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LOGICAL-SEMANTIC KNOWLEDGE MODEL FOR THE KNOWLEDGE BASE OF A LECTURER

The subject *of this study is the process of synthesizing a graphical logical-semantic knowledge representation model with an open architecture for the knowledge base of a university lecturer.* ***The purpose*** *of the proposed model is to develop a lecturer's knowledge base using a graphical logical-semantic knowledge representation model. The objectives of this study include: analysis of existing approaches to the formation of information management systems for organizing the educational process in higher education institutions; definition of the research methodology; analysis of the integrated four-factor architecture of the knowledge model about the existence and activities of the socio-economic ecosystem; formation of a three-factor logical-semantic knowledge representation model based on the results of the analysis; presentation of the practical implementation of the three-factor logical-semantic knowledge representation model for the lecturer's knowledge base; and summarizing the research results and outlining future directions in the field of knowledge modeling for knowledge bases with open architecture.* ***The methods*** *used include an approach that identifies general patterns and hypotheses underlying the construction of lecturers' knowledge bases to organize the educational process in higher education institutions. The theoretical foundation proposes using a logical-semantic model of semiotics knowledge because all known logical and logical-semantic knowledge models are representative objects of semiotics.* ***The following results*** *were obtained. The current focus of implementing information technologies in educational activities is on organizing educational processes in a distance format. At the same time, an important aspect of lecturers' work—providing information supports for their methodological activities—has been overlooked. This work involves preparing initial materials, processing them, and forming the corresponding final materials in the form of textbooks, educational aids, lecture notes, methodological guidelines, and presentations. This paper proposes an architecture for a three-factor graphical logical-semantic knowledge representation model, which defines an algorithm to form the corresponding knowledge base. According to the authors, this knowledge base can be best implemented in Microsoft Excel. The advantage of this knowledge base model is its open architecture, as users hold administrator rights over the knowledge base. The user makes decisions about including relevant knowledge elements in the knowledge base. The inclusion of the "Students" factor in the knowledge base and subsequent recording of their participation results in classes ensures the possibility of providing these results to department and faculty management for further analysis.* ***Conclusions.*** *The architecture of the graphical logical-semantic knowledge representation model and its corresponding knowledge base ensures the resolution of tasks related to the preparation of methodological support for courses. It can also complement existing LMS (Learning Management Systems) and LCMS (Learning Content Management Systems). The next step in using the formed knowledge bases for relevant educational components (courses) is to create department knowledge based on these knowledge bases. This ensures the formation and preservation of the department's intellectual potential and transferability.*

Keywords: *logical knowledge representation model; logical-semantic knowledge representation model; knowledge base with open architecture; semiotics.*

1. Introduction

The organization of educational processes under martial law, which is currently in effect in Ukraine, is receiving considerable attention. The main form of instruction has been designated as online learning, which requires the extensive use of information and communication technologies, and specialized educational platforms. Typically, higher education institutions operate automated information management systems (IMS) that

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oversee the educational process at the administrative level.

Developing a knowledge base for a lecturer is a complex process that requires the combined efforts of specialists from various fields and disciplines (academic staff, technical support, methodological guidance, etc.). It is evident that lecturers play a key role in this process. They serve as the primary source of information on academic programs, teaching methods, and the specifics of individual subjects. Their activities are focused on ensuring a high-quality education. The primary indicator of a lecturer's effectiveness is his or her students' academic performance. However, in addition to teaching, lecturers are required by their job descriptions to perform methodical, research, scientific, and monitoring work, as well as engage in professional development. This highlights the growing need for a knowledge base that systematically encompasses all areas of a lecturer's activities. Currently, the widely accepted concept involves organizing the work of a lecturer through the use of an Automated Workplace of a Lecturer (AWL), which is an integral part of the information management system of a higher education institution (IMS). This raises the following question: what is the role and place of AWL in the IMS? This problem is further complicated by the fact that the architecture of an IMS can be developed based on at least three approaches [1]:

- the IMS serves as a foundation for defining the role and function of the AWL;
- AWL serves as the foundation of the IMS;
- AWL is a self-sufficient knowledge base for organizing and conducting teaching and research activities within higher education institutions.

However, no universally recognized concept or corresponding software product supports the organization of a lecturer's activities across all stages of the educational process. This includes developing methodological materials for various forms of instruction and compiling reports on the outcomes of each class. Therefore, the task is to develop such a concept and provide a practical implementation in the form of a knowledge model for a lecturer's knowledge base. This paper proposes a transition from the concept of an automated workplace to the concept of a knowledge base.

1.1. Motivation

The primary activities of a lecturer at a higher education institution include: conducting classes, preparing teaching materials, conducting scientific research, and organizational work.

