

## Centralized information web-oriented educational environment of Ukraine

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**Abstract.** The modern development of science and technology has provided high quantity of information. This information must be systemized and classified. For taxonomization of educational materials, it was proposed to use existing graph-generators and graph-visualizers of the TODOS IT platform. A separate aspect of the TODOS IT platform is the possibility of using a centralized web-oriented learning environment. Creation of the system and transdisciplinary knowledge is a problem of modern education, which can be solved by creating a centralized web-oriented educational environment. Using this approach is an important part of the learning process. Such a centralized web-oriented environment based on the ontological approach involves filling, adaptive educational services with information resources that reflect the conceptual system of a particular discipline.

One of the systems providing not only collection of information but include its systemizing is centralized web-oriented educational environment based on Ontology4 system. Ontology 4 use elements of the TODOS.

The paper presents specific developments of one centralized web-oriented educational environment can be used to teach different subjects such as biology, chemistry, Ukrainian language and literature, using the STEM approach.

**Keywords:** unified network-centric educational information environment, Ontology4, multiagent system, systematics of microorganisms.

## 1 Introduction

Modernization of the educational process is an important recent problem. One of the huge problems of education is the absence of the methods which can provide a complex of transdisciplinary knowledge transfer, which can be solved by creating a unified web-oriented educational environment. This problem is limiting the implementation of modern approaches in education such as the research approach.

## 2 Literature review and problem statement

Research approach in education is one of the ways to achieve a high quality of education. Simulation of the research process is based on using of main scientific research steps such as choosing of the topic, analysis of previous research results, hypothesis formulating, experimental research, data analysis and publication of results (not used under studying) [13]. Quality of the research may depend on the quality of the analysis of previous researches because it is the key to formulate the actual hypothesis [2; 4]. Hart et al. and Gerard et al. prove the necessity of this step [7; 8]. However, there is no decision which can provide safety for students and structured search for analysis of previous researches. Creation of centralized information web-oriented educational environment which based on educational programs can solve this problem and it is important to provide a research approach in the educational process.

Using the ontological approach to provide informational systemizing is an important part of the learning process. Such an educational environment based on the ontological approach involves filling adaptive educational services with information resources that reflect the conceptual system of a particular discipline. The methodical provision of the educational-cognitive process consists of the assimilation of the conceptual system, axiomatics, rules, syntactic and morphological foundations of this theory. The set of terms determines the conceptual basis of scientific theories by determining a certain ordering of the concepts of the discipline. Thus, the ontological multiagent in content reflects the conceptual system of a certain disciplinary theory. It takes into account the individual characteristics of each subject of the educational process.

We propose using of Transdisciplinary Ontological Dialogues Object-Oriented Systems (TODOS) to provide ontologization of information. A key benefit of this system is the context-based method of data processing and structuring based on semantic relations. Previously there was provided attempts to use ontology-based approaches in education [8; 19]. Then, the received information system is a multiagent and has all the benefits of such a system.

However, they were characterized by not attractive for students and teachers interface and by low interactivity such as the absence of multiagency approaches. In the case of Ukraine, it is very important to provide education in the national language and IT platform TODOS can implement it.

Structures in TODOS are represented by three categories (O, A, R), where O and A are a set of elements called objects and attributes, and R, respectively, is the binary relation between O and A. In particular, if  $oRa$  for  $o \in O$ ,  $a \in A$ , then we assume that “the object possesses the attribute A” or “the object has the attribute O” [9].

The feature of the ontological graph is the high level of structuring and data visualization, the possibility of transition between related vertices and search for semantic links between vertices and its elements. Graph provides a transition to scientific data carried out quickly and understandably. In addition, operability of information can be significantly improved by transforming it to taxonomy under using of ontological approach [6; 18].

### 3 Materials and methods

For creating digital educational programs and other educational content, the sheets were loaded to the part of TODOS IT-platform editor<sup>4</sup>. After that, the generation of the graph edges with its characteristics was carried out.

