UDC 004.89:378.4

ANALYSIS OF POSSIBILITIES TO PRESENT FORMALLY THE ELEMENTS OF VIRTUAL EDUCATIONAL SPACE

O. Morozova, PhD., Assoc. Prof.,
N. E. Zhukovsky National Aerospace University «KhAI»

Abstract. *For formal representation of virtual educational space elements, the paper considers the topology methods, in particularly the methods for categories and functors theory, allowing for solving semistructured and indeterminate problems and reflecting their results at the high level of abstraction. The conducted analysis shows the virtual educational space as a generalized scheme, including an associative connection of the site of departments and general education schools.*

Key words: *category theory, generalized scheme, colleges, schools, educational space, hyperlinks, WEB-sites, portals.*

АНАЛІЗ МОЖЛИВОСТЕЙ ФОРМАЛЬНОГО ПОДАННЯ ЕЛЕМЕНТІВ ВІРТУАЛЬНОГО ОСВІТНЬОГО ПРОСТОРУ

О.І. Морозова, доц., к.т.н.,
Національний аерокосмічний університет ім. М.Є. Жуковського «ХАІ»

Анотація. *Розглянуто можливості формального подання елементів віртуального освітнього простору. Показано узагальнену схему віртуального освітнього простору. Для систематизації об'єктів віртуального освітнього простору запропоновано використовувати теорію категорій.*

Ключові слова: *віртуальний освітній простір, WEB-технології, освіта, навчання, формалізація.*

АНАЛИЗ ВОЗМОЖНОСТЕЙ ФОРМАЛЬНОГО ПРЕДСТАВЛЕНИЯ ЭЛЕМЕНТОВ ВИРТУАЛЬНОГО ОБРАЗОВАТЕЛЬНОГО ПРОСТРАНСТВА

О.И. Морозова, доц., к.т.н.,
Национальный аэрокосмический университет им. Н.Е. Жуковского «ХАИ»

Аннотация. *Рассмотрены возможности формального представления элементов виртуального образовательного пространства. Показана обобщенная схема виртуального образовательного пространства. Для систематизации объектов виртуального образовательного пространства предложено использовать теорию категорий.*

Ключевые слова: *виртуальное образовательное пространство, WEB-технологии, образование, обучение, формализация.*

Introduction

To date, there is a rapid introduction of information technology into the education system, this is obvious, and does not require rigorous evidence. The transition from the information society to a knowledge-based society presupposes profound changes in the structure of the education system and the imparting of new qualities to it [1]. Until recently, many scientists regarded the education system as an organizational system that fulfills the functions of education, training, upbringing and scientific activities. In recent years, the impact on the educational system of the global factor – the information and communication revolution, has led to the fact that the educational system with these functions is viewed as a complex self-organizing system

whose structure has been transformed into an organizational and technical structure consisting of a multitude of educational institutions and organizations. It contains elements and subsystems that have an integrated intelligence [2], i.e. Natural human intelligence and artificial intelligence, whose models are realized in the form of declarative and procedural representations of knowledge.

Analysis of Publications

In the work [3] evolution of structures and processes of self-organization in the system of higher school is shown, where special attention is paid to the place, role and tasks of virtual space. In addition, in the collective monograph [4] and in a number of articles [5, 6], methods of linguistic technology and ontological engineering, including a method for the formation and analysis of semantic networks of key concepts of academic disciplines, have been developed. These theoretical constructions determine the analysis of the existing state of educational networks and, in general, virtual space for constructing the systemological and mathematical foundations of educational portals. The ordering of the elements of the virtual educational space at the present time is an actual task.

Purpose and Tasks

The purpose of this work is to analyze the possibilities of formal representation of elements of the virtual educational space and the systematization of its objects. The object of the study is the processes and elements of the virtual educational space. The subject of the study are methods and models of the formal representation of elements of the virtual educational space.

To achieve the goal, the system approach was used in the work, in particular methods of analysis and synthesis, decomposition and aggregation, methods of mathematical modeling and scientific generalization. In addition, topology methods were used, in particular methods of category theory of functors that allow solving weakly structured and unclear tasks, and display their results with a high degree of abstraction.