Therefore, it follows that an important reserve for improving the efficiency of a lecturer's work is the use of an intelligent decision support system in the form of an expert system. Practically, this should be implemented as an Automated Workplace (AW) for the lecturer. The key element of an AW is the knowledge base. On the other hand, the process of forming a knowledge base in the traditional expert system format is extremely complex and time-consuming, requiring the involvement of experts, knowledge engineers, and programmers. Clearly, this approach is not feasible for widespread use.

The main issue is the methodology underpinning the formation of the knowledge base. According to [2], the foundation of this methodology is formal logic theory, which is used to construct logical knowledge representation models. However, as explored in [3], there is a methodology for developing graphical logical-semantic knowledge representation models. The primary advantage of these models is their simplicity of implementation, for example, through the use of Microsoft Excel.

Thus, the task arises to develop a concept for creating a lecturer's knowledge base based on the methodology of forming graphical logical-semantic knowledge representation models.

1.2. Analysis of Recent Studies and Publications

The development of any database or knowledge base always begins with a specific subject area. As the analysis of recent scientific works over the past few years shows, many studies have been dedicated to identifying challenges for educational institutions related to the implementation of online technologies—initially during the pandemic and now in the context of the war in Ukraine. In this regard, the main focus of researchers has been on various aspects of distance learning, particularly students' perceptions of open and distance education and their satisfaction levels with it [4]. Distance learning requires practical learning materials, digital tools, and online platforms that facilitate interaction with educational content for both students and lecturers. The authors of [5] analyzed the usability of existing platforms, highlighting both their disadvantages and advantages. As the popularity of online education continues to grow, many colleges and universities are interested in understanding how online learning courses affect student engagement. The results of the empirical research presented in [6] demonstrate important correlations between attending online courses and student engagement.

In [7], an additional didactic aspect was explored, specifically the transition from coordinating teaching and learning activities to designing, forming, and mastering individualized learning plans. The organization of assessing distance learning results in Ukraine during martial law training was studied by Ukrainian scientists [8]. They focus on the periodicity, methods and forms of both current and final assessment of student learning outcomes in distance education, the tools and methods preferred by lecturers for evaluating these outcomes and changes in assessment procedures.

An important area of research is the study of experience in remote evaluation. In [9], the authors examined the consequences of transitioning from in-person exams to fully online exams. The results revealed that all academic performance indicators improved, and most students responded positively to online assessments. At the same time, the authors of [10] argued that online exams are more prone to academic dishonesty than traditional examinations. Currently, with the digitalization transition from Education 4.0 to Education 5.0, the number of studies on the use of artificial intelligence (AI) in the educational process is increasing. In this context, contemporary researchers are exploring ways to implement learning management systems with generative AI functions [11]; the competency levels of lecturers in using AI tools in educational activities [12]; the application of AI tools in educational projects [13]; and the impact of AI on educational software [14].

However, very few studies have focused on the technical and methodological support of lecturers. Some studies have addressed the organizational and pedagogical conditions for using the digital environment in general education institutions [15] and the pedagogical conditions for creating an effective information-educational environment in higher education institutions [16]. The process of creating, populating, and administering courses on the Moodle platform is described in [17]. The authors also describe the process of creating Moodle team files, which automate all tasks related to LMS and MATE structures [18]. In [19], an overview of scientific studies was provided, covering the quality design of online courses, facilitating lecturers in online courses, evaluating the quality of online courses, and engaging students in online courses.

An example of an automated information system for managing a higher education institution, the "Electronic University," is demonstrated in [20]. The electronic system for managing university educational programs was discussed in [21]. Research that attempts to streamline the processes and technologies used by lecturers to organize educational processes during wars, pandemics, or other crises deserves special attention.

Although the processes for creating, receiving, processing, and delivering information to end users have been justified and practically verified in general education systems [22], these issues remain problematic in higher education.

Researchers are working on the following tasks:

– determine the educational resources to be used based on their importance for student learning [23];

– streamline the process of student registration and electronic class journal submission [24];

– identify opportunities for applying AI in higher education [26].

Thus, innovative technologies can be divided into the following categories:

– modular digital learning environments;

– massive open online courses (MOOCs);

– distance education technologies;

– LMS (Learning Management Systems);

– LCMS (Learning Content Management Systems).

Unfortunately, among these information technologies, there is no mention of intelligent information technologies, such as knowledge bases in the form of expert systems.

It should also be noted that the composition of modular digital educational environments excludes Intelligent Tutoring Systems (learning intelligent computer systems), which are also based on artificial intelligence technologies.

In our opinion, this is primarily due to the fact that the development of systems based on the principles of artificial intelligence, as a rule, requires considerable time and the involvement of experts in this subject area, a knowledge engineer, and programmers.

