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THE MODEL OF INFORMATIONAL SPACE FOR INNOVATION AND DESIGN ACTIVITIES IN THE UNIVERSITY

Introduction. *The University loses the role of the only source of knowledge in the context of widespread use of network technology for access to information. Simple interfaces for obtaining knowledge on demand provide an opportunity for rapid self-education in the process of realization industrial or domestic tasks. Rethinking the role and place of the university in training engineers and scientists, modernizing of models of information technology achievements' use by universities in their information systems becomes critically important.*

Problem Statement. *Students are poorly involved in research and innovation activity, the model of organization of the work of universities separates the educational process from other activities.*

Purpose. *To develop a model of scientific and educational information space for innovative and project activity of the community of teaching stuff and university students.*

Materials and Methods. *The methods of logical and comparative analysis have been used.*

Results. *The model of the integrated scientific and educational information space of a technical university with the organization of work on the basis of reliable sources is proposed. Taking into account the possibility of various ways of developing scientific research and the need for the formation of appropriate project teams, the information system for the project activity based on the concept of adaptive case management is proposed. The subsystem of the knowledge base of the training system for drilling equipment designing has been developed.*

Conclusions. *The described models of scientific and educational work provide a project approach to the management of joint work of teaching stuff and students. The introduction of such management model necessitates the use of methods of project-based learning. Further research will aim at developing ways of implementation of project-oriented learning in the educational process of the higher education institution within the existing legislative and regulatory framework.*

Keywords: scientific and educational information space, research and innovation activity, university, and information system.

The conditions for access to information have changed significantly during the last decades. Worldwide distribution of the Internet and the paradigm of WEB 2.0, mobile devices with multimedia access to the Internet have led to an increase in the information inflation [1]. The worth of closed sources of information is rapidly falling, but the price of reliability of information is growing.

In modern conditions, the university cannot be considered as the only source of information, and the restriction of access to information during various examinations is counterproductive to the perspective of pursuing graduates' professional tasks in the future. The availability of information and the ease of its reproduction with the use of information technology (IT) leads to the devaluation of traditional approaches to learning and assessment of learning achievements, which consist in memorizing information and reproducing it. T. Wagner and T. Dintersmith emphasize that learning the facts in the modern world is much less important than the ability to determine their reliability and use facts and knowledge to find the solution to professional and life problems. Retrieval of information does not matter, but the time spent on learning and control of remembering the information, which would be forgotten, can be used more productively [2]. M. Ford states that the storage and reproduction of information, processing of big data are best done by computers, so people need to focus on improving their own productivity using IT [3].

The spread of modern technologies leads to the loss of the need for graduates of the traditional institutions of higher education (IHE) in the labor market [2, 3]. It is critically necessary to develop and implement their own information systems based on the use of IT for IHE, especially technical ones. Students must adapt to the new requirements of employers and the market, gain experience in using modern technologies in their professional activities, and ultimately take advantage of the introduction of IT in the educational process, openness and transparency that potentially and at a reasonable price ensure the use of IT achievements in education in particular, during the learning. In addition, this is an important component of readiness for innovation development, declared by Ukraine in the Strategy for Sustainable Development *Ukraine 2020* and in the project of the strategy of innovation development for the period to 2030 [4, 5].

The ideology of using IT in education is still in the stage of active development and search. The concepts and tools of Blended Learning [6] and Online Learning have become widespread. After all, the search for a new paradigm of education in the conditions of wide penetration of IT in almost all spheres of activity continues [2]. Educational institutions use IT with significant restrictions on students' freedom in their use, which, in our opinion, is due to insufficient development of the aspects of ensuring data reliability and academic integrity of students in carrying out tasks using the potential of modern IT achievements.

Building a model for using IT in educational activities, and in project activities in particular, is impossible without an analysis of current trends in education development, the development of IT and their interactions.

IT are rapidly developing and provide opportunities for their use in those areas and industries where it would not be possible for the lower level of development of IT. This is a prerequisite for the need for such an analysis. Due to the Moore's law (doubling the computing power approximately every two years), the four-year cycle of training adopted in higher education practically lags behind the development of IT. The consequence of the lagging of education is the gap between IT capabilities and willingness of graduates to use them at work.

The level of higher education, that a graduate must receive according to the requirements to the modern engineer [8—10], is announced as the level of the developer of new products, the organizer or a member of the project team for its release. It is necessary to know the modern technical level, to understand the relevant basic laws of nature, to have the skills of geometric modeling, text, graphic and verbal communication in the chosen sphere of activity.

