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# COMPARATIVE STUDIES OF MEDICAL INFORMATION-EDUCATIONAL ENVIRONMENTS

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*The article defines the features of training the future doctors, such as those that affect the formation of information-educational environment in medical higher education institutions. The relevant issue is the development of a learning environment for the training of future doctors, the model of which should take into account these features and aims I improving the quality of training. Definitions of the concept of "learning environment" (educational environment) in the historical aspect were analyzed, namely: computer-oriented, personal, information-oriented, educational, virtual, personalized computer-integrated, cloud-oriented, educational environment of distance learning of higher medical education institution and it was determined that the concept of learning environment is considered by the authors as a system or complex, as well as a special technological means, the formation of which can be controlled. It was defined that the concept of "learning environment" has the characteristics of a system, namely: a common goal, links between elements, structure, hierarchical nature, elements of control. The environment creates conditions for the existence of the system, its development and achievement of system goals. It was proposed to define the IEE of a medical higher education institution as a system that is represented by a set of complexes, the interaction of which implements the function of education in a MHEIs, in particular: training, control, inter-subject integration, communication, monitoring of educational activities, modeling. The functions were defined and it was offered to expand the structure of the IEE of the MHEIs in the following blocks: structured database of educational content, database of situational tasks, database of learning scenarios, database of control scenarios, database of online courses, educational content analysis subsystem, block of simulation modeling of biological and physiological processes and objects, electronic resources of departments, electronic journal, electronic catalogue IRBIS and DBSpace repository. The proposed structure of the IEE of medical free economic zones is implemented in Zaporizhzhia State Medical University in the form of a hybrid system of technical resources, information and software services that provide real-time distance learning of medical freelance students. Further perspective direction of our research development is the formalization and expansion of a system of adaptive learning, which is based on cloud services and machine learning.*

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***Key words*:** *comparative studies, educational environment, information and educational environment (IEE), higher medical education institution, composition of the environment, system, cloud services, COVID-19, medical information and educational environment (MIEE), methods of education.*

# КОМПАРАТИВІСТИКА МЕДИЧНИХ ІНФОРМАЦІЙНО-ОСВІТНІХ СЕРЕДОВИЩ

**Н. А. Іванькова**

*У статті визначено особливості підготовки майбутніх лікарів, що впливають на формування інформаційно-освітнього навчального середовища в медичному ЗВО. Актуальним є питання розробки навчального середовища майбутніх лікарів, модель якого враховуватиме названі особливості та матиме на меті підвищення якості навчання. Проаналізовано дефініції поняття "навчальне середовище" в історичному аспекті, а саме: комп'ютерно-орієнтоване, персональне, інформаційно-освітнє, віртуальне, персоніфіковане комп'ютерно інтегроване, хмаро орієнтоване освітнє середовище дистанційного навчання закладу вищої медичної освіти. Визначено, що науковці розглядають поняття "навчальне середовище" як систему або комплекс, а також як особливий технологічний засіб, формуванням якого можна управляти. Встановлено, що поняття «навчальне середовище має ознаки системи, а саме: загальну мету, зв'язки між елементами, структуру, ієрархічність, елементи керування. Середовище створює умови існування системи, її розвитку та досягнення системних цілей. Запропоновано визначення поняття інформаційно-освітнього навчального середовища медичного ЗВО як системи, що являє собою сукупність комплексів, взаємодія яких реалізує функцію навчання в медичному ЗВО, а саме: навчання, контроль, міжпредметну інтеграцію, комунікацію, моніторинг навчальної діяльності, моделювання. Окреслено функції та запропоновано розширення структури інформаційно-освітнього середовища медичного ЗВО такими блоками: структурована база даних навчального контенту, база даних ситуаційних завдань, база даних сценаріїв навчання, база сценаріїв контролю, база онлайн-курсів, підсистема аналізу навчального контенту, блок імітаційного моделювання біологічних і фізіологічних процесів та об'єктів, електронні ресурси кафедр, електронний журнал, електронний каталог ІРБІС та репозиторій DBSpace. Запропонована структура інформаційно – освітнього середовища медичного ЗВО реалізована у Запорізькому державному медичному університеті у вигляді гібридної системи технічних ресурсів та інформаційно-програмних сервісів, які забезпечують дистанційне навчання студентів медичних ЗВО у реальному режимі часу. Подальшим напрямком розвитку є формалізація та розробка системи адаптивного навчання, яка базується на хмарних сервісах machine learning.*