To store information and provide its sharing, Google sheets were used, with their further conversion into the .xls and .csv Excel sheets (see in Figure 1). The obtained documents were used to create the ontology structure .xml and to fill the ontology graphs with semantic and numeric information for ranking and filtering. Some of the instruments of the web-oriented educational environment are using intellectual features of TODOS and to provide these semantic characteristics were added.

A	B	C	D	E	F	G	H	I	J	K
nodeproperties	Температура, С	Об'єм, л	я на реактор, г	курячого послід	навантажені	т коSUBSTRATУ	Net коSUBSTRATУ	Netи, % до об'єму	у відношен	вміст ОР у
cken manure for	37	0,125		50	линення виходу				50	22,5
cken manure for	55	0,125		50	линення виходу				50	22,5
cken manure for	65	0,125		50	линення виходу				50	22,5
estion of Poultry	35	0,2		14		11			75	20
2 2015 Aboueler	35	0,2		14		11			75	20
estion of Poultry	35	0,2		14		11			75	20
4 2015 Aboueler	55	0,2		14		11			75	20
estion of Poultry	55	0,2		14		11			75	20
6 2015 Aboueler	55	0,2		14		11			75	20

Fig. 1. Google sheet with data

Web-oriented educational environment using external network resources as agents to extend own knowledge base. Recommended by the Ministry of Education of Ukraine external resources were used as agents of centralized information web-oriented the educational environment of Ukraine. They were indexed by a TODOS search machine tool.

To improve the interactivity, it is possible to use modern approaches, including approaches of Augmented reality [10; 11; 17; 21] to increase interest to education [12].

### 4 Mechanism of the multiagent using in centralized information web-oriented educational environment of Ukraine

One of the examples of multiagent integration with educational environmental is using of network source stemua.science [14]. Stemua.science is an educational resource based on CMS Wordpress. It was created as repozytorium for transdisciplinary

educational projects. Unlike other internet resources, stemua.science makes possible to add multi-categories and meta fields to post objects by using custom plugins. This portal provides free to use the base of educational materials and gives the possibility to share methods and projects ideas.

Teaching materials presented on it have a clear structure which based on scientific or engineering method. This is achieved by adding custom metadata to post an object. This post object can be used as building part of a centralized information web-oriented educational environment. Stemua.science has open JSON endpoints provided via Representational State Transfer (REST) technology. JSON formatted documents can be converted to XML format on the fly. All amount of education data used for reactive creating ontological graphs and use all information processing benefits of TODOS IT platform in real time.

