Ontological Approach to the Presentation of the Subject Area of the Discipline

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Abstract: The article considers the problem of methodology of designing computer ontology of the subject area of the discipline by future specialists in the field of digital technologies. The scheme of ontology of the subject discipline is presented in which the set of concepts of the future computer ontology and the set of relations between them are represented. The main criteria of the choice of systems of computer ontologies for designing computer ontology of the subject discipline: software architecture and tools development; interoperability; intuitive interface are established. The selection of ontology design methods by means of computer ontology systems has been specified. An algorithm for designing a computer ontology of the subject area of the discipline by future specialists in the field of digital technologies is proposed. The effectiveness of the proposed scheme of ontology of the subject area of the discipline and the proposed method of technology has been investigated experimentally on three indicators: 1) the speed of construction of ontologies; 2) the number of defects; 3) the speed of addition of already created ontologies.

1 INTRODUCTION

One of the important trends in the development of modern computer systems is ontologically managed information systems. The construction of the latter is closely connected with the development of theoretical foundations and design methodologies including a formalized approach, fundamental principles and mechanisms, generalized architecture and structure of the system, a formal model and methodology for designing ontology of the subject field (including ontologies of educational disciplines), formal model of presentation of knowledge, generalized algorithms of procedures for knowledge processing, etc. Accordingly, each of the listed components of the general design methodology is a complex information-algorithmic structure and falls within the scope of future specialists in the field of digital technologies. Comprehensive solution of these tasks of design will provide an opportunity to enhance the role of ontological (conceptual) knowledge in solving concrete problems in applied branches in general and in the educational process in particular (Dovhyi et al., 2013, p. 9).

Ontologies are a promising technology for the development of modern educational systems. Representing the basic concepts of the subject area in a format available for automated processing in the form of a hierarchy of classes and relationships between them, ontologies allow for automated processing of the semantics of information units.

Depending on the approach used in modeling subject knowledge (thematic, functional, procedural, operational or semantic), there are different methods of

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structuring information concepts of the subject area (Gruber, 1995, p. 911): semantic networks, lattice theory, operations on graphs, genetic algorithms, neural networks, ontologies and other mathematical models.

However, the process of designing computer ontologies is complex and lengthy and requires knowledge of many declarative languages, and in order to facilitate it, there is a need for the use of certain systems created to design computer ontologies that provide such interfaces that allow them to conceptualize, implement, verify inconsistency and documentation. In recent years the number of tools for working with computer ontologies has increased dramatically (more than 50 editing tools). However, most of these tools are intended to use existing ontologies by the help of formal languages, such as: Common logic; Cyc; Gellish; IDEF5; KIF; Rule Interchange Format (RIF) and F-Logic; OWL; XBRL (Ovdei and Proskudina, 2004). Therefore, in the process of training future professionals in the field of digital technology, there is a need to use these systems for designing computer ontologies that could provide interfaces that would allow operations to be carried out in connection with the formal representation of sets of concepts and relationships between them. Computer system ontology (CSO) are a certain answer to this need, especially in the context of designing a computer ontology of the subject area of the discipline by future specialists in the field of digital technologies.

The process of developing and using ontology in general form is considered by Noy and McGuinness (Noy and McGuinness, 2001), Nirenburg and Raskin (Nirenburg and Raskin, 2004). Problems of ontologies and their use in computer systems were considered by Lapshyn (Lapshyn, 2010). The discovery of the meaning of the concept of "ontology", given to it in the computer sciences, the works of Gruber (Gruber, 1991, 2008, 2007, 2006, 2003, 1993; Gruber et al., 1996) and others are devoted to it. Some aspects of the use of computer ontologies, in the context of intellectual technologies, are discussed in (Spirin, 2004; Lytvyn et al., 2013; Tsidylo, 2014). An overview of the instruments of ontology engineering was done by Ovdei and Proskudina (Ovdei and Proskudina, 2004). Methods for creating an interface based on ontology in the environment of the web portal were studied by Popova and Stryzhak (Popova and Stryzhak, 2013), Stryzhak (Stryzhak, 2016). The modeling of the ontology of the educational subject field as a means of integrating knowledge was studied by Yevseeva (Yevseeva, 2009), Liubchenko (Liubchenko, 2008), Stryzhak et al. (Stryzhak et al., 2014) and others. Modeling the categorical level of the language-ontological picture of the world was done by Palahin and Petrenko (Palahin and Petrenko, 2006). Ontological representation of decision-making processes was done by Chaplinskyi (Chaplinskyi, 2009). Using the ontology of the subject area to eliminate ambiguities in the computer translation of technical texts was proposed by Morentsova (Morentsova, 2018). The works of the above-mentioned authors contributed to the accumulation and systematization of knowledge for improving the practical training of students on the creation and use of computer ontology. However, they do not sufficiently disclose the peculiarities of training to create an ontology of a particular subject area in the training of future professionals in the field of digital technologies, taking into account their professional engineering and professional pedagogical activities.

The *purpose* of the article is to substantiate the ontological approach of presenting the subject area of the discipline as a means and result of systematization of knowledge of future specialists in the field of digital technologies.

2 RESULTS

In the process of training specialists in the field of digital technologies at higher educational institutions, the study of intelligent systems, in which ontologies are used for the formal specification of concepts and connections inherent in a certain field of knowledge, occupies a significant place. Since the computer cannot understand how a person does, the state of things in the world, it must be submitted with all the information in a formal way. Consequently, ontologies serve as a kind of model of the surrounding world, and their structure is such that it is easily subjected to machining and analysis. Ontologies provide the system with information about well-described semantics of given words and indicate the hierarchical structure of the medium and the relationship of the elements. All of this allows computer programs to draw conclusions from available information and manipulate those using ontologies.