Representation of Virtual Educational Space Elements with the Use of Category Theory

It is known that at the present time the Internet is the main of the important types of information support for general education schools and universities, in which a certain virtual space is allocated to each educational institution and on this basis the websites of these institutions are formed. In addition, many pedagogical and scientific-pedagogical workers develop and use their personal websites in their professional activities. Examples are the site of the scientific-pedagogical worker [7] and the site of the pedagogical worker [8].

The analysis of the structures of virtual spaces of schools and colleges revealed both advantages and disadvantages of the formation of sites which reflect the virtual spaces of these educational institutions. One of the advantages is that at present every school of general education has its own website, which strengthens the information and methodological support of the educational process.

Separate school sites are united by corresponding hyperlinks with the Ministry of Education and Science of Ukraine, colleges and other educational institutions. Introducing the concept of «hyperlinks», let us explain its essence. State standards of Ukraine: terms and definitions [9] state: a hypertext system is an intelligence system based on the use of hypertext. In turn, hypertext is a way of organizing a stored text, which uses associative links between its fragments.

The placement of educational material in a virtual educational space based on web technologies makes it possible to increase the semantic load by organizing special hyperlinks in manuals or textbooks, as it was suggested in work [10], which is posted on the site [11].

The above provides a basis for presenting the virtual educational space in the form of a generalized scheme, shown in Figure 1.

In Figure 1, the generalized space of colleges is indicated with the dashed line and the generalized virtual space of general education schools with a solid line. Such symbolism is due to the fact that the virtual space of schools is strictly limited to curricula and textbooks of general educational nature. The virtual space of colleges has fuzzy boundaries and some vagueness of information representation due to the scientific functions performed by the higher education institution.

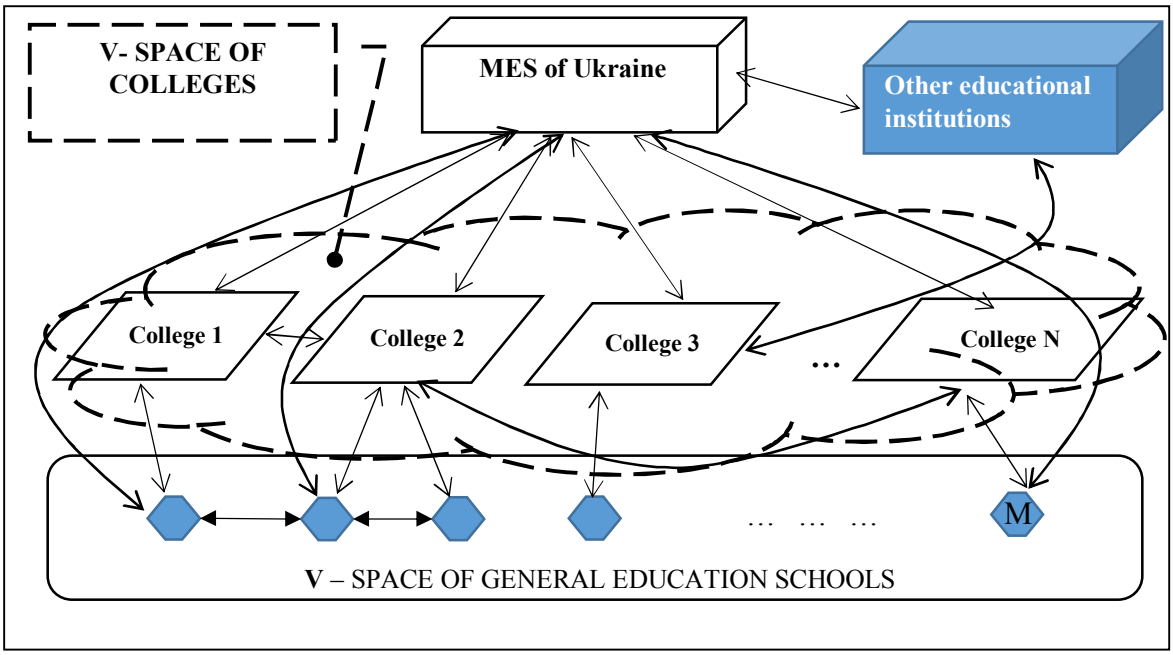

Fig. 1. Generalized scheme of virtual educational space

Figure 1 also shows that two generalized spaces can intersect. Let us denote the virtual space of schools V^{school}, and the generalized virtual space of colleges V^{C}. In the set-theoretic language, generalized virtual spaces can be interpreted by the following formalisms

$$V^{school} = \{v_i^{school},\ i = \overline{1,M};$$
$$V^{C} = \{v_i^{C}\},\ j = \overline{1,N}.$$

Then formally the intersection of these spaces can be written in the form

$$V^{school} \cup V^{C} = G,$$

where G is a virtual space formed by a set of pairs of websites of schools and universities.