## 5 Providing the researches in education due to the integration of multidisciplinary resources

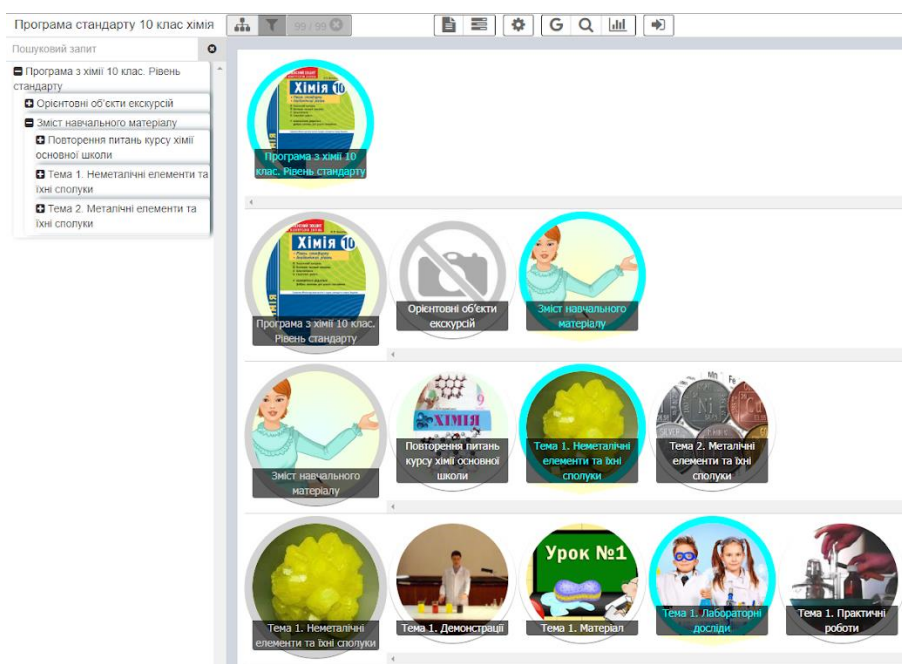


Fig. 2. The educational program of Chemistry for 10<sup>th</sup>-grade students

The base of the centralized information web-oriented educational environment consists of the different types of educational programs (such as primary, secondary, extracurricular). This program differs from classical approaches of educational programs interpretation by a higher level of material structuring and interactivity. Both students and teachers can view all the structure of the curriculum online. To provide

this approach we used a graph edge to describe the topics of the curriculum. Therefore, these graph edges are connected with their mother-edges to create the hierarchy. This is the way of creation of structured interactive educational programs. General view of the educational program of Chemistry for 10<sup>th</sup>-grade students (<http://ontology4.inhost.com.ua/?fname=programma-standartu-10-klas-himiya>) is presented in Figure 2.

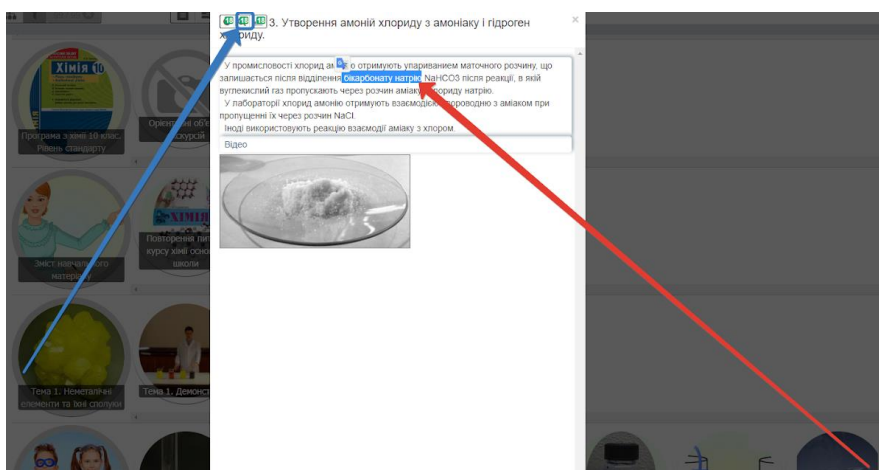


Fig. 3. The mechanism of the internal search function

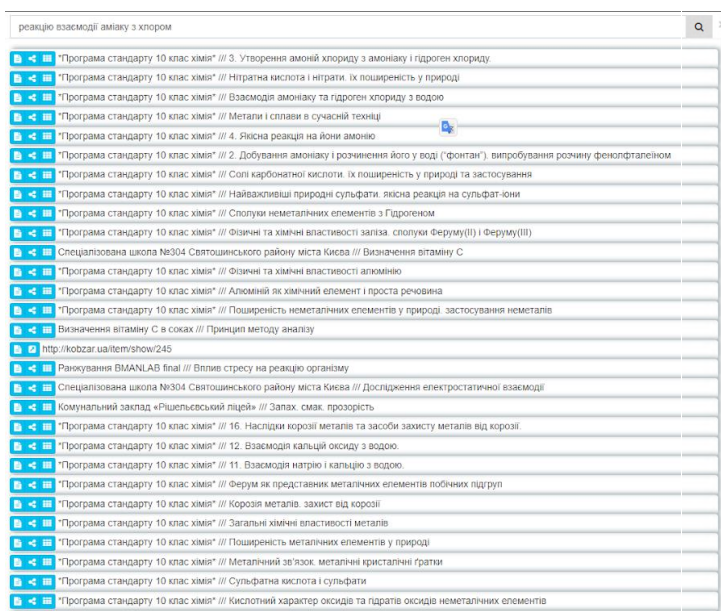


Fig. 4. The results of the internal search function

Integration of the different resources is the way to provide multidisciplinary and research approach of the educational process. A student who studies the subject and uses an interactive web-oriented educational program based on IT-platform TODOS can use external search to provide informational research of question he has. The mechanism of the internal search function is illustrated in Figure 3 and the results of it in Figure 4.

