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## Ontology Web Based Learning Management System

*This article focuses on the last trends in technology-assisted learning. It defines the main conceptual issues discussed in literature, set criteria for the assessment of eLearning platforms and analyzes on these criteria first three Open source management systems for distance learning. After the results were made and the appropriate conclusions are set, we design and develop an Object Oriented platform for learning on a CGI / Apache architecture.*

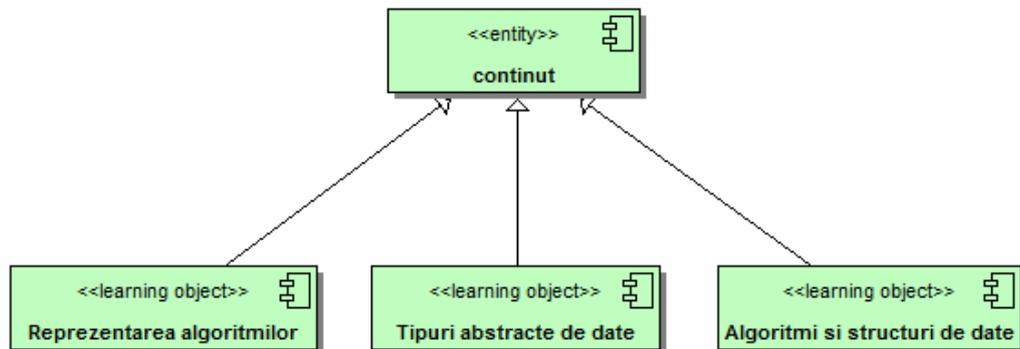
**Key words:** LMS, learning object, CBT, SCORM, OWL, SOA

**JEL classification:** I21 - Analysis of Education

### 1. Virtual education

A support system for distance learning or virtual education is a planned experience of teaching-learning, organized by an institution providing intermediate material in a sequential order and logic to be assimilated by students in their own manner, without the work force of being present or synchronicity. Mediation is done through various ways, from materials on diskette or CD (possibly by mail), to technologies for transmitting content via the Internet, after Istrate (2000).

Accordingly to I.E.E.E. (2002), a LMS (Learning Management System) is composed of several entities called learning objects, digital or non-digital, which can be used, reused or referred to during technology supported learning. Examples of ways to include technology-assisted learning are CBT (Computer Based Training), WBT (Web Based Training), interactive learning environments, intelligent computer assisted instruction systems, systems for distance learning, collaborative learning environments. Examples of learning objects could be multimedia content, lesson plans, operational goals, software tools, and also persons, organizations or events referred to in the computer assisted learning (fig. 1).



**Fig. 1.** Structuring the course of Algorithms and data structures for learning objects for dissemination through the LMS, after Motz (2006)

The standard for distribution of resources in the LMS is SCORM, an ADL initiative (Advanced Distributed Learning) of the Department of Defense. In SCORM, learning objects are divided in Shareable Content Objects (SCO) and actives.

The major event that the Internet produced has facilitated the emergence of new paradigms in education and training. On the background of economic and social changes of major factors such as technological development, new educational theories and sharing responsibility for education with other institutions lead to highlight the following features, after Istrate (2000):

- facilitation roles;
- curriculum-oriented needs of particular students;
- distributed resources;
- virtual facilities;
- asynchronous lessons.

A virtual learning institution may be defined as:

- a. an institution engaged in activities of its educational program which provides tutorial support directly through the means of communication technology;
- b. an organization created in partnership to facilitate teaching and learning without direct involvement as a provider of educational programs.

There are four categories of virtual learning organizations:

- c<sub>1</sub> institutions** that were involved in open education and distance;
- c<sub>2</sub> traditional institutions**, from schools to universities, which have not been involved in distance education, these institutions begin to apply new information technologies to support the additional capacity, productivity and increased flexibility with the premise that such reduces costs and attract revenue by attracting new students, this transition occurs in the typical situation of specific projects that create a virtual in-

stitution in the traditional one;

**c<sub>3</sub> sector corporations or organizations** that develop large training programs for internal use with the support and means of distribution and information technologies and communication with the virtual tag;

**c<sub>4</sub> individuals** who, for reasons ranging from altruism to profit using technology to create learning opportunities for anyone interested.