Hence, it is Gruber (Gruber, 1991) who authored the concept of "ontology" in engineering. The task of constructing a description of knowledge is very specific. Therefore, Gruber (Gruber, 1991) has identified a specific term for this task – the "specification of conceptualization". Under "conceptualization," he understood "an abstract, simplified view of the world, which is used by people to realize a certain goal" (Gruber, 1991, p. 602). The peculiarity of the task of conceptualization lies in the fact that for the exchange of knowledge between software systems (in the context of the concept of artificial intelligence), it is necessary to openly specify their conceptualization, that is to build a description of this knowledge, moreover, sufficiently formal, that it was "understood" by other systems.

In the process of developing intelligent systems, the most time-consuming are the stages of conceptualization and formalization, which are considered in work (Buyak et al., 2018) in the process of designing a structural model of a neuro-fuzzy expert decision-making system for determining the professional selection of students for the training of IT specialties.

More specifically, the concept of ontology is defined by Faure et al. (Faure et al., 1998), who assumes that ontology is an explicit specification of a particular topic.

Therefore, the ontological approach allows a formal and declarative presentation of a topic covering a dictionary (or list of constants) to refer to the terms of a particular subject area, limiting the integrity of these terms or logical statements that limit the interpretation of terms and how they are combined with each other.

Thus, ontology defines a general terminology for scholars who need to share information in a particular subject area. It covers suitable for interpretation by means of a computer definition of the main concepts of the subject field and the interconnection between them. With the increasing popularity of usage of computer ontologies, their study should be included in the curricula of the higher educational institutions, since they can generate test tasks, create didactic materials from different disciplines and branches of knowledge, etc.

However, as mentioned above, the process of designing computer ontologies is complex and time-consuming and requires knowledge of many declarative languages, so in the activities of future professionals in the field of digital technologies it is more appropriate to use CSO that are a computer program or software package that intended for the construction of computer ontology from a certain subject field and perform operations related to the formal representation of sets of concepts and relationships between them, in addition, computer ontologies can be exported to a variety of formats, including invoking RDF (RDF Schema), OWL and XML Schema, etc.

Regarding the choice of a specific CSO, it should be implemented according to some of the following criteria: 1) software architecture and development of tools containing information about the necessary platforms for using the tool; 2) functional compatibility, which includes information on tools and interaction with other languages and tools for the development of ontologies, translation from some languages ontologies; 3) the intuition of the interface, covering the work with graphic editors, the co-operation of several users and the need to provide multiple use of ontology libraries (Kozibroda, 2016, p. 179).

However, to build a computer ontology of the subject area of the discipline, future professionals in the field of digital technology must also reflect the content of the subject area of the discipline, which is described as a list of modules implemented in various forms of classes in a particular discipline. At the same time, relevant competencies for each module are indicated besides the content, form and control, and their extent. Based on the analysis of the subjects and objects of the learning process, the processes of creating and managing the educational material, one can identify the following problems that arise during the development of the training course:

- high complexity of the process of finding new teaching materials;
- the need to assess the conformity of educational resources with the requirements of the content of the training course;
- providing educational resources with the full coverage of the modules of the discipline in general and the course in particular;
- excessive coverage of the modules of the discipline and implementation of the choice of the most optimal educational resource for a particular situation;
- the need to assess the quality of educational resources.

Thus, in the process of developing content modules of the discipline it is important to identify certain requirements for the model of presentation of knowledge and data on the basis of a systematic analysis of the specifics of the subject area, proposed by (Anikin, 2014, p. 62).

To implement a model of presentation of knowledge and data that meet the requirements considered, it is expedient to use an ontological model of presentation of knowledge, which combines the properties and advantages of other models of presentation of knowledge and data (graph model, tree-based model, relational model, semantic network, framing, logical model, etc.).

Solving the tasks of the search and integration of educational material in the personalized educational collection can be realized in the ontological model because of the development and inclusion of the corresponding semantic rules in computer ontology.

The formal model of ontology can be represented as:

$$O = <C, R, F>,$$

where C – the final set of concepts of the subject field, which determines the ontology of O; R – the final set of relations between them; F is the final set of functions of interpretation given on the concepts and/or ontology relations of O.

The restrictions imposed on the set C are not infinity and are not empty ($C \neq \emptyset$). The sets R and F can be empty, which corresponds to certain types of ontology, when it degenerates into a simple dictionary ($R = \emptyset$, $F = \emptyset$), taxonomy of concepts ($F = \emptyset$), etc.

One of the possible ontological bases for the description of computer ontologies in the context of the use of computer ontology systems by future specialists in the field of digital technologies, presented in (Pikuliak, 2014, p. 197), are: lasses united in taxonomy; relationship (type of links between concepts of the subject industry); functions (a special kind of relationship in which the *n*-th element of the relationship is determined by the values of $n-1$ of the preceding elements); axioms (simulate offers that are always true); specimens (entities) that make up specific objects of the real or abstract world.

OWL-DL combines OWL expressiveness and completeness of computations (all logical conclusions performed on an ontology basis will be thoroughly calculated) and extensibility (all calculations are completed at a certain time). The OWL-DL contains all OWL language constructs that are subject to certain restrictions (for example, a class may be a subclass of many classes, but cannot be a representative of another class).

