The Design of a University Ontological Knowledge Base

T.G. Balova*, G. Zhomartkyzy **

* D. Serikbayev East Kazakhstan State Technical University, Department of Information Systems, Ust-Kamenogorsk, Kazakhstan

** *D. Serikbayev East Kazakhstan state technical university, Department of Information Systems, Ust-Kamenogorsk, Kazakhstan

e-mail addresses: TBalova@ektu.kz, GZhomartkyzy@ektu.kz

Abstract **—** Information and Communication Technologies (ICT) are playing more and more important role in the development of the society and, consequently, education. ICT provide new representation languages that allow the development of new learning scenarios. Institutions of higher education must use these new technologies for improving their educational processes. In this sense, ontologies and semantic web technologies are appropriate technologies for knowledge management in educational settings. This paper examines applied ontologies used at higher education institution's portal and aims at the development of ontology for a university portal information system based on that ontology.

I. INTRODUCTION

Today there is an urgent task to form and design a university educational environment ontology as a part of a university's educational space design and formation according to Bologna model. It is also necessary to create a multi-level aggregation of ontologies at all stages of information and communication environment development. [1]

The main problem in the development of learning management systems (Learning Management Systems) is to provide the flexibility and personalization of information resources (content) and services. [2]

The use of information and communication technologies in the context of education has become so prevalent that new models of information resources management allow users to create, present and share knowledge. [1]

The world community has gained some experience in making ontological systems and related portals using the latest Semantic Web (SW) technologies which allow to implement semantic description and comparison of a variety of information resources, to carry out their identification and semantic search. For this purpose, create modern software, which is used to design, build and test an ontology containing semantic description of resources and the domain. [2]

These technologies allow to develop automated control over compliance with schools' regulations, to form a list of directions, specialties, and specializations of training at a higher education institution, as well as to create relevant information banks [3]. Thus, there is a need to use gained knowledge in order to develop an ontological portal of educational information resources management and evaluation.

II. FORMALIZATION OF ONTOLOGICAL KNOWLEDGE BASE MODEL E-UNIVERSITY

Since the problems associated with the problems of knowledge, are a class of semistructured problems developed conceptual series that reflects our concept of knowledge formalization from concept "Knowledge of high school" to "Ontological model of University knowledge representation":

- knowledge of the university is a complex combination of intellectual assets that have a certain level of value to the university and related common structure used in high school terms;

- knowledge of the e-university is that part of the knowledge of the university, which have the property of explication and exist as formatted documents in any electronic medium;

- e-university knowledge base is a combination of knowledge of e-university organized in a way that provides access to the knowledge, the ability to expand and bring new knowledge;

- knowledge representation model is Semantic Web the vertices of which are the concepts of the knowledge base, and the direction of the arc specifies relationship between them;

- ontology is one of the most developed ways of describing the semantic web at present which allows the use of formal languages to describe them (RDF and OWL) and rigorous descriptive logic device to perform inference on the concepts of ontology's metadata [4-5].

Creating a unified ontology for a detailed description of a university knowledge model is carried out gradually based on the priorities of tasks.

Based on the basic concept of the university knowledge formalization presented above we propose a model to use the university knowledge as interrelated and consistent set of ontologies:

$$O = \{ O_U, O_{IR}, O_{SK} \},$$

where:

O_U is a general concept ontology of high school as a top-level ontology

O_{IR} is hierarchically organized, consistently extensible ontology of information resources;

$O_{SK} = \{O_i\}$, is hierarchically organized, consistently extensible ontology main knowledge areas O_i significant for the university.

The description of each object R_i of the ontological model O corresponds to the class with a set of semantic metadata:

$$R_i \in C(O) = (Mk_i(O), Mc_i(O)),$$

where:

$Mk_i(O)$ is context metadata of knowledge object describing the relationship of the object with other objects and ontology's concepts;

$Mc_i(O)$ is content resource metadata that describes the information contained in the object.

Multilingual thesauruses which include the terms of the domain in the form of words and phrases in multiple natural languages act as linguistic addition to the ontology in which the concept of ontologies is represented in the texts and user queries.

Formalized ontological knowledge model and meta descriptions of resources make it possible to search for and measure proximity (similarity) in the intellectual resources of the knowledge space.