## 2. Open source evaluation systems

After Maly (1998), a comparison between different solutions on the market can be made through a series of indicators for defining a system of distance training:

**I<sub>1</sub>. scale** - the number of participants involved in a learning activity for a fixed term, include the distance between participants, covered by the system;

**I<sub>2</sub>. perception** - the technical quality of the materials received by the participants (from realism graphic resolution)

**I<sub>3</sub>. symmetry** - degree to which one can focus attention on each participant (inversely proportional to the size class)

**I<sub>4</sub>. interactivity** - the minimum length of time in which to obtain a response in an interaction;

**I<sub>5</sub>. means** - range of methods / tools available to work participants for learning and communication;

**I<sub>6</sub>. control of the learner** - the extent to which the learner can be active, can collaborate with other students or teachers for the attainment of learning;

**I<sub>7</sub>. integration capacity** - an opportunity to present information in different ways and from different sources;

**I<sub>8</sub>. cost** - the cost of a student to achieve a set of established goals;

**I<sub>9</sub>. time** - the control of the time required for a student to achieve a learning objective

**I<sub>10</sub>. flexibility** – the ease with which it can make improvements throughout the program.

The general criteria for assessment of LMS which formed the basis of comparison of the three aided learning systems by Hammer (2004) are:

- the overall architecture and implementation;
- interoperability;
- cost of use;
- the ability of developers;
- the ease of licensing;
- multilingual support;
- accessibility;
- standardization of learning packages.

**ATutor** is a promising system that provides good documentation, ease of installation, and a strong development potential. While the user interface does not seem to be intuitive for many, the overall functionality is good (Oriented modules) and the development team is committed to open standards. This system is also easy to install and adaptable to a new version of the language. ATutor is one of very few that supports dictionaries LMS metadata associated with learning objects. ATutor is very powerful and standardized can import external files in IMS / SCORM. ATutor is written in a modular format. Show many features and is distinguished by easy use and accessibility, including students with disabilities (fig. 2).



**Fig. 2.** ATutor LMS (Source: [http://en.wikipedia.org/wiki/File:At\\_screenshot1.jpg](http://en.wikipedia.org/wiki/File:At_screenshot1.jpg))

**Moodle** is one of the most usable and flexible Open source courseware products available. It's excellent documented, provides a strong support for security and administration and its standard evolves to IMS / SCORM. The key to success is that Moodle is developed combining the principles of pedagogy with technology. Moodle enjoys both the user and Open source community of developers. Versatile even if it requires increased facilities like the MathML language and tracking. However, this program enjoys a high level of recognition in the academic community. Moodle is a LMS student - centered, designed to facilitate the creation of quality online courses. Software is used worldwide by universities, schools, companies and independent teachers (fig. 3).