This important direction has developed over the last decade, as evidenced by international scientific events such as the Future of Al Summit 2024.

At the same time, as shown in [3], several logical-semantic knowledge representation models have been developed in semiotics, but unfortunately, they have not been realized in the form of corresponding knowledge bases using information technology tools. In our view, this is because such a model must be transdisciplinary, encompassing various fields (psychological-pedagogical, organizational-methodical, informational-communicative, legal-regulatory, etc.).

In this context, it is important to emphasize that the main sources of knowledge regulating a lecturer's activities are the normative documents of the Ministry of Education and Science of Ukraine (MES of Ukraine) and the regulatory documents of educational institutions.

Currently, one such regulatory document is the Order of the Ministry of Education and Science of Ukraine No. 775, dated June 21, 2023, "On the Approval of Forms of Documents for the Training of Specialists in Institutions of Higher (Professional Pre-Higher) Education".

This order introduced nineteen forms of documents.

However, the list does not include documents that organize lecturers' activities during the planning and implementation processes, which were previously introduced by the Ministry of Education and Science, Youth, and Sports of Ukraine's Order No. 384, dated March 29, 2012, such as:

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Innovative technologies used by teachers to organize the educational process during war and other crisis conditions		
→	MODULAR DIGITAL LEARNING ENVIRONMENTS	
	→	**PIES** (Personalized Integrated Education System)
	→	**NGDLE** (Next Generation Digital Learning Environment)
→	MASSIVE OPEN ONLINE COURSES (MOOC)	
	→	MOOC platforms: **Coursera, edX, XuetangX, FutureLearn,** and **Udacity**
	→	Gamification technologies
	→	**OnlineTestPad** – online constructor for tests, quizzes, crosswords
	→	**iLearn** – educational platform with online courses, tests, and webinars
	→	**Stepik** – educational platform for creating online courses and lessons
	→	**Kahoot!** – application that allows creating tests in a game format
	→	**Quizizz** – application for conducting multimedia tests using QR code cards with instant results
→	DISTANCE EDUCATION	
	→	**Skype, Viber, WhatsApp, Zoom, Facebook** – messengers for conducting classes in synchronous or asynchronous format
	→	**Google Classroom, Edmodo** – applications for creating virtual educational platforms with integrated video lessons and electronic assignments
→	LEARNING MANAGEMENT SYSTEMS (LMS) AND LCMS (LEARNING CONTENT MANAGEMENT SYSTEMS)	
	→	**Moodle, IBM Lotus, Shareknowledge** – web services for organizing the educational process online
	→	**Adobe Captivate Prime** – cloud platform for employee training by educating students
	→	**Claroline** – platform for managing projects and coordinating educational activities, with support for integration with other resources
	→	**Trello** – a system for organizing group work on projects, allowing users to create boards with cards for each participant
	→	**Linoit, Padlet** – virtual universal boards where relevant notes with informational posts, images, videos, and documents can be pinned.

Fig. 1. Innovative Technologies Used by Lecturers for Organizing the Educational Process During War, Pandemic, or Other Crises

– Form No. H-4.02 (Volume of Educational Work for the 20__/20__ Academic Year);

– Form No. H-4.03 (Distribution of Educational Work in Hours);

– Form No. H-4.04 (Individual Work Plan of the Lecturer);

– Form No. H-4.06 (Department Report on the Fulfillment of Educational Work).

Additionally, Form No. H-4.07 (Lecturer's Work Log) was also introduced by the Ministry's Order No. 1110, dated December 5, 2008. These forms, especially H-4.04 and H-4.07, are essential for planning lecturers' activities and compiling reports on their work results.

The planning of educational activities for teaching a course is based on the Working Program of the Course (WP), a regulatory document of the higher education institution (HEI) that defines the place of the course in the professional training system, its objectives, tasks, learning outcomes, and the competencies students must acquire during the learning process.

An additional regulatory document in HEIs is the Syllabus, which provides a detailed course outline. This includes a description of the course, its objectives and tasks, content modules, the titles of class topics, the duration of each class, assignments for independent work, consultation times, instructor requirements, assessment criteria, and a bibliography. The syllabus also outlines the content of lectures, practical sessions, and laboratory sessions for each module, along with the duration of each session.

Thus, the planning of daily teaching activities is organized on a weekly basis (through the Working Program and Syllabus) and is later specified in the respective class schedules. Reporting on the fulfillment of teaching responsibilities can be done through the Lecturer's Work Log (Form No. H-4.07), which is not a regulatory document.