***Ключові слова:*** *компаративістика, навчальне середовище, інформаційно-освітнє середовище, медичний заклад вищої освіти, структура середовища, система, хмарні сервіси, COVID-19, медичне інформаційно – освітнє середовище, методи навчання.*

**Introduction of the issue.** One of the main features of the modern system of higher medical education is the organization and fornation of the educational process on the basis of end-to-end use of modern information technologies (ITs) during the training period and the application of existing information-communication competencies (ICC) in professional activities. It becomes possible only if there is an information-educational environment (IEE) in the school, which is built taking into account the peculiarities of the training of future doctors. Medical education, as an element of the educational system of Ukraine, has its own features, patterns and development strategy, which are the basis for the development of modern pedagogical innovative educational models (PIEM) and

technologies in various disciplines [1]. The Ukrainian experience in the organization of education in a medical higher educational institution (MHEI) is analyzed, its features are determined: lifelong learning (lifelong education); interdisciplinarity; multidisciplinarity; creation of a system of value orientations of the doctor; mastery of foreign languages, which provides the possibility of distance learning and promotes mobility in learning; formation of clinical thinking on the basis of algorithmic thinking; application of simulation technologies; combination of theory and practice; use of the educational environment, which includes departments of clinical disciplines located outside the educational institution (university clinics); introduction of test-based licensed exams "Krok (Step) 1, 2, 3" at all stages of training; long term of study: undergraduate and postgraduate education; reduced motivation of students to study the cycle of natural sciences (computer science, physics, mathematics); low level of teachers' skills in applying new information technologies; implementation of world medical standards: IFOM examination test in clinical disciplines; USMLE exam; direct connection of science, practice and education (correspondence of educational programs with the latest achievements of medical science); internationalization of medical education. Thus, there remains an issue of developing a learning environment for future doctors, the model of which will take into account these features and will aim at improving the quality of education.

**Current state of the issue.** The problem of creation and use of the information-educational environment is considered in works of V. Bykov, T. Vakaliuk, R. Hurevych, I. Zakharova, I. Kukharenko, S. Lytvynova, O. Pinchuk, Ye. Polat, I. Robert, S. Sysoieva, I. Trainovykh and M. Shyshkina. Features and peculiarities of the modern educational environment of MHEIs are revealed in the scientific researches of O. Bieliaiev, S. Bilash, V. Bobyrov, V. Zhdan and other. The quality management system of medical education in Ukraine is described in a collective monograph [2]. The issue of creating the IEE in the MHEs is reviewed by I. Kucherenko, A. Titova, O. Ryzhova. The essence of informatization of medical education is covered in the works of O. Mintser [3]. The author emphasizes that the global goal of informatization of medical education is to ensure the digital transformation of activitie. Achieving these goals and objectives cannot be reached at the middle level (deans / administration, library, departments, etc.). This is a systemic task, which involves not only the creation of local databases and the introduction of individual educational technologies, but also requires organizational restructuring of management and covers all structural units of HEI. The author identifies several areas of informatization, one of which is the informatization of academic management, which carries out the following task: "the use of technologies of a single information space that connects information systems of departments, deans, institutes, educational department, accounting department other structural subdivisions of the institution of higher education".

**Outline of unresolved issues brought up in the article.** Thus, the development of the structure of the IEE of MHEI, while taking into account features and peculiarities of training of future doctors, is highlighted in the article.

**Aim of the research** is to analyze the concepts of "information-educational environment (IEE)", "educational environment (EI; learning environment)", "educational environment of the medical higher educational institution (MHEI)", as well

as to determine the structural components of the IEE of MHEIs.