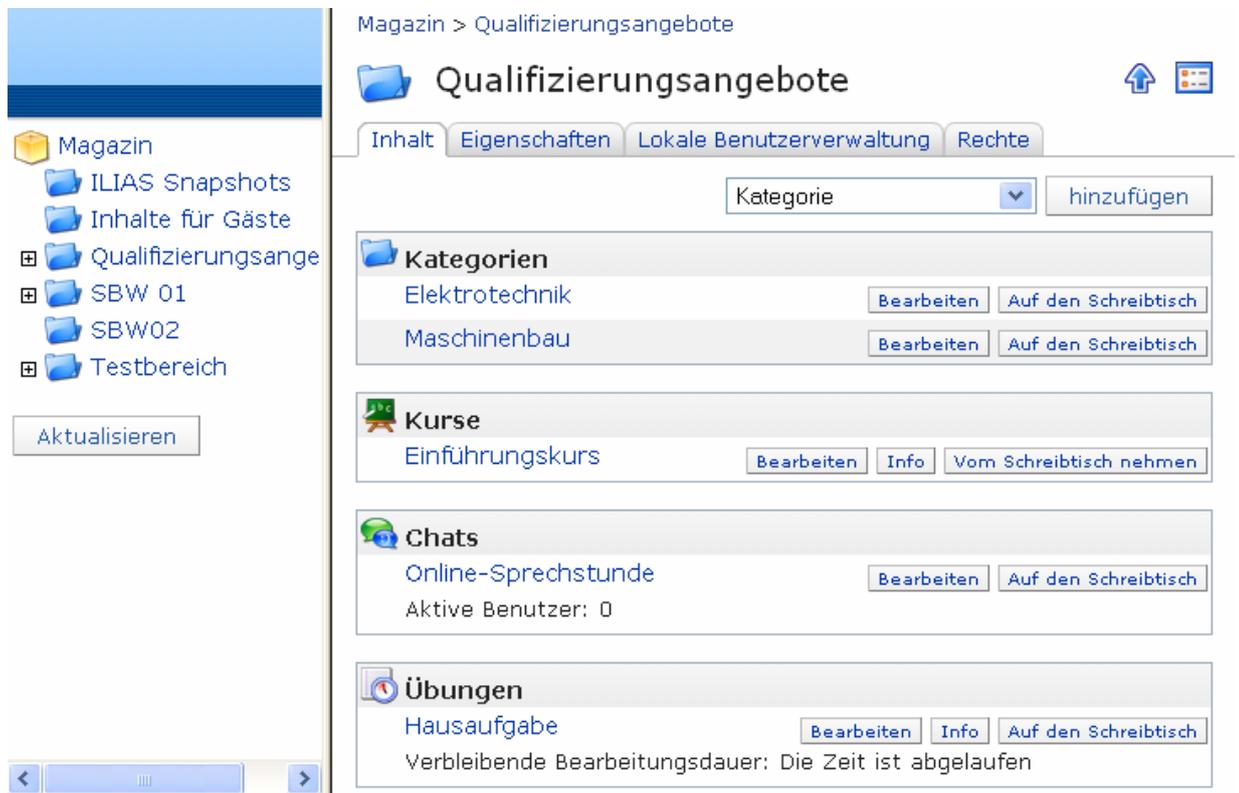
The screenshot displays the Moodle LMS interface for the 'EdNA Groups Game Maker' course. The user is logged in as 'Roland Gesthuizen'. The interface is organized into several main sections:

- People:** Includes links for 'Participants', 'Sub-Groups', and 'Edit profile'.
- Menu:** Contains links for 'Chats', 'Choices', 'Forums', 'Glossaries', 'Resources', and 'Wikis'.
- Online Users:** Shows 'Roland Gesthuizen' as online 'last 10 minutes'.
- Administration:** Features 'Turn editing on', 'Settings...', 'Owners...', 'Members...', and 'Backup...'.
- Sections:**
  - Welcome:** A message asking if the user is a teacher interested in teaching computer game design, accompanied by a cartoon character at a computer.
  - News forum:** A link to the news forum.
  - Digital Games Chat:** A link to a chat room.
  - Open Social Forum:** A link to a social forum.
- Calendar:** A calendar for April 2005 with various event markers.
- Upcoming Events:** Lists 'Game Maker for Beginners' on Monday, 18 April, from 04:30 PM to 07:30 PM.
- Latest News Posts:** Includes a link to 'Add a new topic...' and two recent posts from Roland Gesthuizen.

**Fig. 3.** Moodle LMS

(Source: [http://en.wikipedia.org/wiki/File:Moodle\\_1.3\\_sample\\_course\\_screngab.png](http://en.wikipedia.org/wiki/File:Moodle_1.3_sample_course_screengrab.png))

**ILIAS** is an object-oriented LMS. The user interface is designed in accordance with a paradigm focused on the desktop. Widely used in Europe and China, has extended support for various languages. For the third version, developing packages include support for IMS / SCORM (fig.4).