Accordingly, the ontological model of the subject discipline of the discipline ODD (figure 1) will be defined as:

$$ODD = <CDD, InstDD, RDD, IDD>,$$

where CDD is the final set of concepts for the ontology of the core curriculum knowledge (CDD = {cDD1, cDD2, cDD3, cDD4, cDD5, cDD6, cDD7, cDD8, cDD9, cDD10, cDD11, cDD12}; cDD1 – the DataDomain class for the definition of the subject discipline; cDD2 – is the Competence class for identifying competences in a learning discipline; cDD3 is a Concept class for defining the concepts (terms) of a discipline subject field that is a subclass of cDD2; cDD4 is a UCompetence class for identifying universal competencies; cDD5 is a class of PCompetence for defining professional competencies; cDD6 – ZNKCompetence class for general knowledge competencies; cDD7 – ICompetence class tool for determining competence; cDD8 – SOKCompetence class for the definition of social / personal / general cultural competencies; cDD9 – is the Skill class for determining the skills obtained in the subject discipline, which is a subclass of cDD2; cDD10 is the Ability class for determining the skills obtained in the subject field of the discipline, which is a subclass of cDD2; cDD11 is a Language class that defines the language of presentation of information in the discipline subject field; cDD12 – Complexity class to determine the level of development of competencies of the discipline);

InstDD – is the set of competencies, concepts of the subject discipline, as well as the skills represented in the natural language of instances of classes CDD; InstDD = {iDD1, iDD2, ... iDDm, ... iDDn};

RDD – the final set of relations of the ontology of the knowledge base of the discipline; (RDD = {rDD1, rDD2, rDD3, rDD4, rDD5, rDD6, rDD7, rDD8, rDD9}; rDD1 – hasLanguage ratio, rDD2 – hasComplexity ratio, rDD3 – includes ratio, rDD4 – hasHierarchicalRelation ratio, rDD5 – dependsOn ratio, rDD6 – isSynonym ratio, rDD7 is the ratio is, rDD8 – hasTitle, the ratio rDD9 – hasCompetence);

IDD is the set of interpretation rules, $IDD = \emptyset$.

The set of concepts for the CDD ontology of the knowledge base of the discipline is presented in table 1, and the set of RDD relationships is in table 2. The defining areas and the domains of relationship values can be both defined concepts and their daughter concepts within the framework of the ontology. Based on the plurality of these concepts and the relationship between them using the CSO, future teachers-engineers will be able to conduct ontological design of the subject field of the discipline they need.

However, the question of how to design a computer ontology remains open. Currently, there are several methods of constructing ontologies and they are all based on the principles proposed in (Gruber, 1995, p. 918): 1) Clarity. The ontology must effectively convey the meaning of terms; 2) Compatibility. The ontology must be compatible, i.e. the conclusions that can be drawn from the definitions of concepts and the relationships between them must be compatible with the original terms; 3) Extendibility. The ontology should be constructed so that it can be used effortlessly in separate ontology libraries; 4) Minimal encoding bias. The designed conceptual scheme should not depend on the specific language used to write the formalized description; 5) Minimal ontological commitment. The ontology should contain as few facts as possible about the ontology of the world being modeled, while giving the freedom to use this ontology in other worlds.

However, in the context of designing a computer ontology of the subject area of the discipline on