Currently, no universally accepted methodology exists for planning teaching activities that simultaneously includes elements for weekly lesson planning and reflects the results of these lessons, including the participation of each student. This gap makes it difficult for lecturers to establish corresponding knowledge bases to plan and implement their activities effectively.

1.3. Purpose of the Article

The purpose of this article is to increase the efficiency of the lecturer's activity due to the integration of the main results of his educational activity into the lecturer's knowledge base using the application of logical-semantic models of knowledge representation.

The key tasks and stages of this research are as follows:

Stage 1: Analyze existing approaches to developing information management systems to organize the educational process in higher education institutions and identify strengths and weaknesses (Section 1).

Stage 2: Define the research methodology (Section 2).

Stage 3: Analyze the integrated four-factor architecture of the knowledge model related to the existence and functioning of the socio-economic ecosystem. Based on this analysis, we develop a three-factor logical-semantic knowledge representation model (Section 3).

Stage 4: Development of proposals for practical implementation of the three-factor logical-semantic knowledge representation model for lecturers' knowledge base in higher education institutions (Section 4).

Stage 5: Summarize the research results and outline future directions for developing knowledge modeling in lecturer knowledge bases (Section 5).

2. Research Methodology

The research approach involves identifying general patterns and hypotheses that form the foundation for building knowledge bases for lecturers in higher education institutions. The theoretical basis of this study is the use of a logical-semantic knowledge model from semiotics. The rationale for this choice is that all known logical and logical-semantic models of knowledge are representative semiotic objects [3].

3. Research Materials

An analysis of recent studies and publications reveals that the innovative information technologies used by lecturers to organize educational processes are applied in the development of [26]:

- modular digital learning environments;
- massive Open Online Courses (MOOCs);
- distance education technologies;
- LMS (Learning Management Systems);
- LCMS (Learning Content Management Systems).

Unfortunately, none of these innovative information technologies include the development of knowledge base models for lecturers and higher education students.

On the other hand, according to [1], the Automated Workplace of a Lecturer (AWL) is an integral part of the Information Management System of a Higher Education Institution (IMS HEI). The architecture of this system can be developed using at least three approaches:

The IMS HEI serves as the foundation for defining the role and tasks of the AWL;

The AWL serves as the basis for the formation of the IMS HEI;

The AWL is a self-sufficient knowledge base for organizing and implementing the pedagogical and scientific activities of the lecturer.

We have chosen the third approach, which envisions the development of a self-sufficient knowledge base for organizing and implementing the pedagogical and scientific activities of the lecturer. The feasibility of this task was demonstrated in [3], where it was demonstrated that, in addition to traditional knowledge bases built on logical knowledge representation models (expert systems), there are graphical, logical-semantic knowledge representation models. The primary advantage of these models is the openness of the physical model's architecture to the user.

According to [3], the simplest graphical logical-semantic knowledge representation model is a regular table that includes a header and sidebar. An example of such a table is a weekly class schedule. Typically, the header consists of a set of course codes for the corresponding academic program. The sidebar contains days of the week and the corresponding time slots for the classes. The cells in the table contain the course name, session type, lesson topic, lecturer name, and classroom number. According to semiotic theory, this table can be classified as a two-factor logical-semantic knowledge representation model.

Examples of such tables are also found in the "Lecturer's Work Log." Let's consider the table titled "Record of the Lecturer's Teaching Work," where the header includes the following elements in Table 1.

Table 1

Record of the Lecturer's Teaching Work

Date	Stream Code or Academic Group	Course Title	Lesson Topic	Type of Session	Number of Hours

The table you uploaded appears to be titled "Results of Semester Control, Defense of Educational Modules" and includes the following elements in its header, as shown in Table 2.

ECST (European Credit Transfer and Accumulation System credits) A characteristic feature of these tables is that one of the two factors that shape the table is the time factor. The eight-factor logical-semantic models studied in [3] exclude the time factor; they are designed to represent the knowledge that characterizes objects and their properties.

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Table 2
Results of Semester Control: Defense of Educational Modules

№	Surname and Initials of the Student	Attendance Record and Results, Date							Summary		
									Number of Points	ECST	Grade

Among the four-factor logical-semantic models studied in [27, fig. 14.14], one includes the time factor (Fig. 2). Based on the structure of this model, it is possible to develop a three-factor logical-semantic knowledge representation model (Fig. 3).

In this architecture, two tables are combined, with time serving as the common factor. This allows for integrating dialectically opposing factors:

- Process factors of organizational activities.
- Process factors of technological activities.