**Fig 4.** Platforma ILIAS (*Source: Wikipedia*)

In conclusion, Moodle has limits, especially faced with the lack of support for SCORM standard, and determining the roles and permissions is poor. However, these problems can be solved and are part of the project we are presenting further on. ATutor is solid in terms of function ability and ease of operation, but the overall architecture needs tweaking even if some features such as creating IMS packages can recommend it to be ported to Moodle. ILIAS on the other hand, has a complex architecture which raises difficulties in development and debugging. Code is new and lacks maturity. ILIAS community for developers is very small outside the core team.

### 3. Open source project to support open distance education

"Using the Internet, Intranet or groupware system type, the data available grows every day - for customer support communications, internal research reports or competing web sites are some sources of electronic data, accordingly to Pugno (2007). This is the reason we want to develop an eLearning platform using only free or Open source software tools, respecting the principles of ob-

ject oriented programming and a CGI / Apache architecture.

The Bourne shell is developed by Steve Bourne, control structures are based on Algol 68. The Bourne-again shell, called simply Bash is the GNU shell provided to accompany all Linux systems. A Bash script can be configured so as to generate valid HTML output, as apparent from the following:

```
#!/bin/bash

HOST=127.0.0.1
USER=utilizator
PASS=parola
DB="admin"
ID=`echo "$QUERY_STRING" | cut -d"&" -f1 | cut -d"=" -f2`
PWD=`echo "$QUERY_STRING" | cut -d"&" -f2 | cut -d"=" -f2`
qry="SELECT info FROM admin.utilizatori WHERE id='$ID' AND pwd='$PWD'"
echo "Content-type: text/html"
echo ""
echo "<html><head><title>Pagina Student lui</title></head><body><h1>Bine ai venit!</h1>";
qr=$(/usr/bin/mysql -u$USER -p$PASS << eof
$qry
eof)
if [ -z "$qr" ]; then
    echo "<em>Ne pare rau. Nu ai trecut testul nostru de autentificare.</em><br />"
else
    echo "<em>Buna ziua,</em><em>$ID</em><br />"
fi
echo "</body></html>";
```

This example copies the users' ID and Password into two variables, as in Tanasa (2002),, that are concatenated into a SQL query string. This string is passed after the authentication to the mysql server and if it returns nothing, the access is forbidden; else, a welcome message with the user ID is prompted.

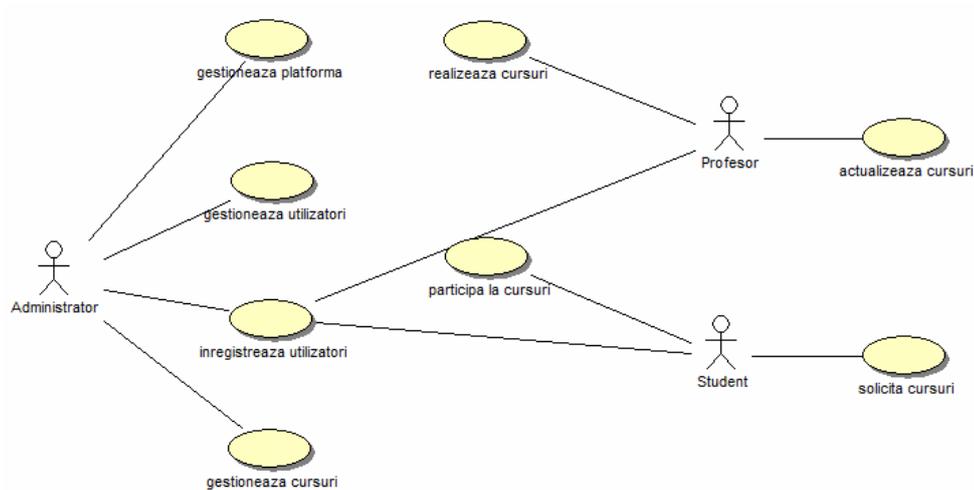
CGI (Common Gateway Interface) is the most common technique for generating dynamic content for the open architecture of UNIX (Red Hat, Ubuntu, Mandriva, Fedora, etc.). If some chooses for binaries written in C/C++ and compiled with GCC, it has all the advantages of the POSIX and STDIO software libraries. For example, the STAT structure contains information about each file type, from type to the group access to which it belongs. Handling file types is facilitated by appropriate macro command: S\_ISREG () for text or bi-