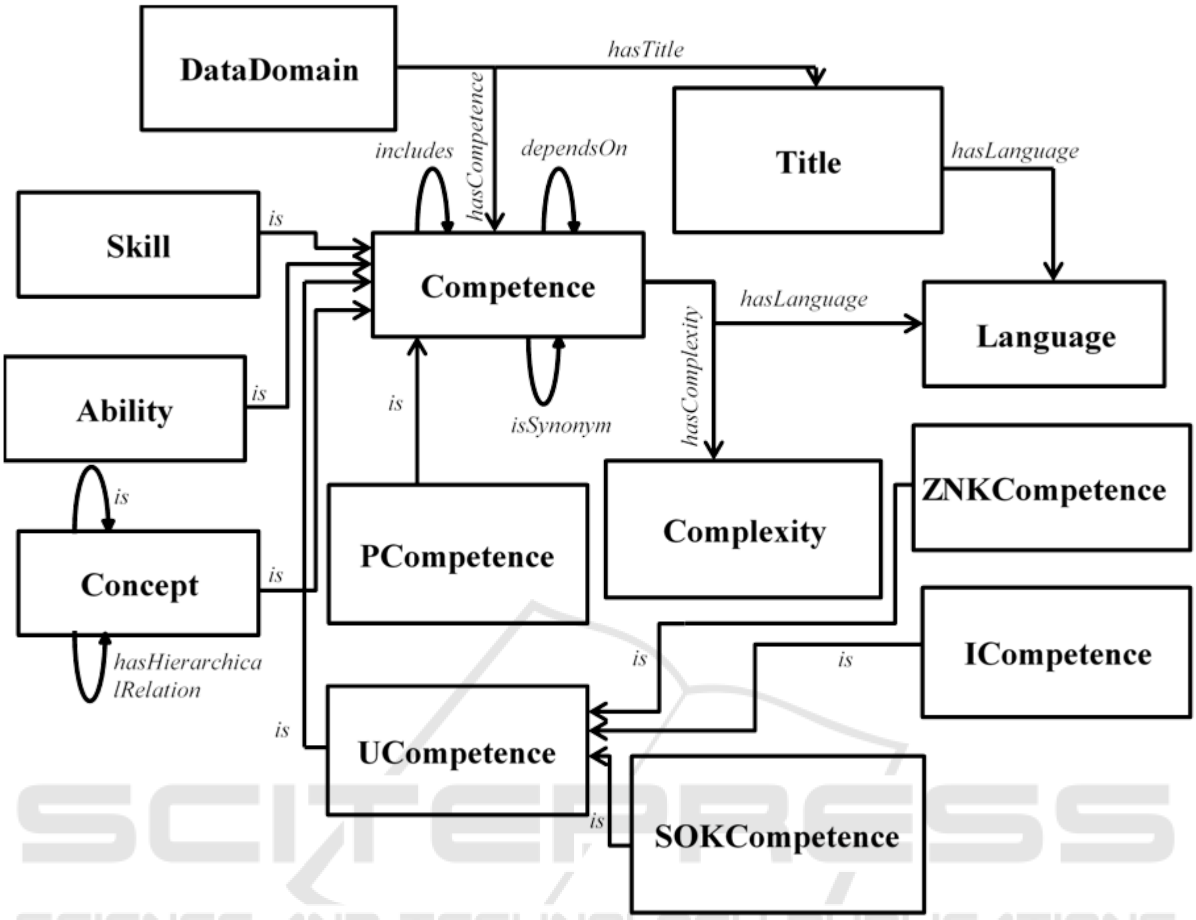

Figure 1: Scheme of ontology of the subject field of discipline.

the basis of the selected cloud-oriented environment WebProtégé, it is most appropriate to use the method of building an ontology proposed by Lytvyn et al. (Lytvyn et al., 2013), which consists of seven steps (Lytvyn et al., 2013, p. 319).

Step 1. Defining the field and scale of the ontology.

Step 2. Ability to use existing ontologies.

Step 3. List of important terms in the ontology.

Step 4. Defining classes and their hierarchy.

Step 5. Defining the properties of classes.

Step 6. Defining the facet properties.

Step 7. Creation of instances.

Therefore, to design a computer ontology of the subject area of the discipline, future specialists in the field of digital technologies in the field of computer technology should be carried out according to the following algorithm:

1. Select on the basis of the scheme proposed in figure 1, competencies of the first level – universal (general, instrumental, social-personal competencies of subject discipline) and professional – on the basis of analysis of the work program of discipline and matrix of competencies. Describe them as instances of the corresponding classes of computer ontology of the study discipline (UCompetence, PCompetence, ZNKCompetence, ICompetence, SOKCompetence). An example of filling the PCompetence class is shown in figure 2.
2. Sequentially allocate competences of the second level by analyzing the list of acquired knowledge, skills and abilities. Describe them as instances of the corresponding classes of computer ontology of the discipline (Concept, Skill, Ability).
3. Based on the analysis of the work program of the discipline and the matrix of competencies, allocate the third level competencies that are implemented within each module of the curriculum and describe them as instances of the corresponding classrooms of the computer ontology (Concept, Skill, Ability).

Table 1: The set of concepts of ontology of the subject discipline.

Ontology concept	Parental concept	Concept description
DataDomain	Thing	Subject field of discipline
Competence	Thing	Competences
Concept	Competence	Concepts (terms) of the subject discipline
UCompetence	Competence	Universal competences of the subject discipline
PCompetence	Competence	Professional competence of the subject field of the discipline
ZNKCompetence	UCompetence	General scientific competence of the subject field of the discipline
ICompetence	UCompetence	Instrumental competences of the subject discipline
SOKCompetence	UCompetence	Sociopersonal / general cultural competences of the subject discipline
Skill	Competence	Skills in the subject field of the discipline
Ability	Competence	Ability of the subject field of the discipline
Language	Thing	Language of presentation of information

Table 2: The set of relations of the ontology of the subject discipline.

Correlation	Definition area	Value range	Description
hasLanguage	Competence	Language	The ratio that sets the language of the presentation of the ontology
hasComplexity	Competence	Complexity	The ratio that sets the level of competence development
includes	Competence	Competence	The relation of inclusion of competences in the competence of a higher level, concepts, skills and abilities – in competence (through the mechanism of imitation)
dependsOn	Competence	Competence	Relationship between the two competencies, concepts, skills or abilities
isSynonym	Competence	Competence	The relation of synonymy to the concepts of the subject field and competencies
is	Concept	Concept	The relationship "is" between the concepts of the subject field
hasHierarchical	Concept	Concept	The ratio of the hierarchy between the concepts

4. Based on the knowledge of the future specialist in the field of digital technologies about the subject area of the discipline and the availability of educational and methodological literature, identify competencies of lower levels and describe them as instances of relevant classes of computer ontology of the discipline (Concept, Skill, Ability). The recommended number of levels of competence in describing the set of knowledge discipline – 3-4. Additional levels can be used in the description of knowledge in the form of concepts of the subject area in the case of availability in the individual modules of discipline a large number of terms of the subject field, which are related hierarchically. For the description of skills and abilities, in most cases it is up to 3-4 levels of competencies.
5. Based on the work program of the discipline and the links proposed in table 2, as well as knowledge of the subject area and the analysis of educational methodical literature, identify the relationship between the competencies described and set them with the following relationships of the ontology of the discipline: includes (the ratio of the inclusion of competencies in a higher level of competence), dependsOn (dependency ratio between two competencies, concepts, skills or abilities). If there is synonymy, set the appropriate relation to isSynonym. In describing the discipline subject field, use the hasTitle and hasLanguage relationship to describe the description of the respective competences in the natural language and language of the description figure 3.