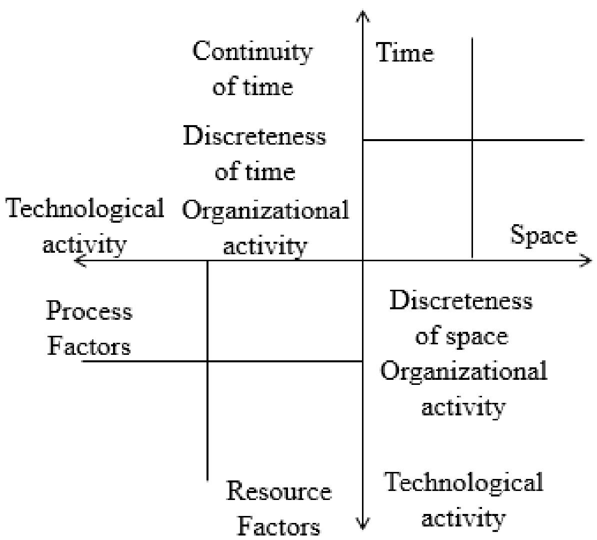

Fig. 2. Integrated Four-Factor Architecture of the Knowledge Model on the Existence and Activities of the Socio-Economic Ecosystem

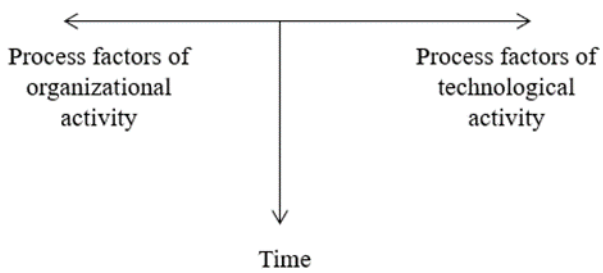

Fig. 3. Architecture of the Three-Factor Logical-Semantic Knowledge Representation Model

By incorporating the time dimension into these knowledge representation models, the system can better track dynamic changes and activities over time, ensuring that both organizational and technological processes are adequately captured and reflected in the knowledge base. This integration helps construct more flexible and comprehensive models that align with real-life processes.

The task now arises to define the specific content of the elements of these factors according to the structure and organization of the educational process. The educational activity is carried out through interaction between the lecturer and student. This interaction can take different forms, but it is most effectively realized during in-class activities. This activity is represented in the form of problem-solving tasks. The lecturer is responsible for describing the relevant tasks, and the student is responsible for solving them.

Formulating tasks implies structuring knowledge for various educational activities such as lectures, practical and laboratory sessions and independent work. The challenge for students is to acquire the necessary competencies by mastering the knowledge provided.

Thus, the lecturer selects the appropriate tool (platform) for the "materialization" of the formulated tasks.

The following tasks are proposed to be included in the set of factors titled "Process Factors of Organizational Activity (PFOA)" (Table 3):

- reparation of lecture materials by the lecturer;
- preparation of practical session materials by the lecturer;
- preparation of laboratory work materials by the lecturer.

The following tasks are proposed to be included in the set of factors titled "Process Factors of Technological Activity (PFTA)":

- Student mastery of knowledge presented in lecture materials;
- Student acquisition of practical skills during practical sessions;
- Student acquisition of abilities during the execution of laboratory work.

The task is to select the appropriate tool to form the proposed architecture of the three-factor logical-semantic knowledge representation model. This architecture includes two interconnected tables; thus, it is rational to implement this model in Microsoft Excel.

A further development of this model would be to include knowledge carriers for each element in the formed matrices. For example, additional folders titled "PFOA - Time" and "PFTA - Time" could be created in advance to store the relevant materials for each task.

This approach would allow for a more structured and flexible organization of the knowledge base, aligning it with the educational process, where both organizational and technological activities are tracked and monitored over time.

Table 3

Example of a Physical Model for the Three-Factor Logical-Semantic Knowledge Representation Model for a Lecturer's Knowledge Base

Process Factors of Organizational Activity				Process Factors of Technological Activity		
Lectures (L)	Practical Sessions (PS)	Laboratory Work (LW)	Weeks	Surname, first name, patronymic of the student		
				L	PS	LW
Topic 1	Topic 1	Topic 1	1	Points	Points	Points
			2			
			3			

In the folder "PFOA - Time" (Process Factors of Organizational Activity), it is possible to create additional subfolders titled "L" (Lectures), "PZ" (Practical Sessions), and "LR" (Laboratory Work). Similarly, in the folder "PFTA - Time" (Process Factors of Technological Activity), subfolders can be created for each student. This structure allows users to navigate directly to the content of each folder via hyperlinks from specific cells in a table. For example, clicking on the cell corresponding to "L" (Lectures) links to the content stored in the "L" folder, where lecture files can be organized and stored.

Another option involves using more specific hyperlinks from individual cells. In this scenario, within the "L" folder, additional subfolders can be created for each lecture topic. For example, clicking on the cell labeled "Topic 1" would direct the user to the "Topic 1" folder in the "L" folder.