nary files, `S_ISDIR ()` for directories, etc. There are three levels of access: read, write and execute on the user, user group and others. `CHMOD` command allows secure access and modifies each bit of the new permissions. To open a file, execution permission is needed first to be associated with the file. After the search bit has been tested the system checks the permissions for read and write. In this way access to a directory can be restricted to a single user or user group.

```
#include <stdio.h>
#include <stdlib.h>
int main(void) {
    char buffer[2];
    printf("Content-type: text/html\n\n");
    printf("<html><body>");
    for (int i=0;i<20;i++) {
        printf("Disciplina_");
        printf(_itoa(i,buffer,10));
        printf("<BR>");
    }
    printf("</body></html>");
    return 0;
}
```

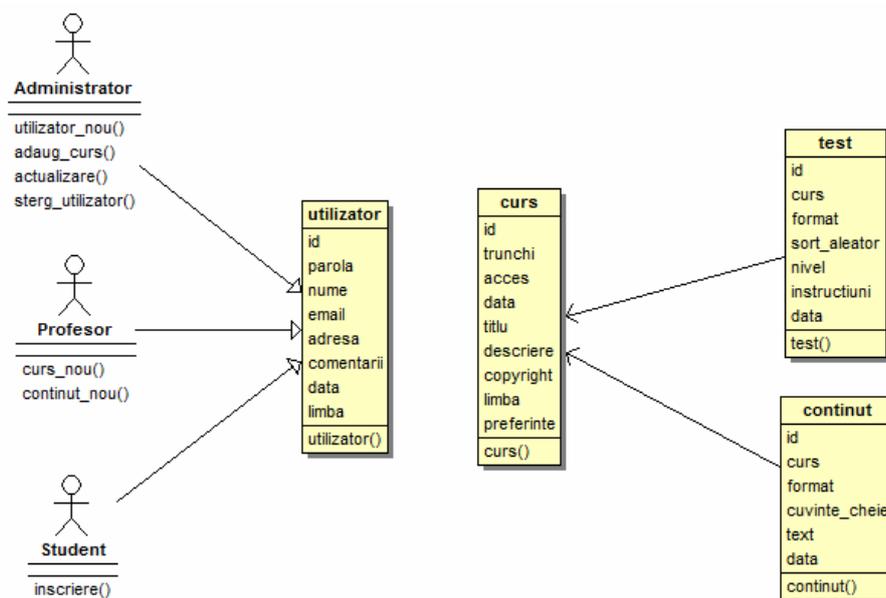
This example uses the `STDIO` and `STDLIB` to show a message in the browser for twenty times. It is worthy to notice the non-standard method `_itoa` to cast an integer to a char value and the break line HTML tag `<BR>` instead of the new line character (`\n`) which is meaningless for the browser.

Apache is a high quality Open source web server, which simultaneously handles requests issued by web browsers. In UNIX environment, each client is assigned its own server process. CGI processes are not part of the process initiated by the Apache server, each CGI process is created automatically by spawning, accordingly to Hawkins (2002) . This is the result of the combined command `fork` followed by `exec` command. First makes a copy of the parent, given a non-negative integer identifier of the child and the second command launches the process in execution. The parent process cease control to the child until it ends its execution, accordingly to Stevens (2005). This mode of operation requires additional hardware resources especially when running multiple client processes.



**Fig. 5.** Use-case diagram for Open source LMS, after Álvarez-González (2005)

There are three main actors, or roles, the administrator, an instructor (or teacher) and the students (fig. 5). The administrator manages courses, users and updates platform patches. The user registration is public, so that any person can be registered as a student, but only the administrator can assign the role of instructor. Instructor can create courses and import students from other classes.