Thus, we will have a computer ontology of the subject area of the academic discipline as shown in figure 4. However, to conduct an analysis to obtain numerical estimates of the feasibility of designing such ontologies of academic disciplines, it is advisable to conduct an experiment and analyze

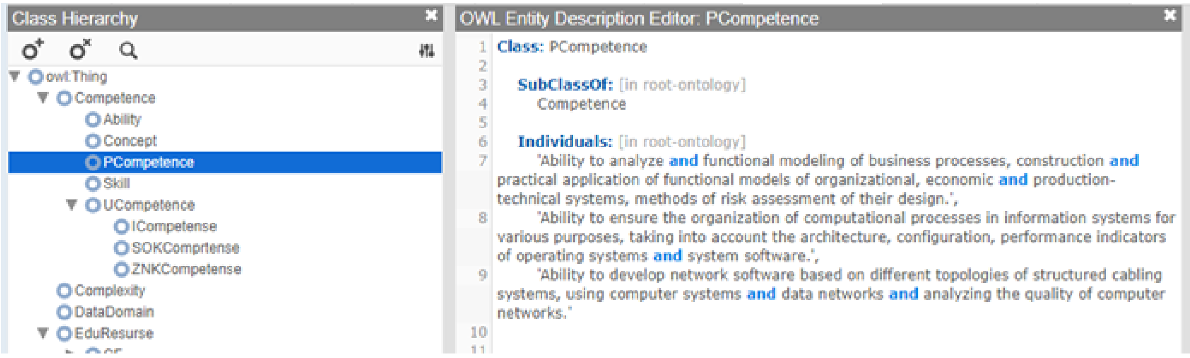

Figure 2: Example of filling the PCompetence class with appropriate instances.

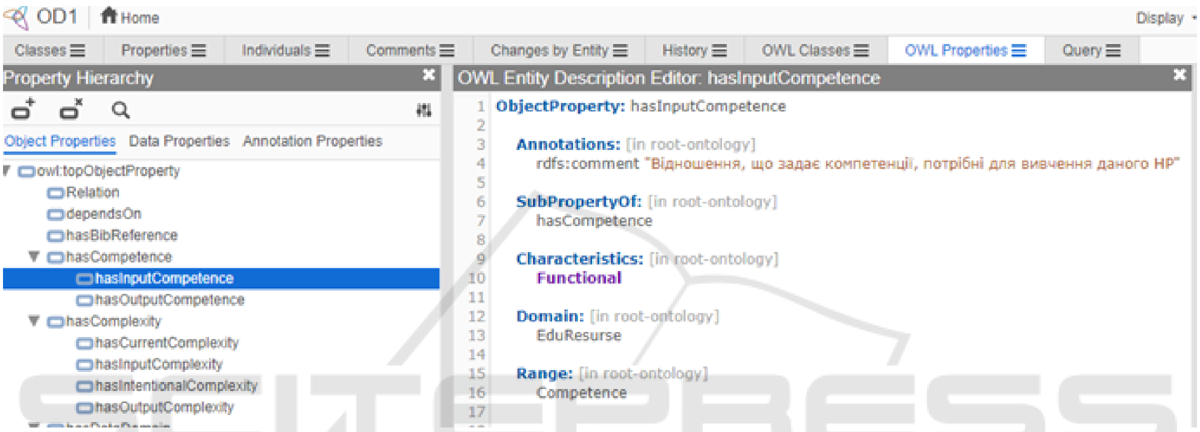

Figure 3: Example of setting the hasInputCompetence relationship between the corresponding instances and classes.

the effectiveness of cloud-based WebProtégé environment and ontologies based on the criteria proposed in (Buyak et al., 2019): 1) speed of construction of sub-ontologies, 2) the number of defects. Another important criterion here is the speed of addition of already created ontologies.

Therefore, an experiment was conducted on the basis of the engineering and pedagogical faculty of Ternopil Volodymyr Hnatiuk National Pedagogical University, which involved 40 students of future specialists in the field of digital technologies (20 students in the experimental group and 20 students in the control group). For the experimental group, the process of designing a computer ontology of the subject area of the discipline was carried out on the basis of the proposed ontological model and methodology based on the use of cloud-oriented WebProtégé environment. The students in the control group carried out the design of a computer ontology of the subject area of the discipline without the use of a model and with the help of declarative programming languages.

The construction of the computer ontology of the subject area of the discipline in both control and experimental groups was modular, i.e. developed as a set of small modules (sub-ontologies), which are then assembled for the formation and use as a single modular ontology. Like ontology learning (ontology extraction, ontology generation, or ontology acquisition), it is the automatic or semi-automatic creation of ontologies, including the extraction of concepts from the corresponding domain and the relationship between these concepts from a natural language text block and their coding with ontological language for easy retrieval. Therefore, each student (both in the experimental and control groups) built 1 ontology of the subject area of the discipline. However, these ontologies can later be combined as sub-ontologies into one computer ontology of educational resources of the university.

In the process of building ontologies of the subject area of the discipline, students use general concepts, which are sufficiently defined in one of the ontologies, and they will be available for other ontologies, which will avoid excessive description of objects of the subject area by reusing certain concepts. It will also make it possible to simplify the semantic rules for finding didactic materials in a particular discipline (Tsidylo and Kozibroda, 2018, p. 259).