The basis of the philosophy of constructing the information system of a modern educational institution is formulated as follows: the university is a place for studying the basics of scientific creativity, working on the implementation of projects in the team and, most importantly, using a scientific approach to solve the tasks with documenting the process of research's conduction and engineering search in the learning process in the conditions of an innovative economy. In general, the concept is known except the documenting [9, 10].

Some of the possible varieties of the educational process are considered in detail to justify the need for documenting and the impact of documenting on a solution to the problem of the demand for IHE services.

Practical acquaintance with the general technical level can be carried out on a factory, at show, in museums. Information about the current technical level can be obtained from advertising messages, periodicals, books, and experts in personal communication.

In the process of practical acquaintance, visual information and other indicators that a person can get with the help of senses and tools for fixing information are received. The information of the sensory organs cannot be documented, but the fact of presence can be documented in the form of photographs, records in the logs of registration etc. However, the results of measurement are easily recorded in the form of established forms of documenting the experimental research. Indicators can be geometric (dimensions, distances) as well as various parameters related to the operation of the relevant exhibits.

Information acquaintance involves the fact of obtaining information and its processing by a person. The fact of obtaining information is easily documented (issuance registration, various logs of user activity in the information system (logs) etc.). This is employers' way, well-known educational management systems contain such a functional, the same features is one of the basic elements of Blended Learning [7] and Online Learning.

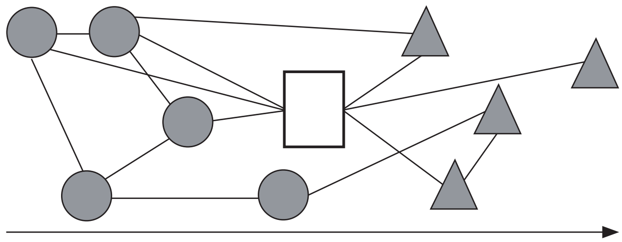
The results of human processing and assimilation of data obtained during information acquaintance are traditionally checked by means of tests or solving test tasks. This approach is also used by both manufacturers and IHE. However, the tasks of manufacturers are mainly focused on the result in the form of a product or service, and the tasks of IHE are mostly abstract, academic, which confirms a comprehensive review of T. Wagner and T. Dintersmith [2].

According to our observations, a specialist's assessment in the market takes place on the basis of two indicators: 1) the ability to solve problems with obtaining practical results that correspond with the technical task; 2) the time of solving a task, which may be limited by a certain term (the deadline of the project, completion of the process). Therefore, the IHE tasks must be formulated in the form of real objects, the design work and production of which must be performed by students themselves or in groups.

Projects can be modelled at will (reduced scale, metal replaced by paper with a corresponding change in the technological process etc.), but must lead to obtaining results similar to the results of future professional activities. At the level of the bachelor's degree one of the options is to create physical models for selected patents from the patent bases, further research of their work, optimization of constructive or technological parameters. The creation of laboratory facilities based on descriptions in the scientists' writings and other scientific publications to verify the results of relevant scientific works is also promising. Execution of such projects is likely to lead to a flow of engineering tasks, in order to provide solutions to which students will be required to obtain relevant information and skills.

The function of the IHE in general and the teachers in particular is to minimize the efforts and time spent on the search for such information. The form of such minimization (selection and compilation of sources' lists, lectures, methodical instructions, exhibits etc.) is chosen by the teacher independently within the limits of academic freedom. Similar goals and, in addition, reducing the cost of providing educational services and improving their accessibility are pursued by Blended Learning and Online Learning [6, 7]. But the main function of the teacher in modern conditions should not be the transmission of information, but assistance in the implementation of appropriate tasks, verification of independence of their implementation and control of the correctness of the results. To our mind, verification is not conducting control measures but the proof of the performance of work by a student in the presence of a teacher.

An important but not decisive factor is the interaction with the producers and graduates of the IHE, the obligation of which was proclaimed at the CDIO initiative and the like [8–10] in



IRS's network pattern: ▭ — some scientific knowledge (CK — current knowledge); ● — the scientific knowledge that preceded CK; ▲ — scientific knowledge that follows CK

the described model of the work of the IHE. Such interaction allows to obtain an assessment of past training programs, adjust the content of postgraduate courses, possibly graduate programs. Therefore, the information security system should provide the possibility of interacting with these categories of market participants, and the IHE must disseminate information about the possibility of such interaction. However, manufacturers (employed graduates) tend to deal with a certain range of problems inherent in the organizations in which they are employed. Depending on the orientation of the organization, the stage of the loop cycle, on which the organization or its products are located, such a range of problems does not necessarily cover the perspective directions of market development.