**Results and discussion.** The development of information-educational environment for the training of future doctors is impossible without a proper analysis of the terms and concepts that have historically been used by various authors. The term "information sphere (infosphere)" was introduced by A. Yershov, thus it created the foundations of informatization. "The infosphere is a parallel world in relation to the traditional information world, where information rotates, transformed into a form convenient for electronic processing." According to the scientist, the information resources of mankind are divided into personal information, social memory of human communities and operational information that arises constantly and continuously in the process of perception and understanding of everything that happens in the world by the humanity [4]. Therefore, we can say that any branch of human life and activity has its own infosphere: medicine, pharmacy, education, manufacturing, law, linguistics, etc. When it comes to medical education, we see a combination of two infospheres – medicine and education. The medical infosphere provides information, at the same time, technology provides the processing, storage, and transmission of information.

Many scientists use the concept of "environment" to denote the conditions of human existence and learning. We will analyze the manifestations of different environments, namely: informational, educational, computer-oriented, personal educational, informational, e-educational and virtual-educational, and their conceptual peculiarities, which will allow us to conclude the proper use of this term. Similar analysis was conducted by S. Lytvynova in 2014, in particular: the concepts of "learning environment", "information-educational environment", "information-learning environment", "information environment", "personal learning environment", "educational environment", "virtual-educational environment", "network environment", "innovative educational environment" have been analyzed, as well as the “educational environment” was identified as "a specially organized environment aimed at the acquisition of certain knowledge, skills, abilities, competencies and equal access to education for all participants of the educational process." [5]. We agree with the point of view of the scientist, but currently the concept of "educational environment" has changed due to the variety of functions that this environment should provide. Educational environments of particular educational institutions were formed permanently and unsystematically. Now we can state the provision of the educational process with technical means that help to implement only certain functions of learning. Moreover, a question of determining the structure of the educational environment arises, taking into account the peculiarities of the field of study and functions.

The concept of the information environment was first proposed by Yu. Shreider [6], who considered the information environment not only as a conductor of information, but also as an active nod, which influences its participants. In particular, the scientist offered a semantic approach to the phenomenon of information and a mechanism for determining the degree of semantic information (as a measure of change of a person's thesaurus under the influence of incoming data) and the concept of information as knowledge potential (knowledge accumulated in society; data available through the media; knowledge, processing, storage, retrieval and transmission of information). Some authors consider the concept of "educational space" as an analogue of

the learning environment. Thus, the researcher [7] defines that "space in relation to the environment is a construct of a higher order, in which there can be several environments. The construct "environment" reflects the relationship of conditions that ensure human development. In this case, the presence of man in the environment, interaction, interaction of the environment with the subject are supposed. Space can exist without man. Scientists distinguish the following hierarchy of pedagogical constructs: educational space, educational environment, learning environment." Scientists interpret the concept of bulk environment differently, focusing on its functions (Table 1).

*Table 1*

**Analysis of the "educational environment" concept**

| Concept | Definition | Author |
|---|---|---|
| Educational environment | it is an ***artificially constructed*** system, the structure and components of which contribute to the achievement of the goals of the educational and upbringing process. | Bykov V. [8] |
| Computer-oriented educational environment | it is such a learning environment, the structure of which provides for the purposeful ***use in the educational and upbringing process of tools, technologies and information resources of the global educational space***, which form the educational-spatial component of the learning environment. | Bykov V. [9] |
| Personal learning environment (PLE) | information environment that ***a person creates around him/herself for his/her own educational needs***. | Oliinyk N. [10] |
| Information-educational environment | is formed in the educational institution and ***includes a system of hardware, software, professionals and users, databases, etc., which realize the information processes***. | Noskov I. [11] |
| Information-educational environment | ***complex socio-technological and information-management system****, which includes people (subjects of management and participants in the educational process), as well as different in purpose and structure technical and technological objects.* | Topuzov M. [12] |
| Information-educational environment | ***open system*** that accumulates intellectual, cultural, program-methodological, organizational and technical resources, as well as a set of computer tools and methods of their operation, which is used to implement educational activities. | Konevshynska O. [13] |
| Information-educational environment | **integrated systemic means** of increasing the efficiency of the educational process (through the relationship of scientific, career guidance, educational, sports and sanative activities, organization of training and production activities, the work of the | Sokoliuk O. [14] |