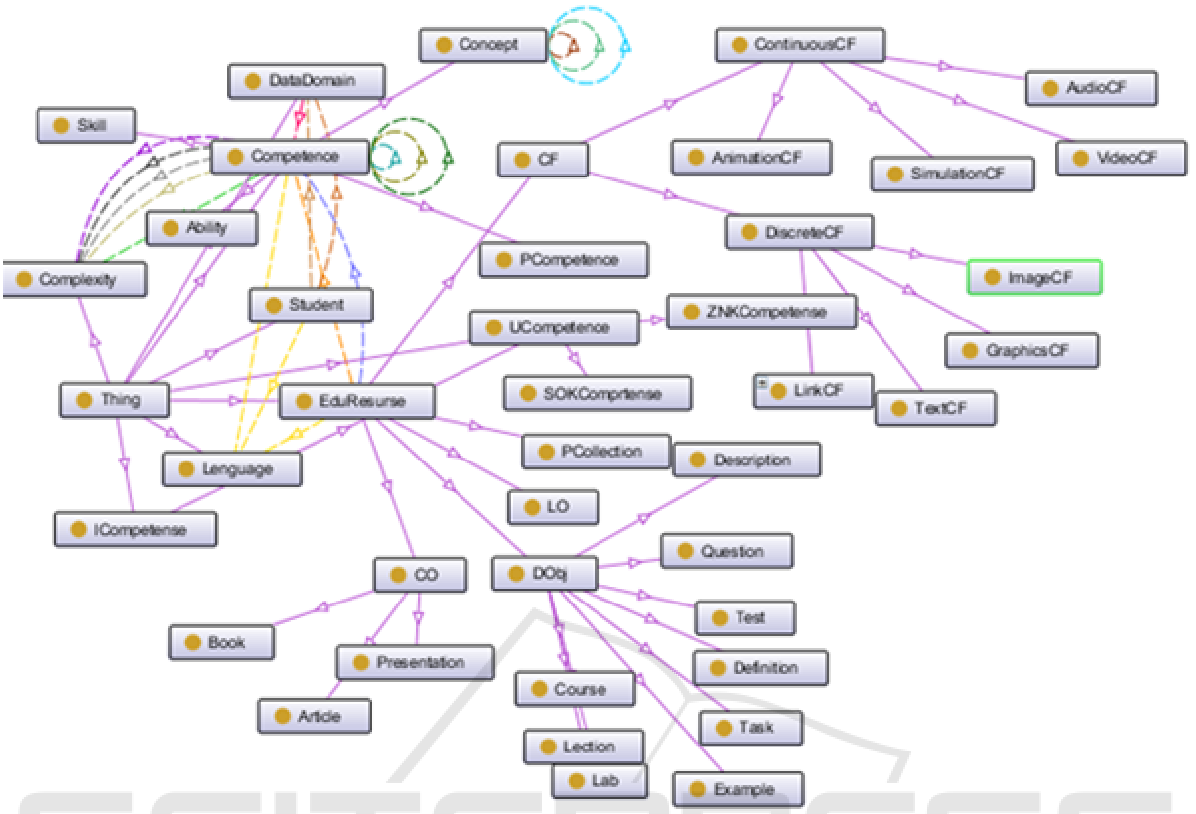

Figure 4: Graphical representation of the computer ontology of the discipline and the relationships between components and classes.

As mentioned above, the process of analysis of the design of computer ontologies of the subject area of the discipline by students of the experimental and control groups was carried out according to the following criteria:

1) *speed of construction of ontologies.* The students of the control group (20 students) and the experimental group (20 students) were allotted with 20 disciplines with appropriate structural elements that should be reflected in the ontology, on the basis of which students should build ontologies of the subject area of the discipline. How long it took the students of the groups to build these 20 ontologies was also taken into account. The results show (figure 5) that the students of the experimental groups coped with this task on average 2.5 times faster;

2) *the number of defects.* The study of this indicator was based on the analysis of 20 constructed ontologies of the subject area of academic disciplines. According to the results of the analysis (figure 6) it was found that future students of the experimental groups, who used the proposed ontological model of the subject area of the discipline and methodology based on the use of cloud-based environment WebProtégé, had significantly fewer defects (almost 2 times) than the students of the control groups, who designed the computer ontology of the subject area of the discipline without the use of the model and with the help of declarative programming languages;

3) *the speed of addition of already created ontologies the number of defects.* This indicator reflects how quickly future specialists in the field of digital technologies will be able to integrate their ontologies of the subject area of the discipline into the supra-ontology of the educational resources of the university. According to the results of the analysis of these indicators (figure 7), the students of the experimental group who used the cloud-oriented WebProtégé environment to integrate their ontologies coped with this task much faster (almost 3 times) than the students of the control groups who did the integration using declarative languages.

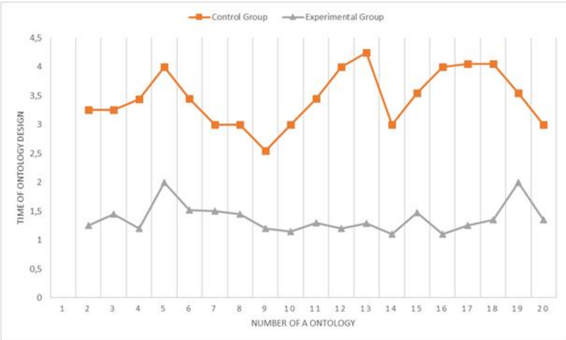

Figure 5: Comparison of the speed of construction of ontologies by the students of the control and experimental groups.

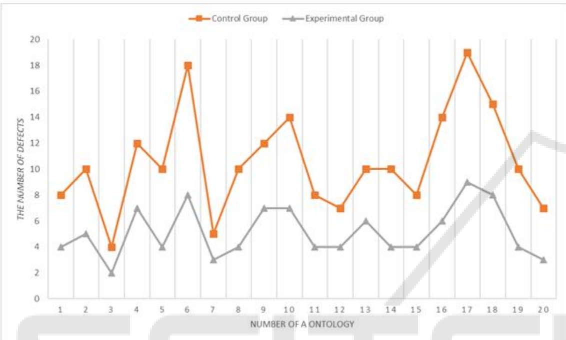

Figure 6: Comparison of the number of defects in ontologies built by the students of the control and experimental groups.