For the folder "PFTA - Time," similar subfolders can be created to store files related to the students' performances and results. These could include reports from laboratory work, outcomes of practical sessions, and other relevant materials documenting the students' mastery of the learning material.

This physical model allows for the structured organization of both the lecturer's teaching materials and students' results, enabling easy access to and management of the educational process. Using hyperlinks within Excel, each element of the knowledge base can be efficiently navigated, thereby making the system user-friendly and enhancing the organization of the knowledge base.

4. Practical Case: Implementation of a Three-Factor Logical-Semantic Knowledge Representation Model for a Lecturer's Knowledge Base

Table 3 presents an example of the implementation of this logical-semantic knowledge representation model for the course "Information Systems and Information Technologies".

The set of elements under "Process Factors of Organizational Activity" (PFOA) includes an additional element, "Hours/Date," placed next to each task. This ensures the recording of the session's duration and date.

The set of elements under "Process Factors of Technological Activity" (PFTA) includes the elements "Surname, First Name, and Patronymic" (PIB) for each student. Additionally, for each of these elements, the following are included: "Lecture (L)", "Practical Session (PZ)", and "Laboratory Work (LR)." These additional elements ensure that student participation in the respective sessions is recorded.

The "Time" factor includes the elements "Schedule" and "Week." The inclusion of the "Schedule" element allows links to the relevant schedule file via a hyperlink. The "Week" element enables the formation of topics for each week. Each week corresponds to a row in which the session date, session duration, class hours (periods), session types planned (Lecture, PZ, LR), and location are indicated. An important part is information about students' attendance and their activities during the session, which is determined by the corresponding score according to the Working Program of the Course. The results of the students' educational activities are determined after the completion of the module. The knowledge base also includes a row where test control results are recorded along with the total score. A key advantage of this method for constructing a knowledge base is that any cell can be linked via a hyperlink to the corresponding folder. This applies to both elements of the sets of respective model factors and cells formed because of the Cartesian product operation of adjacent factor elements. These folders can store specific files containing the knowledge that forms the content of the relevant session (Table 4).

An important feature of these folders is that they can also store additional materials used during the preparation of the final content of the knowledge to be presented in the sessions. From this perspective, the proposed architecture of the logical-semantic knowledge representation model can be used as a tool that facilitates an important aspect of a lecturer's work, namely, the development of methodological support.

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Table 4

Example of the Architecture of a Logical-Semantic Knowledge Representation Model for the Course "Information Systems and Information Technologies"

Knowledge base for the discipline "Information Systems and Information Technologies"																					
Date	Hours	Pair	Lecture Topics / Auditorium	Date	Hours	Pair	Practical Class Topics / Auditorium	Date	Hours	Pair	Lab Work Topics / Auditorium	Schedule	Full name of the student.			Full name of the student.			Full name of the student.		
Module 1: Theoretical Foundations of Information Technologies												Week	L	PS	LW	L	PS	LW	L	PS	LW
02.08.	2	1	Topic 1	02.08.			PS 1	2			LW 1	1	0	2	2	4	2	2			
2			Topic 2	2			PS 2	2			LW 2	2	4	2	2	4	2	2			
2			Topic 3	2			PS 3	2			LW 3	3	4	2	2	4	2	2			
2			Topic 4	2			PS 4	2			LW 4	4	4	2	2	4	2	2			
2			Topic 5	2			PS 5	2			LW 5	5	4	2	2	4	2	2			
2			Topic 6	2			PS 6	2			LW 6	6	5	2	2	5	2	2			
2			Topic 7	2			PS 7	2			LW 7	7	5	3	3	5	3	3			
			Current Control										26	15	15	30	15	15			
			Test										40			40					
			Overall Points										96			100					
Content Module 2: Theoretical Foundations of Automated Information Technologies												Week	L	PS	LW	L	PS	LW	L	PS	LW
2			Topic 8	2			PS 8				LW 8	8	4	2	2						
2			Topic 9	2			PS 9	2			LW 9	9	4	2	2						
2			Topic 10	2			PS 10	2			LW 10	10	4	2	2						
2			Topic 11	2			PS 11	2			LW 11	11	4	2	2						
2			Topic 12	2			PS 12	2			LW 12	12	3	2	2						
2			Topic 13	2			PS 13	2			LW 13	13	4	2	2						
2			Topic 14	2			PS 14	2			LW 14	14	3	2	1						
2			Topic 15	2			PS 15	2			LW 15	15	4	1	2						
			Current Control										30	15	15						
			Test										40								
			Overall Points										100								

By linking cells to folders with relevant teaching materials, the architecture ensures that lecturers can easily access, update, and present the necessary content for each session. This makes the model an effective organizational framework for managing educational content and preparing for classes.