As an example of such a pair, it is possible to cite the sites of the school No. 105 of Kharkov city and the site of the department of geoinformation systems, land and real estate appraisal of the A. N. Beketov National University of Urban Economy in Kharkiv (see Figure 2).

In Figure 2, a dimensional arrow shows a hyperlink that provides an injective, bijective and surjective mapping of the elements of the sites under consideration. In the language of category theory, the set of such mappings can be regarded as a functorial morphism. By the definition given in work [9] the term «functor» is treated as a special type of mapping between categories. A category is defined as the class of objects $Ob(K)$ together with the class of morphisms $Mor(K)$ and the composition law μ, if the following axioms are satisfied:

1. Associativity of the composition law: for $f \in Mor(X,Y)$, $g \in Mor(Y,Z)$, $h \in Mor(Z,T)$, correct

$$h \circ (g \circ f) = (h \circ g) \circ f;$$

2. The existence of the unit: for each $X \in Ob(K)$, there exists a morphism $lx \in Mor(X,X)$, called the identity or unit morphism of object X, such that for any $f \in Mor(X,Y)$, and $g \in Mor(Z,X)$, takes place

$$f \circ l_x = f,\ l_x \circ g = g.$$

This definition of the category gives it fundamentally new properties in comparison with the notion of «set». An important property of the category is that its objects $Ob(K)$ can have any nature, of the virtual space as well which makes up the sites, in the form of models or other mathematical constructions – formalized theories, ontological and algebraic models, groups, circles etc.

Let us identify the generalized virtual spaces V^{school} and V^{C} with the categories

$$K^{school} \equiv V^{school} \text{ and } K^{C} \equiv V^{C}.$$

Fig. 2. Illustration of the associative link of the site of the department and the general education school № 105

These properties of the categories allow to use already formulated formal theories, models, etc., which describe specific subject areas when formalizing [3, 4]. In addition to the above properties, in category theory there are subcategories that can be objects of a category. In the works [1, 2] a function or mapping of one set into another is also placed on a higher stage of generalization.

Conclusion

In this article, an analysis of the possibilities of a formal representation of the elements of a virtual educational space was made. The associative connection of the departments and general education schools site with the use of methods of topology, in particular methods of category theory and functors is shown. An important property of category theory is that its objects can have any nature, as well of virtual space.

References

1. Формирование общества, основанного на знаниях. Новые задачи высшей школы; пер. с англ. – М.: Весь Мир, 2003. – 232 с.
2. Метешкин К.А. Кибернетическая педагогика: теоретические основы управления образованием на базе интегрированного интеллекта / К.А. Метешкин. – Х.: МСУ, 2004. – 400 с.
3. Метешкин К.А. Краеугольные камни пирамиды знаний научно-педагогических и педагогических работников. XXI век / К.А. Метешкин. – Х.: ХНУГХ, 2012. – 335 с.
4. Кибернетическая педагогика: онтологический инжиниринг в обучении и образовании / К.А. Метешкин, О.И. Морозова, Л.А. Федорченко, Н.Ф. Хайрова. – Х.: ХНАГХ, 2012. – 207 с.
5. Морозова О.И. Создание учебного вебсайта с элементами оценивания знаний на основе использования современных информационных систем и технологий / О.И. Морозова // Системи обробки інформації: зб. наук. праць. – 2013. – Вип. 4 (111). – С. 152–156.
6. Морозова О.И. Особенности организации процесса обучения в вузе игровыми методами с использованием IT-технологий / О.И. Морозова // Системи обробки інформації: зб. наук. пр. – 2015. – Вип. 1 (126). – С. 201–205.
7. Сайт Метешкина Константина Александровича. – Режим доступа: http://meteshkin.com.ua/. – 27.07.2017.
8. Сайт учителей информатики Харьковской гимназии № 47. – Режим доступа: http://info47.at.ua/. – 27.07.2017.

