

# Methodology of Object-Oriented Knowledge Base Development for Increase of Educational Quality

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## Abstract<sup>1</sup>

The paper is devoted to the problem of the education quality increasing on the base of knowledge management technique. The knowledge interchange strategy is a new approach in solving education process problems through cooperative knowledge base of the university. Objective-cognitive analysis methodology is presented for the knowledge base design. This methodology integrates methods of the objective analysis and design, semantic analysis and ontology analysis of domain. Semantic Web Rule Language is used for modelling rule-based metadata in the ontology of education process management. The algorithm of the decision support in the problem situations is presented. The example of application of the knowledge management technique in the development of courses is discussed.

## 1. Introduction

Nowadays one of the most relevant tasks in educational domain is the increase of educational quality. An important constituent of the educational quality problem is psychological individual aspect. The social aspect of this problem is the problem of specialists educating

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quality, that is a central problem in the question of it's great demand in modern society and in the question of international recognition of Russian degrees and qualifications. This problem is closely related to the educational content and to the educational programs realization technology.

Knowledge is the main value in the university activity. University knowledge are: teacher's methodical instructions, science results of the university science staff participation in science researching. Effective usage of stored knowledge undoubtedly increases the quality of educational processes.

## 2. The Survey of the Existing Approaches to the Problem Solution of Educational Quality Increase

Existing approaches to the problem solution of educational quality increase consist in the increase of teaching quality and in educational process management perfection. The solution of the problem of educational quality increase firstly means the perfection of education-methodical provision and perfection of constituents of educational process. It is important to use modern intelligent technologies, because the main part of criteria are qualitative, not quantitative. Secondly, it is possible to perfect the educational quality management with the help of virtual education system introduction: development of electronic learning courses, electronic tests, training tasks.

Electronic learning course is a computing learning tool. It is intended for teaching the course and provides the theoretical training using different knowledge presentation tools (texts, graphic, multimedia).

Usually, existing systems of electronic courses development are directed to the effective usage of

program components. At the same time the problem of electronic course content is still not enough investigated. In this connection the following weakness of computing education tools are brought to light: content locality that leads to limited usage of computing education tools, considerable volume of efforts course content development and efforts of computer realization conception development (knowledge structurization tools, control methods and knowledge evaluation criteria, etc.). It is necessary to have a concordance between the course content and requisites of state educational standard, branch qualification requisites, adjoining courses requisites and basic courses programs. Nowadays the main part of university methodical material is an archive. Unfortunately, this knowledge is not used in corpore. It is important to activate the knowledge we have to give birth to the new knowledge. To solve this task it the application of the intelligent information system on the base of Educational Knowledge Base (EKB) to the educational process management system is proposed. It is proposed to develop this system on the base of object-cognitive methodology that integrates methods and results of object-oriented analyses, ontology analyses and semantic net of knowledge presentation. For the development of virtual education system it is recommended to carry out the object-cognitive analysis, keeping to the following principals:

1. The principle of the hierarchical knowledge composition based on the different knowledge representation forms applying, polymorphism of the description relations between semantic net objects and polymorphism of the logical inference.

2. The principle of attributes inheritance based on the relation "class-subclass" in the concepts description of the different knowledge representation forms.
3. The principle of the ontological analysis and the domain semantic modelling integration on the base of concepts hierarchy.
4. The principle of embedding of the concepts into domain ontology on the base of controlling object-oriented analysis.
5. The principle of the similarity measurement in the semantic nets on the base of domain terms cluster analysis and development of the taxonomical hierarchical ontology structure.

Thus, the results of the object-cognitive analysis are formal descriptions of relations between abstract concept and entities  $a_i \in A$  which are the domain basic objects (cognitive elements), in ontology with description logic.

### 3. Conception of Educational Process Quality Management

In consideration of educational quality on the inside as index of university functioning quality and on the outside as index of specialist educating, we may conclude that Integral Index of Complex Valuation of Educational Quality is a sum of Inherent Valuation of Educational Quality (potential quality and educational process quality) and of Exterior Valuation of Educational Quality (quality of the result of education).