| | | |
|---|---|---|
| | administration offices, scientific and scientific-methodical councils, psychological service, legal counsel, library. economic activity, etc.) through a set of means of transmitting information. | |
| Virtual learning environment | ***VLE is a pedagogically substantiated complex of services*** (software modules) and information resources that provide the educational process in a certain educational institution**.** | Tovazhnianskyi L. [15] |
| Virtual educational environment | is an ***immersive, specially organized educational environment, characterized by closeness to reality***, psychological credibility of perception and focus on achieving educational goals. | Tereshchuk V. [16] |
| Virtual learning environments (VLE) | is educational process management systems that are designed for students' learning activities and provide the necessary content and resources for the dissemination of knowledge and successful learning. | Stiles M. [17] |
| Personalized computer-integrated learning environment | is an open computer-integrated learning ***environment of pedagogical systems***, which provides configuration of ICT-infrastructure (including virtual) for individual information-communicative, information resource-based and operational-procedural needs of participants in the learning process. | Bykov V. [18] |
| Cloud-oriented learning environment | is ***artificially constructed system*** consisting of cloud services and provides educational mobility, group cooperation of teachers and students for effective, safe achievement of didactic goals. | Lytvynova S. [19] |
| Information-learning environment | is an ***open system*** that accumulates intellectual, cultural, program-methodological, organizational and technical resources, as well as a set of computer tools and methods of their operation used for the implementation of educational activities. | Konevshynska O. [20] |
| Information-educational environment of the general secondary education institution | is a system consisting of a set of subsystems (educational resources) that are used for information exchange between 3 participants in the educational process using the modern web-based technologies. | Vakaliuk T. [21] |
| Information-educational environment of | is ***united information-educational space*** created focusing on the principle of integration…, which includes virtual | Titova A. [22] |

| | | |
|---|---|---|
| the MHEI | learning tools, electronic libraries, distributed databases, optimally structured teaching and methodological complex and expanded didactics, which operates the principles of a new pedagogical system based on web technologies. | |
| Educational environment of distance learning of MHEI | is ***systematically organized set*** of modern electronic educational and other information resources focused on meeting the needs of participants in the educational process, and its scientific and educational support, as well as a set of hardware and software storage, processing and transmission of educational materials that provide prompt access to them (materials) and telecommunication interaction of students and teachers in order to achieve learning goals, in particular the acquisition of the necessary professional competencies. | Kucherenko I. [23] |

As can be seen from the Table 1, the concept of "environment" (a set of conditions that contribute to the achievement of a certain pedagogical result) is considered by the authors as a system or complex, as well as a special technological tool, the formation of which can be controlled [24]. The target function of the environment is to create conditions for the organization of modern learning technologies for teachers and students, which allows to increase the efficiency of learning. The environment provides conditions for the implementation of functions, which, in turn, determine its structural components. The elements of the environment are the *physical component* (computers, network resources, technical teaching aids, multimedia tools, etc.) and the *intellectual-psychological component*: (communication, motivation, etc.). Thus, any learning environment has the characteristics of a system, namely: the overall purpose, the relationships and interconnections between the elements, structure, hierarchy, controls. A system is a set of interconnected elements that form a single whole, interact with the environment and with each other [25], and have a purpose. A system is a set of interconnected components [26]. System as the complex of interacting elements was studied by Ludwig von Bertalanffy [27]. System is a form of unity and integrity, which enables one to transform means into purposes [28]. Using the concept of "complex" in defining the concept of "learning environment", the authors emphasize the implementation of one (specific) function (learning, control). A "complex" is a set or combination of objects, phenomena, actions, properties. The dominant opinion is that the "complex" is a system with a high degree of internal interconnection, quite rigidly organized, with great inertia and stability. That is, a complex is a mandatory combination of objects, phenomena, actions, properties. A system is a set of complexes, the interaction of which implements the function of the target function of the system.

