Development of knowledge base of intellectual system for support of formal and informal training of IT staff

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Abstract. The choice of educational digital content, according to education goals (descriptors which are formed by competences, labor functions, etc.), becomes an important practical task because of the variety of existing educational online systems that is available to persons within formal, informal IT education formats. Ontologies can form a basis for working out knowledge bases, which are center of intellectual system support in IT specialist training. The paper describes a technology of ontological model creation; analyzes the structure and the content of basic data. The structure of knowledge interrelation of the considered subject and IT education is considered. This knowledge base is applied for solving tasks of educational and methodical supplementation of educational programs of the higher and additional professional education, corporate training; for creating systems of certification and testing for students and practicing experts; for forming individual trajectories of training and career development.

1. Introduction

The leading role of information technologies in development of modern society and production causes special requirements for vocational training of IT specialists.

To provide the necessary level of training results formation, numerous normative and recommendatory documents are developed and applied such as frameworks of competences and qualifications, educational and professional standards.

Requirements for the results of IT specialists training are formalized in normative and recommendatory documents of various levels.

In Figure 1 there is the chart of the knowledge structure according to the requirements for the results of IT specialists training (Knowledge structure diagram) that are significant for this research.

The knowledge which describes the requirements for results of education, and training of IT specialists is divided into two groups – knowledge of the educational and professional environment (Kurzaeva L.V., 2016).

Each of them contains documents of national and international levels.

"The other knowledge" represents three types of knowledge: procedural, conceptual and factual which sources are the standards that describe procedures of professional tasks solutions, IT methodologies and terminology of IT branch.

The complexity of documents coordination, which is presented in the chart, is explained by different interpretations and features of competence-based approach application.
Knowledge structure for training IT professionals

![Diagram](image_url)

**Figure 1.** Knowledge structure diagram "Requirements to results of IT specialists training»

- level and disciplinary (as in international educational standards CC2016, projects of Tuning);
- qualification and position (as in professional standards);
- qualification and process (as in professional framework of competences);
- qualification (as in framework of qualifications) (Kurzaeva L.V., 2013).

Under the circumstances, their combined application is a difficult task which solution is in a combination of such scientific directions as pedagogics, engineering of knowledge and management of knowledge of the organization. Thus, as existing studies demonstrate (Boeker M, Chusavitina G.N., Popova I.V., Rybina G.V.), it has a cross-disciplinary character.

The observed discrepancy between the existing various descriptions of requirements for results of IT specialists training and complexity of their cooperative application courses, there is a problem of harmonization of requirements for IT preparation within formal and informal education.

Moreover there is something more in the systems of formal and informal education. Now the special popularity in the conditions of formal and informal training is gained by the mass open online courses (MOOC).

MOOC is meant as an educational internet course that is taught in a specific format on specialized platforms.

The main advantages of using MOOC in an educational process are free access to educational content, for teachers – an opportunity to provide training and assessment of knowledge gained by persons in the online mode, for persons – an opportunity to receive the certificate confirming successful development of a course; for educational institutions – an opportunity to present the best educational practices in the world educational market.

Such courses can become an addition to traditional forms and methods of formal and informal education, and in certain conditions they could be an alternative which will allow persons not to
interrupt a process of self-development and self-education in rapidly changing conditions of modern life.

However, the variety of platforms of continuous education and online courses complicates the search of necessary training material [5].

The solution of this task may be in development of the decision-making support system on the basis of the ontological knowledge base, by means of which it is possible to find an online course according to the disciplines, competences and labor functions.

Within formal training, this system will allow one to select online courses for disciplines and competences according to the educational plan.

Within informal training, this system will allow one to select online courses according to requirements of professional standards during rotation and professional development of IT specialists.

For the development of the knowledge base of intellectual system support of formal and informal training, the following sources were used.

1. Federal State Educational Standards (FSES) of the following directions: 090303. Application-oriented Informatics (it is registered in the Ministry of Justice of the Russian Federation on March 27, 2015 N 36589), 38.03.05 Business Informatics (it is registered in the Ministry of Justice of the Russian Federation on June 28, 2011 N 21200);
2. Curricula of the above-mentioned directions of preparation.
3. Professional standards.
4. Courses of open education of the Open Education platform

The developed knowledge base will act as a centre of intellectual system support of formal and informal training which will allow one:
- to provide support of educational programs development on the basis of the agreed requirements of FSES and professional standards
- to increase the efficiency of educational programs development and implementation within formal training;
- to increase efficiency of corporate training systems.

