Napa, Cyprus.

[24] Smrz, P. (2004). Integrating ontologies into learning management systems – A case of Czech. In R. Meersman, Z. Tari, & A. Corsaro, OTM Workshops, LNCS 3292, 768-772. Berlin: Springer. Retrieved June 20, 2007 from http://www.springerlink.com/index/ PG6PQAGL390PRY3T.pdf

[25] Henze, N.; Dolog, P.; Nejdl, W. Reasoning and Ontologies for Personalized E-Learning in the Semantic Web. Educational Technology & Society, Vol. 7(4), (2004), 82 – 97.

[26] Power, G. et. al. Goal Oriented Personalisation with SCORM. In: Proceedings of IEEE International Conference on Advanced Learning Technolgies. Koahsiung (Taiwan), 2005.

[27] Gauch, S., Speretta, M., Chandramouli, A., & Micarelli, A. (2007). User profiles for personalized information access. In B. Peter, K Alfred & N. Wolfgang (Eds.), The adaptive web (pp. 54- 89): Springer-Verlag. http://dx.doi.org/10.1007/978-3-540-72079- 9_2

[28] Jeremic´, Z., Jovanovic´, J., & b, D. G. (2012). Student modeling and assessment in intelligent tutoring of software patterns. Expert Syst. Appl., 39(1), 210-222. http://dx.doi.org/10.1016/j.eswa.2011 .07.010

[29] Jovanović, J., Gašević, D., & Devedžić, V. (2009). TANGRAM for Personalized Learning Using the Semantic Web Technologies. Journal of Emerging Technologies in Web Intelligence, 1(1), 6-21. http://dx.doi.org/10.4304/jetwi.1.1.6-21

[30] Brusilovsky, P., Sosnovsky, S., & Yudelson, M. (2005). Ontologybased framework for user model interoperability in distributed learning environments Paper presented at the Proceedings of World Conference on ELearning (E-Learn 2005), Vancouver, Canada.

[31] Dolog, P., & Schäfer, M. (2005). A framework for browsing, manipulating and maintaining interoperable learner profiles. Paper presented at the Proceedings of the 10th international conference on User Modeling, Edinburgh, UK.

[32] Brut, M., Asandului, L., & Grigora, G. (2009). A Rule-Based Approach for Developing a Competency-Oriented User Model for E-Learning Systems. Paper presented at the Internet and Web Applications and Services, 2009. ICIW '09. Fourth International Conference on Venice/Mestre.

[33] Klasnja-Milicevic, A., Vesin, B., Ivanovic, M., & Budimac, Z. (2010). E-learning personalization based on hybrid recommendation strategy and learning style identification. Computers & Education, 56(3), 885-899. http://dx.doi.org/10.1016/j.compedu.2010.11.001

[34] Baishuang, Q., & Wei, Z. (2009). Student Model in Adaptive Learning System Based on Semantic Web. Paper presented at the Proceedings of the 2009 First International Workshop on Education Technology and Computer Science - Volume 02. http://dx.doi.org/10.1109/ETCS.2009.466

[35] Liu, Z., Liu, L., Kang, H., Zhong, S., & Jia, B. (2009). An Ontology-Based Method of Adaptive Learning. Paper presented at the Proceedings of the 2009 Fifth International Joint Conference on INC, IMS and IDC.