Considering the environment from the standpoint of a systems approach, we can state that the environment creates the conditions for the existence of the system, its development and

fulfillment of system purpose(s). In relation to the system there are external (media and means of information delivery) and internal (media and means of storage, information delivery, which are available to subsystems) environment. Modern information and educational environment is formed on the basis of information and communication technologies, which become a means of transporting information from the external environment to the internal and perform the functions of preservation, delivery of educational content for participants in the pedagogical process. Important properties of the internal information and educational environment are the availability of educational content for all participants in the learning process and dynamism (the ability to quickly apply changes according to needs). These features allow to provide training in situations that are related to external challenges, i.e. changes in the epidemiological situation in the context of COVID-19, altered treatment standards due to healthcare reform, etc. Thus, the modern ICT-based information-educational environment transforms the EI into a state of a dynamic system that has the ability to respond quickly to social challenges. Information-educational environment, which is built on the basis of ICTs, differs from the classical one, in which educational information is recorded on paper, moreover, new opportunities for independent work of students appear thanks to interactivity of the educational content, which creates the possibility of personalizing the learning process. On the other hand, automated assessment tools reflect educational achievements by means of cloud services, making it easier for the teacher to supervise the activity of the students. Communicative Internet services create a new dimension of space and time, giving the participants of the educational process the opportunity to communicate with each other regardless of location and time of the day. Virtual professional reality modeling services allow students to form and test skills in the conditions, which are the closest to the clinical situation.

In the work [29] the author identifies the components of the educational environment of distance learning in MHEI, namely: user management subsystem, messaging subsystem, subsystem of access to distance learning courses, testing subsystem, subsystem of accounting for student learning outcomes (academic achievements), distance learning management subsystem. Based on the peculiarities of future doctors training procedures, we consider it appropriate to add the following components: structured database of educational content (implementation of interdisciplinary links), database of situational tasks, database of learning scenarios, database of assessment scenarios, database of online courses, subsystem of educational content analysis, block of simulation modeling of biological and physiological processes and objects, digital resources of departments, digital journal, digital catalog IRBIS and DBSpace repository.

Thus, in our opinion, the information-educational learning environment (IELE), which provides the implementation of learning conditions, is a system that is a set of complexes (teaching, controlling, assessing etc.), the interaction of which implements the function of the system (learning, control, communication, mobility). IELE of MHEIs is defined as a system represented by a set of complexes, the interaction of which implements the functions of the educational system in medical higher educational institutions, namely: training, control, assessment, interdisciplinary integration, communication, monitoring of educational activities, modeling.

The existing conditions in the form of the environment affect the selection and use of methods that allow to implement the functions of education (Table 2).

*Table 2*

**Realization of the functions of the learning environment in MHEI**

| **Methods** | **Conditions: components of the environment** | | | **Functions** |
|---|---|---|---|---|
| | **hardware** | **software** | **informational** | |
| Verbal, visual, practical, interactive, supervisual, assessing. | Computer classroom | OS (Operating System), applications. | Teaching materials, textbooks in printed and in digital form. | Educational, supervisual, assessing, informational, developing, diagnostic. |
| | Computer network | Active Directory access permissions, personal data, antivirus, protection. | Active directory for management, personal data and software on servers. | Educational, supervisual, assessing, managing, monitoring, informational, developing, diagnostic, reflective. |
| Visual, practical, supervisual, assessing. | Student's personal device (SPD) (Smartphone, tablet PC etc.) | OC, LMS edX, Moodle, websites of the departments, SPOO (SPDO) – student's personal online (digital) office, online (digital) journal, social networks. | Online courses, websites of the departments, digital resources of the departments. | Educational, supervisual, assessing, managing, monitoring, informational, developing, diagnostic, reflective. |
| Visual, practical, supervisual, assessing. | Servers | SPOO, IRBIS digital catalogue. | Online courses, websites of the departments, digital resources of the departments. | Educational, supervisual, assessing, managing, monitoring, informational, developing, diagnostic, reflective. |
| Verbal, visual, practical, supervisual, assessing. | Cloud services | MS Office 365, MS Teams, SharePoint, Office 365 active account. | EMC (educational-methodical complexes) and digital documentation. | Educational, supervisual, assessing, managing, monitoring, informational, developing, diagnostic, reflective. |