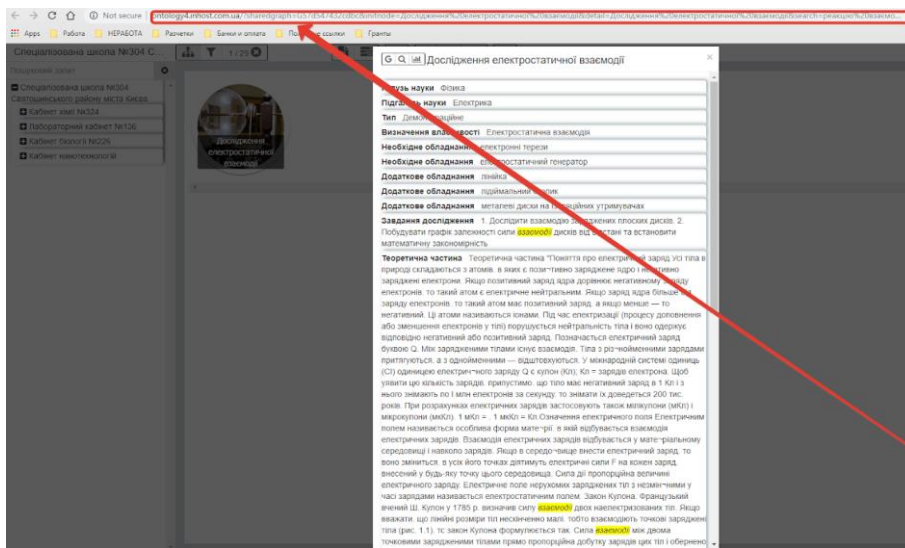


Fig. 5. Internal material visualizing

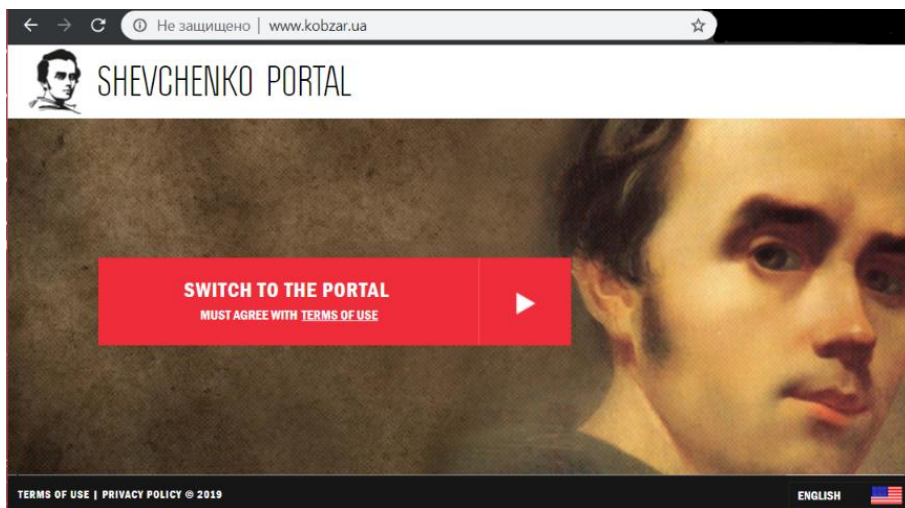


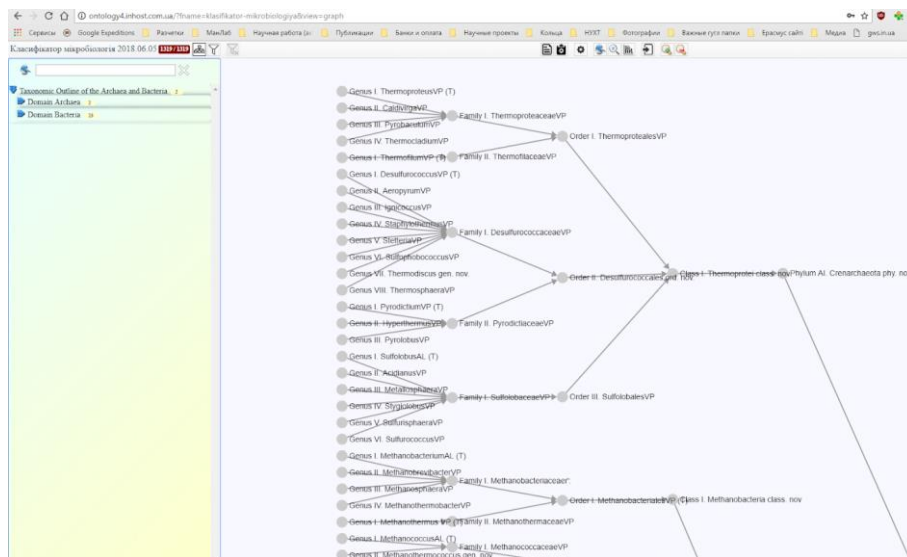
Fig. 6. The external material opening

The internal resources are shown in results as names of graphs, but multiagents of the centralized information web-oriented educational environment are shown as web-links (as we can see in Figure 4 – <http://kobzar.ua/item/show/245>). In the case of transition to internal graphs, it will open in TODOS-visualizer (ontology4.inhost.com.ua) (Figure 5).

Clearly, that multiagent opening mechanism of TODOS web-oriented educational environment differs and an opening of them is lead to opening websites (Figure 6).

## 6 Instruments to informational support of research and educational process

Ontology-based instruments are the same characterized by a higher level of informational structuring. To show an example of such instruments we chose microorganism classification due to the problem of the absence of their interactive systemized structures which can be used in the educational process. It is clear, that hierarchy is created by their own taxonomy: types, genera, families, classes, orders, divisions, domains. Semantic characteristics are used to provide filtering. General view of the ontology-based structure is presented in Figure 7 and filtering of microorganisms in Figure 8.



**Fig. 7.** Ontology-based structure of microorganisms

We already propose a few methodical approaches to use TODOS web-oriented educational environment in classes. First of all, we propose to use it to provide STEM-education. It may be used to provide research on topics such as “yogurt preparation” [3; 16]. However, the proposed educational environment can be used to provide