**Fig. 6.** LMS classes diagram

The diagrams (fig.5 and fig. 6) were developed with BOUML aided design tool and the associated code was automatically generated and presented as it is, further below:

#### utilizator.h

```
#ifndef _UTILIZATOR_H
#define _UTILIZATOR_H

#include <string>
using namespace std;

class utilizator {
private:
    string id;
    string parola;
    string nume;
    string email;
    string adresa;
    string comentarii;
    unsigned int data;
    string limba;
public:
    utilizator();
};
#endif
```

#### continut.h

```
#ifndef _CONTINUT_H
#define _CONTINUT_H

#include <string>
using namespace std;

class curs;
class continut {
private:
```

#### curs.h

```
#ifndef _CURS_H
#define _CURS_H

#include <string>
using namespace std;

class curs {
private:
    unsigned int id;
    unsigned int trunchi;
    bool acces;
    unsigned int data;
    string titlu;
    string descriere;
    string copyright;
    string limba;
    string preferinte;
public:
    curs();
};
#endif
```

#### test.h

```
#ifndef _TEST_H
#define _TEST_H

#include <string>
using namespace std;

class curs;
class test {
private:
```

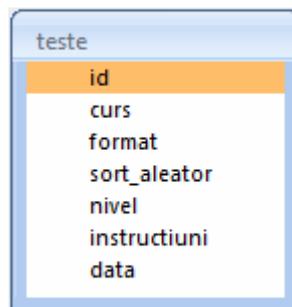
```

    unsigned int id;
    unsigned int curs;
    string format;
    string cuvinte_cheie;
    string text;
    unsigned int data;
public:
    continut();
private:
    curs * ;
};
#endif

    unsigned int id;
    unsigned int
    curs;
    string format;
    int
    sort_aleator;
    unsigned int
    nivel;
    string
    instructiuni;
    unsigned int
    data;
    curs * ;
public:
    test();
};
#endif

```

A vector space defined by Salton (1991) is used to determine any similarities between keywords and topics of a course related to a scientific field. The model consists of two vectors: keywords and content courses. Topic vector specifies for each keyword the relative frequency estimated for occurrence in the content. Text vector contains the absolute occurrence frequencies of the keywords in the text. The similarity between the text and keywords is measured by calculating the cosine angle between two vectors. It is considered that the text is "sufficiently close" to the requested topic when this value is superior to a minimum value set by the administrator.



**Fig. 7.** Persistence model for test class

Generating random testing is done by inserting a random numeric values in the **sort\_aleator** field (fig. 7) from **tests** table. Following SQL instruction change the **sort\_aleator** field with a random value between 150 and 200:

```
UPDATE teste SET teste.sort_aleator = Int((200-150+1)*Rnd()+150);
```

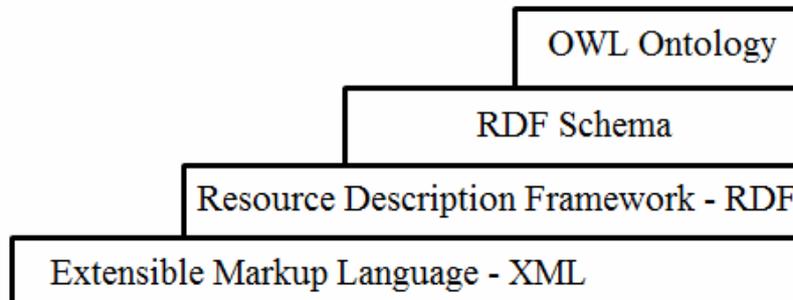
Obtaining sets of tests that will constitute an examination involves selecting a number of tests with the **nivel** and **data** criteria from a virtual table ordered ascending or descending by the **sort\_aleator** field. This we can achieve with the following instruction:

```
SELECT TOP 10 qry_teste.id, qry_teste.curs,
qry_teste.format, qry_teste.sort_aleator,
qry_teste.nivel, qry_teste.instructiuni,
qry_teste.data
FROM (SELECT teste.id, teste.curs, teste.format,
teste.sort_aleator, teste.nivel, teste.instructiuni,
teste.data
FROM teste
ORDER BY teste.sort_aleator) qry_teste
WHERE (((qry_teste.nivel)=1) AND
((qry_teste.data)>#6/6/2008#));
```

Accordingly to Buraga (2009) Semantic web is based on SOA (Service Oriented Architecture), an architectural style for development of services considered to be invoked by other applications. In general, system components have a high degree of independence and the services can be restructured according to the requirements. SCA (Service Component Architecture) reuse software components, providing facilities for defining, assembling, and invoking mediation services from the object-oriented point of view. Transferring data from storage systems is facilitated by SDO (Service Data Objects).