| | | | | |
|---|---|---|---|---|
| | Cloud services | Skype for Bussines, MS Teams, e-mail, Outlook | Digital (electronic) methodical materials: work programme, digital tasks & tests, lectures in the form of multimedia presentations. | Educational, supervisual, assessing, managing, monitoring, informational, developing, diagnostic, reflective. |
| Verbal, visual, practical, supervisual, assessing. | Classroom with multimedia board or multimedia projector. | OS Windows, OS Android | Digital (electronic) methodical materials: work programme, digital tasks & tests, lectures in the form of multimedia presentations. | Educational, supervisual, assessing, managing, monitoring, informational, developing, diagnostic, reflective. |
| Verbal, visual, practical, supervisual, assessing. | Computer classroom with PC workstations. | Software, RATOS test system, OpenLabyrinth. | Database with tests on subjects, KROK (STEP) tests, simulation programs for modeling biological and physiological processes and objects. | Educational, supervisual, managing, monitoring. |
| Visual | Computer workroom (library) with 100 PC workstations. | IRBIS digital (electronic) catalogue and DBSpace repository. | Library catalogue, catalogue of digital editions (issues) and publications. | Informational, developing. |

Functions of the educational environment of MHEI that are listed in Table 2 have been sucessfully implemented in Zaporizhzhia State Medical University at the physical component level, which includes 56 computer classrooms with 739 PC workstations, 289 TVs and 59 plasma panels, 11 interactive sensoric touchboards, a network of Distance Learning Centers at the regional and local levels. Information component of the educational process, namely educational and methodical content, which includes educational and methodical complexes for each discipline, is hosted on FTP-server and consists of 637 online courses, virtual anatomical visualization system, virtual patient technology, interactive video lecture channels based on MS Stream cloud service with the current survey in MS Forms tests, electronic library, RATOS (control, supervisual and assessment system). Management and monitoring of independent work of

students is carried out by the automated control and assessment system (SPOO of the HEI) in which functions of educational process planning, monitoring and the analysis of students' academic success are implemented and realized. The computer network of the university allows students to have authorized access to educational content from computer classrooms and personal devices (tablet PCs, smartphones), which provides new opportunities in organizing their own schedule.

The introduction of COVID-19 quarantine has led to the large-scale implementation of cloud services and technologies into the educational process, thereby making it necessary to switch from time-to-time exploitation of the above mentioned advanced educational means to their constant use in Zaporizhzhia State Medical University. The inability to communicate directly with teachers in this situation, as well as the use of computer classrooms formed the motivation to search for a communication environment with the properties of social networks for the organization of real-time distance learning. After the analysis of services in various online sources, the use of MS Teams was offered as the main environment for interaction with students. The peculiarity of MS Teams is that this service acts as an integrator of other IT services, which made possible to embed all the necessary Internet applications into hubs that corresponded to groups of students and create an information-educational environment for each academic group of students in individual subjects in order to ensure conditions for effective learning. [30] Currently, the IEE of ZSMU [31] can be characterized as a hybrid system of technical resources, harware, information and software services that provide real-time distance learning for medical university students.

**Conclusions and research perspectives.** After analyzing the concepts of "learning environment", "educational environment", "educational environment of MHEI", their structural components are identified, which ensure the implementation of learning functions, namely: technical, software and information support. The structural and functional analysis of the IEE and the characteristics of information and software services allowed to quickly form appropriate environment in the MS Office 365 cloud and reorganize the learning process in ZSMU in accordance with the conditions of the COVID-19 quarantine period. The result of the state certification of final year students and the independent licensed exam KROK (STEP) showed that the average score is not statistically significantly different from the results of the previously registered outcome of 2019.

A further perspective of our scientific research is its formalization and development of a system of adaptive automated learning in medical higher educational institutions.

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