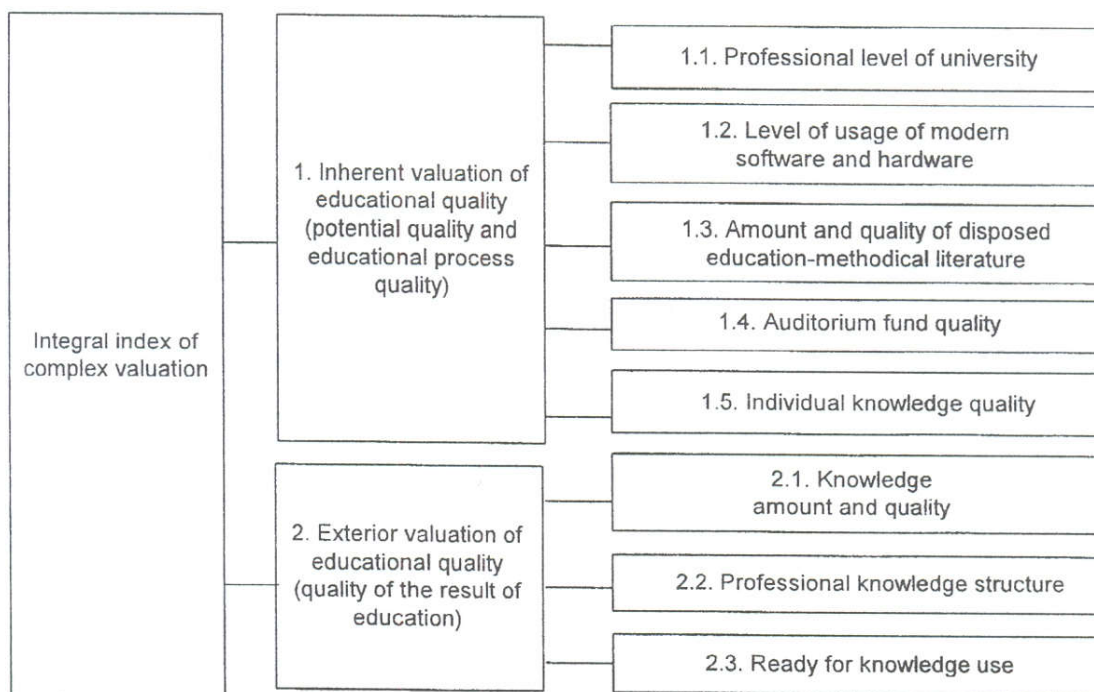


Figure 1. Hierarchical System of Educational Quality Indexes



On the figure 1 there is shown the hierarchical system of educational quality indexes.

Consecutive hierarchical decomposition of each integral property based on result of ontological analyses allows to determine the multitude of educational process objects that may be determined on the base of measured data in educational process or may be evaluated by experts. Then rating scale (consists of 5 types of values: low, less than middle, middle, higher than middle, high) brings into line with each named element. In numerical expression following ranges correspond with these values: 0-0,2; 0,21-0,4; 0,41-0,6; 0,61-0,8; 0,81-1.

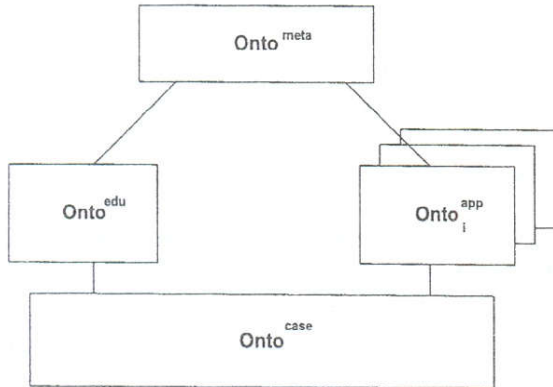


Figure 2. Hierarchical Structure of Educational Process Ontology Classes

#### 4. Educational Process Ontology

It is proposed to structure the knowledge about the educational process quality with the help of ontological analyses the base of which is domain description in terms of entities, relations between entities and actions with entities. Thus, in the process of structure ontology of educational process is represented as a hierarchical system (figure 2). Ontology sets the unified information space where integrate models of educational process knowledge, knowledge of specific domain of specialists educating (representation form is ontology  $Onto^{edu}$ ), rules of educational process management ( $Onto_i^{app}$ ) and cases of specific problem situations. Ontology of educational process includes ontology of the highest level (metaontology)  $Onto^{meta}$ , ontology of education  $Onto^{edu}$  and subject ontology of different specialists educating  $Onto_i^{app}$ .

$$Onto = \langle Onto^{meta}, Onto^{edu}, \{Onto_i^{app}\}, Inf \rangle,$$

where  $Inf$  is an inference associated to the ontological system  $Onto$ . The entities of metaontology  $Onto^{meta}$  are terms as "object", "attribute", "value", "relation" e.t.c.

Ontology  $Onto^{edu}$  operates with terms that characterize process of specialists educating (fore example, "university", "teacher", "student", "learning course" e.t.c.) and it is generated according to ontology  $Onto^{meta}$ . Subject ontology  $Onto_i^{app}$  includes terms that characterize semantic of specific specialists specification ("educational standard", "special discipline", "information technology" etc.) and that are structured according to the hierarchy of specific specialty. The structure of considered domains presumes that there are the following relations in ontology: inheritance, static aggregation, and several types of associative paradigmatic relations (aggregation, case-based relations, similarity and semantic similarity). Inflated subject ontology  $Onto_i^{app}$  may be both: a component of knowledge base and a model of generation of dynamic component for knowledge base that exchanges while exploring different tasks.

To develop the ontology the case-tool of ontology development "Stanford's Protégé 3.1." with OWL and SWRL plug-in for ontology and knowledge base encoding was used (figure 3).