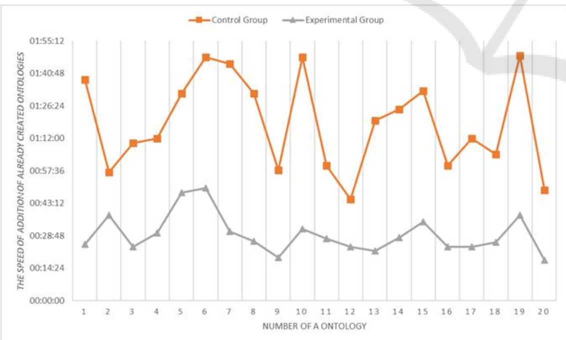

Figure 7: Comparison of the speed of completion of computer ontology by the students of the control and experimental groups.

Thus, in the context of the ontological approach, for the construction of computer ontologies the scheme of ontology of the subject area of the discipline and the use of cloud-oriented environment WebProtégé improves the quality characteristics of designed ontologies such as speed of ontologies, number of defects and speed of addition of already created ontologies.

3 CONCLUSIONS

1. The scheme of ontology of the subject area of the discipline is presented, on the basis of which future specialists in the field of digital technologies will be able to describe many concepts of the future computer ontology of the subject area of the discipline. In addition, a set of relations between them and the corresponding domains of definition and domains of values of relations is presented, in which there can be both the specified concepts, and their child concepts within the ontology. Based on the set of these concepts and the relationship between them using the cloud-oriented WebProtégé environment, future experts in the field of digital technology will be able to conduct ontological design of the subject area of the discipline they need.
2. The main criteria for choosing a CSO are: 1) software architecture and tools development contain information on the required platforms for using the tool; 2) functional compatibility contains information on tools and interaction with other languages and tools for the development of ontologies, translation from some languages ontologies; 3) intuitive interface – covers work with graphic editors, collaborative work of several users and the need to provide multiple uses of ontology libraries.
3. In the process of selecting a method of designing computer ontologies by means of computer ontology systems, the best option in the educational process of the future specialist in the field of digital technologies is the method proposed by Lytvyn et al. (Lytvyn et al., 2013), which provides a number of stages of designing a computer ontologies.
4. The methodology of designing the computer ontology of the subject area of the discipline by future specialists in the field of digital technologies is proposed. Which includes the scheme of the ontology of the subject area of the discipline, selection of a computer ontology systems(a web-based environment WebProtégé) with the help of which the design, the method of computer ontology design and the algorithm for designing a computer ontology of the subject area of the discipline by future specialists in the field of digital technologies will be carried out.
5. The effectiveness of the projected ontologies of the subject area of the discipline in the context of training future professionals in the field of digital technologies has been experimentally tested on such indicators as: 1) the speed of construction

of ontologies; 2) the number of defects; 3) the speed of addition of already created ontologies. Based on the analysis of the results, it should be noted that by all criteria the indicators of students of the experimental group, where the process of designing computer ontology of the subject area of the discipline is carried out on the basis of the proposed scheme of ontology and methodology based on the use of computer ontology system (in our case, web-oriented environment WebProtégé) were higher than the indicators of the students of the control groups who carried out design using declarative programming languages.

6. The continuation of scientific research on the given problem is useful in the study of the dependence of constructed hierarchy concepts in the computer ontology of the subject discipline and the development of ontologically managed information systems on their basis.

REFERENCES

Anikin, A. V. (2014). *Metod poiska i intehratsyi raznorodnyh raspredelenyh obrazovatelnyh resursov na osnove logicheskoho vyvoda na ontolohii (A method for the search and integration of heterogeneous distributed educational resources based on the logical conclusion on the ontology)*. PhD thesis, Volgogradskyi gos. techn. un-t, Volgograd.

Buyak, B., Tsidylo, I., Kozibroda, S., and Repskyi, V. (2019). Ontological model of representation of university resources. *CEUR Workshop Proceedings*, 2393:29–40.

Buyak, B., Tsidylo, I., Repskyi, V., and Lyalyuk, V. (2018). Stages of conceptualization and formalization in the design of the model of the neuro-fuzzy expert system of professional selection of pupils. *CEUR Workshop Proceedings*, 2257:112–121.

Chaplinskyi, Y. P. (2009). Ontolohichne predstavlenia protsesiv pryjniatia rishen (Ontological representation of decision-making processes). *Problemy informatyzatsii ta upravlinia*, (2(26)):146–150.

Dovhyi, S., Velychko, V. Y., Hloba, L. S., Stryzhak, O. Y., Andrushchenko, T. I., Halchenko, S. A., Honchar, A. V., Huliaiev, K. D., Kudliak, V., Liashuk, K. V., Palahin, O. V., Petrenko, M. H., Popova, M. A., Sydorenko, V. I., Sliusarenko, O. O., Stus, D., and Ternovoi, M. Y. (2013). *Kompiuterni ontolohii ta yikh vykorystannia u navchalnomu protsesi. Teoriia i praktyka (Computer ontologies and their use in the educational process. Theory and practice)*. Instytut obdarovanoi dytyny, Kyiv. http://biblos.iod.gov.ua/docview.php?doc_id=2497.

Faure, D., Nédellec, C., and Rouveirol, C. (1998). Acquisition of semantic knowledge using machine learning methods: The system "ASIUM". Technical report, Universite Paris Sud.