5. Discussion

From the literature analysis, it is evident that current efforts in the implementation of information technologies in educational activities are predominantly focused on the organization of educational processes in online formats. At the same time, a crucial area of lecturers' work is often overlooked: informational support for their methodical activities. This work involves the preparation of source materials, their processing, and the formation of final materials such as textbooks, educational aids, lecture notes, methodological guidelines, and presentations. The three-factor logical-semantic knowledge representation model proposed in this paper (see Table 3) outlines an algorithm to form a relevant knowledge base. The authors believe that the best implementation of this knowledge base can be achieved using Microsoft Excel (see Table 4). The advantage of this knowledge base model is its open architecture, as users have administrator rights to manage the knowledge base. The user can select the knowledge elements to be included in the base. Additionally, incorporating the "Students" factor and tracking their participation in lessons allows for providing these results to department and faculty leadership for further analysis.

The proposal to use Microsoft Excel to form the interface of the knowledge base is due to the fact that the basis of the formation of logical-semantic models of knowledge representation is ordinary tables (matrices), the modeling of which is expedient to be carried out with the help of a table processor. It is important that hyperlinks are easily implemented in this application. At the same time, programming using Visual Basic is practically not used. This gives lecturers who do not possess the technologies of traditional databases and knowledge the opportunity to independently develop their own knowledge bases.

Because universities usually have licensed Microsoft Office products, lecturers have free access to use these products.

6. Conclusions and Future Research Directions

The formation of data and knowledge bases using traditional technologies requires the involvement of relevant information technology specialists. For the formation of knowledge bases, experts with knowledge, knowledge engineers, and programmers are involved. At the same time, appropriate database and knowledge base management systems are also used.

It should also be noted that data and knowledge bases are used by users to solve problems by searching for solutions in relevant databases.

Currently, a generally recognized method for designing knowledge bases using logical-semantic knowledge representation models has not been developed. If such methods and corresponding tools are developed and actively used in traditional intelligent information technologies, then such methods and corresponding tools are only being developed for researched knowledge bases based on logical-semantic ones.

It should also be noted that procedural knowledge is not employed in the developed knowledge bases. This is explained by the fact that elements of knowledge are placed in the corresponding nodes of the coordinate axes, as well as in the nodes of inter-coordinate matrices in the form of concepts. The semantic component of the knowledge is determined by the meaning of the concepts that define the coordinate axes and nodes on these axes.

Unfortunately, this form of knowledge presentation does not allow the inclusion of knowledge presented on electronic media in these nodes. The proposed application of matrices in the form of spreadsheets solves this problem. This is explained by the fact that an electronic carrier of specific knowledge is combined with the corresponding cell of the matrix via hyperlinks. In this case, the search for the necessary knowledge is excluded. It is sufficient to choose appropriate coordinate axes and, based on the specified elements on these axes, to find a node in the corresponding matrix that indicates the path to the necessary electronic knowledge carrier.

From another perspective, the activity of any specialist is always purposeful. This leads to the primary task of forming the purpose of the activity. In physiological cybernetics, the purpose of an activity is considered a project of future activity.

It is proposed to form such a project based on a logical-semantic model of the knowledge representation that constitutes the content of the lecturer's activity. Logical-semantic models are part of logical models of knowledge representation, along with frames, semantic networks, graphs, and production models.

The main difference from other knowledge representation models is the openness of the architecture of logical-semantic knowledge representation models for their developers due to the use of appropriate graphic models. At the same time, the original architecture of this model is universal. In this case, the lecturer is given the opportunity to independently establish an appropriate knowledge base.

Thus, the logical-semantic model of knowledge representation for the knowledge base is designed to solve a completely different problem, namely: planning the lecturer's activity with the determination of the necessary resources and time with the results recording of the implementation of this activity.

Since the interface of such a logical-semantic model of knowledge representation is open to the lecturer (white box), the need to search for the necessary methodological materials in the knowledge base is eliminated. After all, at the stage of its formation, its location is determined with precision to the corresponding file or folder.

The proposed architecture of the graphical logical-semantic model of knowledge representation and the corresponding knowledge base can be used autonomously.

It can also be added to existing LMS (learning management system) and LCMS (learning content management systems) systems.