Rule formalization is made on the base of descriptive logic and cases are the examples of ontology classes, they represent the aggregate of objects. Case-based reasoning realizes on the base of analogical principles and corresponds to CBR-principles. Further the example of EKB usage for educational process information support is presented. In the table there are shown methods of ontology of educational process usage for educating specific specialist as thematic decomposition of electronic learning course and tests development.

Table

$Onto_i^{app}$	Thematic decomposition of learning course content, learning fragment terms determination
$Onto^{case}$	Decision making in problem situation (modern learning courses development) on the base of methodical resources of the university

$Onto^{edu}$  is educational management ontology on the base of which quality indexes of educational process are determined.

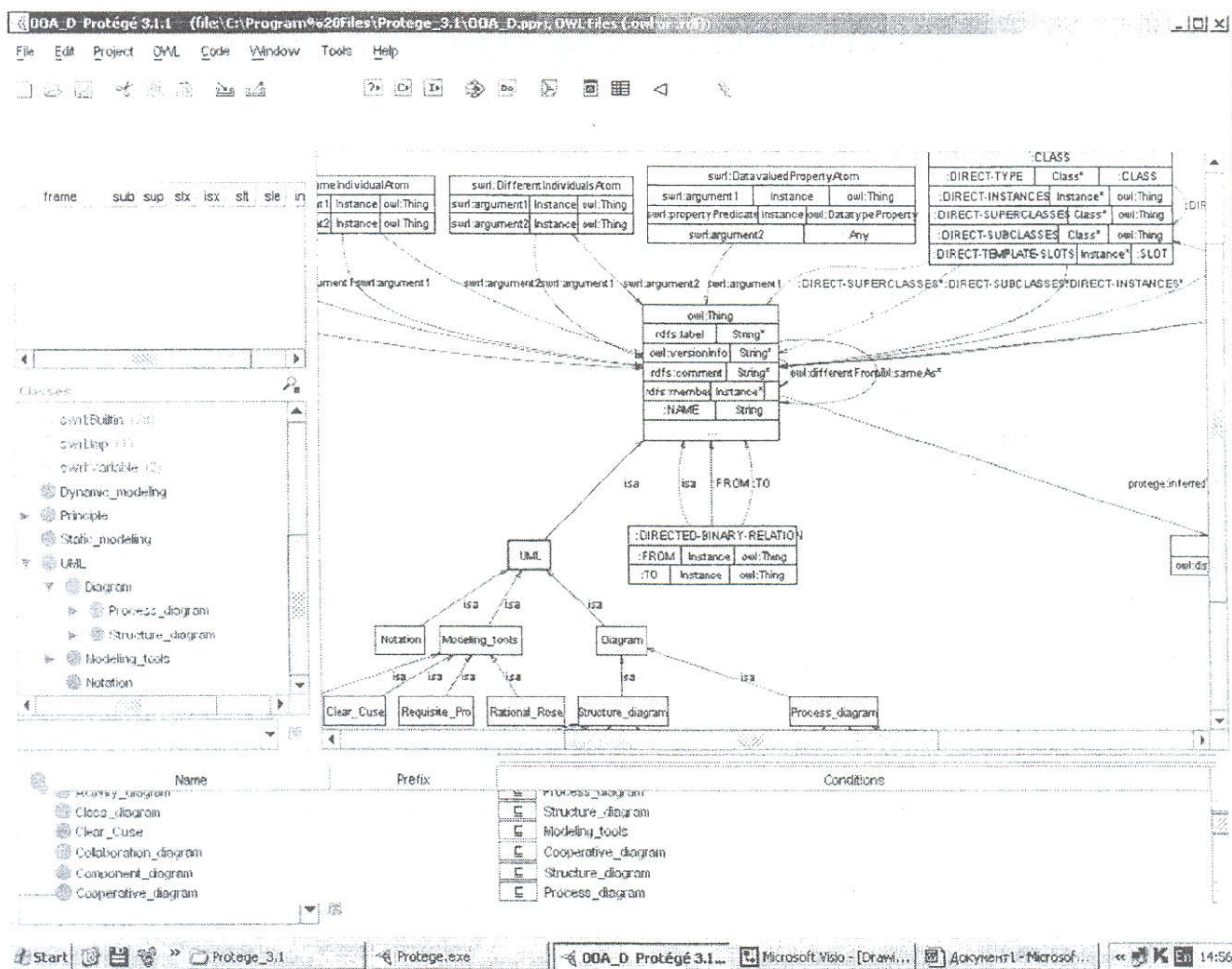


Figure 3. Ontology Development with the Help of Stanford's Protégé 3.1

## 5. Conclusion

It is represented that EKB developed on the base of object-oriented approach may be used for quality indexes generation and for learning courses development. The usage of electronic learning courses in the educational process developed on the base of EKB leads to following aspects:

1. educational quality increase owing to the development of didactic and methodic of modern educating forms;
2. decrease of costs for educational process organization and management;
3. redistribution of teachers working load from routine to creative activity and individual approach to teaching;

4. increase of efficiency of educational process provision by learning-methodical tools during the changes of structure and content of educating.

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