To formalize the model are also subject to semantic query search. In the model of the semantic search query object or set of objects of a certain class of ontologies used describe the properties of objects, relationships between them are defined. Model of semantic search request:

$$Q=\{R_i C(O) | P(R_i) \& R^1(R_i) \& R^{-1}(R_i)\}$$

where:

$R_i \in C(O)$ is a desired object or set of objects of ontology class which satisfy the properties described in the request;

$P(R_i)$ is a desired object property description Ri of class $C(O)$ in the form of restrictions on the values of class properties;

$R^1(R_i)$ is the properties of objects describing the "direct" relationship between objects of the $C(O)$ class;

$R^{-1}(R_i)$ is the properties of objects describing the "inverse" relationship between objects of the $C(O)$ class.

The estimation of the distance or similarity between the metadata $S(M_i, M_j)$ can be determined through the similarity of their constituent statements in the language of descriptive logic [6].

The model to estimate semantic proximity or similarity between the metadata is the following:

$$S(M_i, M_j) = \sum_I \sum_J sim(T_i, T_j)$$

where:

$S(M_i, M_j)$ is a value of semantic proximity meta descriptions of the object i and object j;

$sim(T_i, T_j)$ is a value of proximity concepts of T_i and T_j in the language of descriptive logic included in the compared meta descriptions.

The results create a taxonomy of classes of the e-university. The results create the e-University taxonomy of classes. Figure 1 shows the structure of the taxonomy of science and electronic educational resources classes.

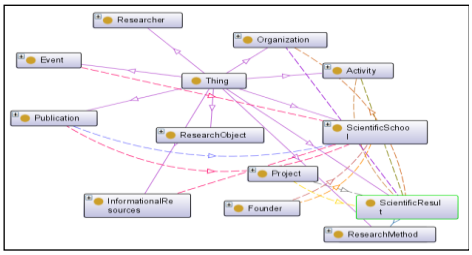

Figure 1. Ontology classes taxonomy

When creating the taxonomy we used the following resources:

- the existing IEEE standard for describing learning objects metadata (Learning Object Metadata, LOM) and application profile IEEE LOM metadata to describe the learning resources [7-8];
- a set of Dublin Core metadata for describing educational resources [9];
- DL dialect language OWL (Web Ontology Language) which supports the descriptive logic;
- an open cross-platform editor ontology Protégé 4.1 developed by the Stanford Center for Biomedical Informatics Research (belongs to a class of free software license MPL (Mozilla Public License)).

The proposed ontological model of the university knowledge base is being developed for the following tasks: to create a technological infrastructure for the interaction of distributed learning environments based on a model for credit by type ECTS; to monitor the development of scientific schools of the university.

REFERENCES

[1] J. T. Fernández-Breisa, D. Castellanos-Nievesa, J. Hernández-Francob, C. Soler-Segoviaa, M.C. Robles-Redondoa, R.González-Martíneza, and M.P. Prendes-Espinosac. "A semantic platform for the management of the educative curriculum," Expert Systems with Applications, vol.39, issue 5, pp 6011–6019, April 2012.

[2] S. Bianchi, Ch. Mastrodonato, G. Vercelli , and G. Vivanet "Use of Ontologies to Annotate and Retrieve Educational Contents: the

AquaRing Approach, “ Journal of e-Learning and Knowledge Society, vol. 5, n. 1, pp. 211 – 220, February 2009.

[3] N.V. Ryabova, A. Shevchenko, and M.V. Beloivanenko “Razrabotka arhitektury raspredelennoy versii ontologicheskogo portala MONU”, http://www.twirpx.com/file/278772/.

[4] T. R. Gruber. Toward Principles for the Design of Ontologies Used for Knowledge Sharing. International Journal of Human Computer Studies, pp. 907–928, 1995.

[5] A.F. Tuzovskiy, NB.Ngok, "Model informatsionnogo poiska ha osnove semanticheskih metaopisaniy", http://ubs.mtas.ru/bitrix/components/bitrix/forum.interface/show_file.php?fid=6034

[6] IEEE LOM, http://www.metadata.ru/content/view/33/52/http://www.dublincore.org/groups/

[7] Metadannye dlya informatsionnyh resources sfery education. Spetsifikatsiya informatsionnoy modeli, Moscow – 2006