Resources can be classified as taxonomies, according to previously established relationships between entities that represent the real world. Accordingly to Micky (2009), ontology is a formal description of concepts and relationships between them. It is a specification of a field, a formal representation of it. Ontology is an important part of the semantic web. The idea of semantic web is to contain data, not documents. Web should be a basis of knowledge that can be understood and processed by both humans and computers. Ontologies help to create the knowledge base by structuring information in a form common to both parties.

In generating web pages, we seek to respect the OWL (Web Ontology Language). OWL (fig. 8) is intended to provide a language that can be used to describe classes and relations between them, inherent to object-oriented web applications. It extends RDF by practical possibility of using instruments to inference ontology data. An OWL ontology consists of classes, instances of classes and relations between instances of classes, after W3C (2004).



**Fig. 8.** Semantic web layers, after Hobbs (2003)

The main directions of application of OWL concern:

- d<sub>1</sub>. formalizing domains** by defining classes and their properties
- d<sub>2</sub>. definition of entities and attributes** that differentiate them,
- d<sub>3</sub>. relations between classes and categories of entities** covered by the OWL formal semantics.

Depending on the level of complexity and taxonomic relation, the OWL proposes three languages, mutually compatible:

- **OWL Lite** allows descriptions of objects organized hierarchically (site map) and allows a limited set of restrictions, such as cardinalities of the type (0.1) and (1.1);
- **OWL Description Logics (DL)** tightly separates the types of entities and is suitable expert systems;
- **OWL Full** treats a class both as a general type and as an object.

**Curs, utilizator** and **test** class we'll be defined in OWL as follows:

```

<owl:Class rdf:ID="Curs" />
<owl:Class rdf:ID="Utilizator" />
<owl:Class rdf:ID="Test" />
  
```

An instance of the **curs** class may be obtained with the following expression:

```

<Curs rdf:ID="Tehnologia_informatiei" />
  
```

Properties are binary relations which specify the facts concerning a class or individuals. Properties may be objects or common data types. An object property is defined as follows and associates two different instances of the **continut** and **curs** classes:

```

<owl:ObjectProperty rdf:ID="curs">
  
```

```
<rdfs:domain rdf:resource="#curs" />
<rdfs:range rdf:resource="#continut" />
</owl:ObjectProperty>
```

A common type property is defined in the next example and it is initialized by the following expressions:

```
<owl:DatatypeProperty rdf:ID="data">
<rdfs:domain rdf:resource="#curs" />
<rdfs:range rdf:resource="&xsd;positiveInteger"/>
</owl:DatatypeProperty>

<curs rdf:ID="Tehnologia_Informatiei">
<data rdf:datatype="&xsd;positiveInteger">170908
</data>
</ Tehnologia_Informatiei >
```

Restrictions are considered classes defined by describing the properties of individuals which may include specifying a lot of individuals in terms of known classes (sharing common properties) and some can use this description to define a more restrictive new class. Classes and properties can have multiple definitions. Statements about individuals should not be required to be stored within the same document.

#### 4. Conclusions

eLearning may be the answer for many problems that mark the classic educational system like time sharing, mobility, high fees and availability. In time, with the gradual implementation of the semantic web, it may change even the very nature of the internet that may stand today for chaotic and valueless information, to a more organized and responsible like global network. There are many steps to be taken forward these noble goals but one day we'll look back at this stage of development and wonder at our incapacity to prevent innocent exposure to harmful content.

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