9. Системи оброблення інформації. Інтелектуальні інформаційні технології: терміни та визначення: ДСТУ 2481–94. – Режим доступа: http://dbn.at.ua/blog/gipertekstova_sistema/ 2016-12-15-20804. – 27.07.2017.
10. Основы теории систем. – Режим доступа: http://kaf-gis.kh.ua/osnovy-teorii-sistem-konspekt-lekciy. – 27.07.2017.
11. Сайт кафедры геоинформационных систем, оценки земли и недвижимого имущества. – Режим доступа: http://www.kaf-gis.kh.ua/home. – 27.07.2017.

References

1. *Formirovaniye obshchestva, osnovannogo na znaniyakh. Novyye zadachi vysshey shkoly* [Formation of a society based on knowledge. New tasks of the higher school], Moscow, Ves Mir Publ., 2003, 232 p.
2. Meteshkin K.A. *Kiberneticheskaya pedagogika: teoreticheskiye osnovy upravleniya obrazovaniyem na baze integrirovannogo intellekta* [Cybernetic pedagogy: theoretical bases of education management on the basis of integrated intelligence], Kharkiv, MSLL Publ., 2004, 400 p.
3. Meteshkin K.A. *Kraeugol'nye kamni piramidy znaniy nauchno-pedagogicheskikh i pedagogicheskikh rabotnikov. XXI vek* [The cornerstones of the knowledge pyramid of scientific-pedagogical and teaching staff. XXI Century], Kharkiv, KhNUGKh Publ., 2012, 335 p.
4. *Kiberneticheskaya pedagogika: ontologicheskiy inzhiniring v obuchenii i obrazovanii* [Cybernetic pedagogy: ontological engineering in training and education], Kharkiv, KhNAHKh Publ., 2012, 207 p.
5. Morozova O.I. *Sozdaniye uchebnogo veb-sayta s elementami otsenivaniya znaniy na osnove ispol'zovaniya sovremennykh informatsionnykh sistem i tekhnologiy* [Creation of a training website with elements of knowledge assessment based on the use of modern information systems and technologies], *Systemy obrobky informatsiyi*, 2013, no. 4 (111), pp. 152–156.
6. Morozova O.I. *Osobennosti organizatsii protsessa obucheniya v vuze igrovymi metodami s ispol'zovaniyem IT-tekhnologiy* [The features of the training process organization in higher educational institution by game methods using it-technologies], *Systemy obrobky informatsiyi*, 2015, no. 1 (126), pp. 201–205.
7. *Sayt Meteshkina Konstantina Aleksandrovicha* [Site of Meteshkin Konstantin Alexandrovich]. Available at: http://meteshkin.com.ua/ (accessed 27.07.2017).
8. *Sayt uchiteley informatiki Khar'kovskoy gimnazii № 47* [Site of computer science teachers of Kharkov gymnasium № 47]. Available at: http://info47.at.ua/ (accessed 27.07.2017).
9. *DSTU 2481–94. Systemy obroblennya informatsiyi. Intelektual'ni informatsiyni tekhnolohiyi: terminy ta vyznachennya* [DSTU 2481-94. Information processing systems. Intelligent information technologies: terms and definitions]. Available at: http://dbn.at.ua/blog/gipertekstova_sistema/2016-12-15-20804 (accessed 27.07.2017).
10. *Osnovy teorii sistem* [Fundamentals of systems theory]. Available at: http://kaf-gis.kh.ua/osnovy-teorii-sistem-konspekt-lekciyhttp://kaf-gis.kh.ua/osnovy-teorii-sistem-konspekt-lekciy (accessed 27.07.2017).
11. *Sayt kafedry heoynformatsyonnykh system, otsenky zemly y nedvyzhymoho ymushchestva* [Site of the Geoinformation System, Lend and Property Evaluation department]. Available at: http://www.kaf-gis.kh.ua/home (accessed 27.07.2017).

Рецензент: В.В. Бондаренко, доцент, к.пед.н., ХНАДУ.