2. Functions
The main functions of the system are:
- storage of data on the existing online courses, disciplines and labor functions;
- input of the discipline description according to curricula;
- input of the competences requirements description to FSES;
- input of the labor functions description of the professional standard;
- performance of online courses search requests from the list of open online education on the specified discipline, competence, labor function or in their combination.

The decision-making support system will include the recommendation about online courses only for the disciplines, competences and labor functions that are connected with IT specialists training.

Main aspects which have formed the basis of intellectual system development of support of formal and informal training have been integrated in the intelligent card of the project (Figure 2). Design and development of the ontological knowledge base "Open IT education" were carried out in the editor of ontologies and framework for creation of knowledge bases of Protégé.

3. Classes
The process of the knowledge base development was divided into the following stages.
1. Design of the knowledge base:
   – definition of classes in ontology;
   – organization of classes in some hierarchy (a basic class —>; a subclass).
   – definition of slots and their admissible values.
2. Control of a data form of input copies.
3. Filling of copies of the class "Directions_of_training".
4. Filling of copies of a class of “Professional_standards”. 
5. Filling of copies of the class "Platforms".
6. Check of consequence of the knowledge base.

The developed hierarchy of classes of ontology looks as follows (subclasses of professional standards are not presented for simplification):

- Platforms
  - Open \_education
    - Courses\_OE
- Directions\_of\_training
  - FGOS\_Applied\_informatics
    - Disciplines\_AI
    - Formed\_competences\_AI
      - General\_cultural\_competences\_AI
      - General\_professional\_competencies\_AI
      - Professional\_specialized\_competences\_AI
      - Professional\_competences\_AI
  - FGOS\_Business\_Informatics
    - Disciplines\_BI
    - Formed\_competences\_BI
      - General\_cultural\_competences\_BI
      - General\_professional\_competencies\_BI
      - Professional\_specialized\_competences\_BI
      - Professional\_competences\_BI
- Professional\_standards
  - PS\_Database\_Administrator
    - Labor\_functions\_DA
The knowledge base includes platforms of online courses, directions of preparation and professional standards the corresponding classes are created for them. Professional standards will be identical regarding the structure of subclasses.

The structure of the ontological model of the designed knowledge base is presented in Figure 3. Similar classes are excluded in the graphic model.

Let us consider creation of the class "Direction of training". The following is selected as the directions of preparation: 38.03.05 Business Informatics and 09.03.03 Applied Informatics; therefore as a subclass of the class "Directions_of_training", the following subclasses were created: "FSES_Business_Informatics" and "FSES_Applied_Informatics".

These classes are the abstract ones as the modelling concepts are general, not connected to some specific entity; at the same time, they cannot have copies without more detailed study.

For the classes "FSES_Business_Informatics" and "FSES_Applied_Informatics", subclasses of "Disciplines_BI", "Formed_competences_BI" and "Disciplines_AI" and "Formed_competences_AI"

**Figure 3. Structure of classes of ontological model of knowledge base "Open IT education"**
respectively have been created. The knowledge base will be filled with online courses of the Open Education platform. For the class "Platforms", the corresponding subclass of "Open Education" of abstract type, which in its turn includes a subclass "Curses_OE" of particular type, is created. While working out slots of the subclass "Curses_OE", the authors followed the norm standards of the online courses description. According to this standard, the following slots were created: "author_course", "university_developer" and also slots which are necessary for communication with other classes: "includes_discipline", "includes_competences", "includes_the_direction_of_training", "includes_PS", "includes_labor_function".

For checking competence of ontology, a set of inquiries was made. The test check and experts’ assessment confirmed the correctness of the answers to the requests that were given by the system.

4. Conclusion
The developed knowledge base can become a part of the support system of formal and informal training of IT specialists and can be applied to elaborate educational programs of secondary professional, higher and additional professional education and corporate training; to create systems of testing and certification of students and practicing specialists; to form an individual trajectory of training and career development.

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