Gruber, T. (1993). A translation approach to portable ontology specifications. *Knowledge Acquisition*, 5(2):199–220.

Gruber, T. (2003). Ontology progress - what is an ontology. *Software World*, 34(1):6.

Gruber, T. (2006). Where the social web meets the semantic web. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 4273 LNCS:994.

Gruber, T. (2007). Ontology of folksonomy: A mash-up of apples and oranges. *International Journal on Semantic Web and Information Systems*, 3(1):1–11.

Gruber, T. (2008). Collective knowledge systems: Where the social web meets the semantic web. *Web Semantics*, 6(1):4–13.

Gruber, T., Olsen, G., and Runkel, J. (1996). The configuration design ontologies and the vt elevator domain theory. *International Journal of Human Computer Studies*, 44(3-4):569–598.

Gruber, T. R. (1991). The role of common ontology in achieving sharable, reusable knowledge bases. In *Proceedings of the Second International Conference on Principles of Knowledge Representation and Reasoning*, KR'91, page 601–602, San Francisco, CA, USA. Morgan Kaufmann Publishers Inc.

Gruber, T. R. (1995). Toward principles for the design of ontologies used for knowledge sharing. *International Journal of Human-Computer Studies*, 43(5):907–928.

Kozibroda, S. V. (2016). Prohramni zasoby rozrobky ontolohii u protsesi pidhotovky inzheneriv-pedahohiv compiutornoho profiliu (Software tools for developing ontologies in the process of preparing engineers-teachers of the computer profile). *Zbirnyk naukovyh prats Khersonskoho derzhavnoho universytetu. Pedahohichni nauky*, 74 (3):175–180.

Lapshyn, V. A. (2010). *Ontolohii v computernyh systemah (Ontologies in computer systems)*. Nauchnyi mir, Moscow.

Liubchenko, V. V. (2008). Modeli znanij dlia predmetnyh oblastei uchebnyh kursov (Knowledge models for subject areas of training courses). *Iskustvennyi intelect*, (4):458–462.

Lytvyn, V. V., Yatsyshyn, Y. V., and Pasichnyk, V. V. (2013). *Intelectualni systemy (Intellectual systems)*. Novyi Svit – 2000, Lviv.

Morentsova, A. V. (2018). Vykorystania ontolohii predmetnoi oblasti dlia usunenia neodnoznachnostei pry compiuternomu perekladi technichnyh tekstiv (Using the ontology of the subject area to eliminate ambiguities in the computer translation of technical texts). In *Aktualni pytania suchasnoi nauky: III Mizhnarodna naukovo-praktychna internet-konferentsia: tezy dopovidei*, pages 82–87.

Nirenburg, S. and Raskin, V. (2004). *Ontological Semantics*. MIT Press, Cambridge.

Noy, N. F. and McGuinness, D. L. (2001). Ontology Development 101: A Guide to Creating Your First Ontology. *Stanford Knowledge Systems Laboratory*. http://www.ksl.stanford.edu/KSL_Abstracts/KSL-01-05.html.

Ovdei, O. M. and Proskudina, H. Y. (2004). Obzor instrumentov inzhenerii ontolohii (Ontology engineering tool overview). *Russian Digital Libraries Journal*, 7(4). https://elbib.ru/article/view/254.

Palahin, O. V. and Petrenko, M. H. (2006). Model katehorialnoho rivnia movno-ontolohichnoi kartyny svitu (Model of the categorical level of the language and ontological picture of the world). *Matematychni mashyny i systemy*, (3):91–104.

Pikuliak, M. V. (2014). Ontological approach to the construction of the subject area based on the quantum-frame model. *Medical informatics and engineering*, (1):50–54.

Popova, M. A. and Stryzhak, O. Y. (2013). Ontolohichnyi interfejs yak zasib predstavlenia informatsijnyh resursiv v HIS-seredovyschi (Ontological interface as a means of representing information resources in the geoinformation environment). *Uchenye zapisky Tavricheskoho natsyonalnoho universiteta imeni V. I. Vernadskoho Seria: Geographia*, 26 (65), No. 1:127–135.

Spirin, O. M. (2004). *Pochatky shtuchnoho intelektu (The beginings of artificial intelligence)*. Vyd. ZhDU im. I. Franka, Zhytomyr.

Stryzhak, O. Y. (2016). Ontolohichnyi pidruchnyk paradyhma formuvania interaktyvnoi systemy znan u navchalnomu protsesi (Ontological textbook paradigm of forming an interactive system of knowledge in the learning process). *Computer u shkoli ta simi*, (7):7–16.

Stryzhak, O. Y., Popova, M. A., and Liashuk, K. V. (2014). Metodyka stvorenia ontolohichnoho interfeisu u seredovyschi WEB portalu (The method of creating an ontological interface in the environment of the WEB-portal). *Radioelectronni i compiuterni systemy*, (2):78–84.

Tsidylo, I. M. (2014). *Pidhotovka inzhenera-pedahoha do zastosuvania intelectualnyh tehnolohij u profesijnij dialnosti (Training of the engineer-teacher to the application of intellectual technologies in professional activity)*. Vektor, Ternopil.

Tsidylo, I. M. and Kozibroda, S. V. (2018). Systems of computer ontologies as a means to form future engineering teachers' design competences. *Information Technologies and Learning Tools*, 63(1):251–265. https://journal.iitta.gov.ua/index.php/itlt/article/view/1838.

Yevseeva, O. H. (2009). Modeliuvania navchalnoi predmetnoi oblasti (Modeling of a learning subject area). *Iskustvennyi intelect*, (1):79–86.