classical lessons such as the role of copper in the environment and industry [20] and to solve the problem of the research works ranging for students [5; 15].

	Продукти життєвості	Екологічна роль	Форма	Субстрат	Основні місця існування
Genus I. Methylocystis VP				Метан	
Genus II. Methylophilus VP				Метан	
Genus III. Methylobacterium VP				Метан	
Genus XIII. Methylobacterium VP				Метан	
Genus I. Methylobacterium AL				Метан	
Genus I. Methylobacterium VP				Метан	
Genus II. Methylobacterium AL				Метан	
Genus III. Methylobacterium VP				Метан	
Genus IV. Methylobacterium VP				Метан	

Fig. 8. Filtering of microorganisms to select

## 7 Existing methodical support for teachers for providing STEM/STEAM education

Educational portal stemua.science particularly devoted to providing ontology-based research approach, using of the ontology-based instruments in the educational process, methodical support and instruction to use centralized information web-oriented the educational environment of Ukraine and its elements.

## 8 Conclusions

1. Firstly, we propose the method of informational support of the educational process based on the ontologized interactive program.
2. The proposed method is characterized by a higher level of informational structuring and simple interface to use.
3. Firstly, we have implemented to use a multiagent approach for creation of centralized information web-oriented the educational environment to increase the quantity and quality of information support of the research approach in education.
4. It is created the methodical support to the simplify implementation of centralized information web-oriented the educational environment.



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