To assess the level of improvement in the lecturer's activity, it is proposed to use the following indicators. As a quantitative indicator, determine the number of specialists that need to be involved in the development of the knowledge base. With the traditional approach to developing a knowledge base in the form of an expert system, it is necessary to involve a knowledge expert (lecturer), a knowledge engineer who owns the technology of extracting knowledge from the lecturer, and a programmer. With the proposed approach, the lecturer implements both the stage of knowledge formation and its presentation in the knowledge base. In this case, there is no need to involve a knowledge engineer or programmer. Therefore, the development time is reduced by more than 60%. The development time is also reduced because the architecture of the physical model of the knowledge base is universal and does not require additional time for development.

As a qualitative indicator of improving the effectiveness of the lecturer's activity, it is proposed to determine the completeness of coverage of the main stages of the lecturer's work. As a rule, the lecturer performs a preliminary selection and preparation of educational and methodological materials and then develops their final version. Then, according to the schedule, the correspond-

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ing classes are held, during which the level of participation of applicants in conducting classes is assessed. Thus, the proposed method of forming the lecturer's knowledge base ensures the integration of the main results of the activities of both the lecturer and applicants into a single knowledge base. A fully formed lecturer's knowledge base can be included in the department's knowledge base.

In this way, the formation and preservation of the intellectual potential of the department and the possibility of its transfer are ensured.

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Conflict of Interest

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The manuscript does not contain any relevant data.

Use of Artificial Intelligence

The authors confirm that no artificial intelligence methods were used in the creation of this work

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ЛОГІКО-СМИСЛОВА МОДЕЛЬ ЗНАНЬ ДЛЯ БАЗИ ЗНАНЬ ЛЕКТОРА

С. І. Доценко, О. В. Баніт, Д. І. Нор, О. І. Морозова

Предметом вивчення в статті є процеси синтезу графічної логіко-смислової моделі представлення знань з відкритою архітектурою для бази знань викладача вищого навчального закладу. **Метою** є бази знань викладача з використанням графічної логіко-смислової моделі представлення знань. Завданнями даного дослідження є: аналіз існуючих підходів до формування інформаційно-управляючих систем для організації навчального процесу у закладах вищої освіти; визначення методології дослідження; аналіз інтегрованої чотири факторної архітектури моделі знань про існування та діяльність соціально-економічної екосистеми, формування на основі результатів аналізу даної архітектури трьох факторної логіко-смислової моделі представлення знань; представлення практичної реалізації три факторної логіко-семантичної моделі представлення знань для бази знань викладача вищого навчального закладу; узагальнення результатів дослідження та окреслення майбутніх напрямків розвитку в галузі моделювання знань для баз знань з відкритою архітектурою. Використовуваними **методами** є: підхід, який передбачає виявлення загальних закономірностей і гіпотез, які складають основу побудови баз знань викладачів для організації освітнього процесу у вищих навчальних закладах. Тео-

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ретичною основою пропонується використовувати логіко-семантичну модель знань семіотики. Основою такого рішення є те, що всі відомі логічні та логіко-смислові моделі знань є репрезентативними об'єктами семіотики. **Отримані такі результати.** Встановлено, що на цей час основна увага при впровадженні інформаційних технологій в освітній діяльності зосереджена на організації освітнього процесу в дистанційному форматі. В той же час, поза увагою залишається важливий напрямок роботи викладачів, а саме: інформаційне забезпечення їх діяльності при виконанні методичної роботи. Ця робота пов'язана з підготовкою вихідних матеріалів, їх опрацюванням, формуванням відповідних кінцевих матеріалів у формі підручників, навчальних посібників, конспектів лекцій, методичних вказівок, презентацій, тощо. Запропонована у статті архітектура графічної три факторної логіко-смислової моделі представлення знань визначає алгоритм формування відповідної бази знань. На думку авторів найкраще ця база знань може бути реалізована у додатку Microsoft Excel. Перевагою цієї моделі бази знань є відкритість її архітектури для користувача, адже він має право адміністратора цієї бази знань. Він приймає рішення про включення відповідних елементів знань у базу знань. Включення до складу бази знань фактору «Здобувачі освіти» й послідуючої фіксації результатів їх участі у проведенні занять забезпечує можливість надання цих результатів керівництву кафедри й факультету для послідуючого аналізу. **Висновки.** Запропонована архітектура графічної логіко-смислової моделі представлення знань й відповідна їй база знань забезпечує вирішення задач підготовки методичного забезпечення дисциплін. Вона також може бути доповненням до існуючих систем LMS (системи управління навчанням) та систем LCMS (системи управління змістом навчання). Наступним напрямком використання сформованих баз знань для відповідних освітніх компонентів (дисциплін) є формування на їх основі відповідної бази знань кафедри. Таким чином забезпечується формування й збереження інтелектуального потенціалу кафедри й можливість його передачі.

Ключові слова: логічна модель представлення знань; логіко-смислова модель представлення знань; база знань з відкритою архітектурою; семіотика.

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