Let's dwell upon another model of interaction with production, which is now proposed by the Ministry of Education and Science of Ukraine — the model of dual education. The concept of dual education offers the division of the teaching time into two parts. Student spends some part of time in classrooms and the other part while performing production tasks at enterprises. The advantage of such a model is proclaimed to receive real production experience. Note that the capacity of the labor market in the aspect of student admission is limited. The problem of interaction with production described above also arises — not necessarily the problems faced by the employee of a particular organization, they will be sufficiently versatile and will cover the perspective directions of market development. Perhaps, it is with the exception of IT companies or vocational education [12, 13]. In addition, dual education can significantly limit the academic mobility of students of MFA in the proposed option in Ukraine.

It is common knowledge that the determining factor in the success of any organization that is focused on providing services is the demand for services by market participants. From our point of view, the most important factor that will help IHE to be relevant is the fulfillment of the IHE's function of studying the history of the development of scientific areas, principal for a specific IHE, and the construction of a description of such a history in such a way that is easy to carry out an analysis of the current technical and scientific state of the corresponding market and to identify problems that need to be solved.

The promising one is the description of the history in the form of the information and reference system (IRS) with a network pattern, as shown in Figure.

The division the information at universities into two categories: literature and documents is suggested. Literature is the information in different media forms that cannot serve as a procedural confirmation. Documents are the legally certified information of various media kinds.

Students use literature for studying while teachers do this for scholarly research work. Documents are the consequence and evidence of the teachers' performance of their functional responsibilities as scientific and pedagogical staff of universities. Documents can become the basis for creation of publications that are treated as literature. Literature cannot become the basis for the documents.

Considering this division, the paradox is clearly outlined: the educational or scientific work based on literature can be the basis for creating a document that certifies the performance of work, achievement, qualification level, etc. The paradox is inherent to both traditional f2f education and for modern Blended and Online Learning. The solution to the paradox lies in introducing the notion of a reliable source.

The reliable source is a literature, the position of which is confirmed in the admissible scientific or legal way that is evidenced by relevant documents (protocols of experimental research, verification by normative documents or by expertise/certificates). The reliable source can be considered only if of the relevant document or package of documents are available. In this case, a reliable source can be considered as a generalizing document and used as a basis for documents.

Any publication is transferred to the category of reliable sources by students, teachers or mixed teams in one of two ways: 1) the documents on the basis of which the publication was created; 2) studies are carried out and properly documented, the results of which are confirmed by the information of the literature. Involving students in such work is almost obligatory, since these are practical tasks that require a scientific approach, and their amount requires significant labor costs.

Scientific and educational information space (SEIS) is the space of documents and reliable sources.

The source information and research results must coincide literally or even by symbol, otherwise the authenticity of the literature is not confirmed. Checking of coincidence is a task for IT solutions of SEIS.

All new documents or publications can be considered as reliable sources only if they contain quotes in the sense of linguistics. In such a way, in the SEIS citation is the use of text (formulas/drawings/tables etc., or parts of them) of the course practically unchanged.

The quote in the SEIS contains the completed idea, opinion, regular expression (term), text paragraph, factual material, etc. fully. In fact, the quote in the SEIS is the part of the publication that can be found by the anti-plagiarist program. Consequently, the antiplague system or the natural text analysis system is an integral part of the SEIS, as well as the regulations for its use.

If the possibility of quoting is limited by copyright, only those documents should be cited that are copyrighted or permission for use of which is owned by an IHE or research work must be done, the result of which will be such a document. A description depicting the general perception of the source document by the developer of a document can only serve to identify the possible connectivity of the IRS nodes, but not to verify the authenticity of the link or document.

The described citation model will provide the opportunity to place documents and reliable sources in chronological and citation order, which will automatically give the history of development as a network hierarchical structure. The number of citations of the publication makes it possible to establish the place of highlighted thoughts (knowledge) in science / theory: root, trunk, branch, sprout.

In technical engineering, every "sprout" or "branch point" must contain documents that reflect the parametric geometric model of the part, device, equipment, control system etc. The most approximate of known classification systems is, basically, the International Patent Classifier (IPC).

In the information space, the division of information into source information and knowledge is offered. Source information is documented experimental research data (including data from sensors and automated systems, results of computational experiments etc.). Knowledge is generalizations, hypotheses, laws based on source information as well as models and design techniques developed on their basis. Knowledge is described in the documents of the project and expert groups. As a rule, documents with source information are confidential at least until documents with knowledge are published.

The proposed model potentially changes the existing model of scientific interaction, since the publication is interpreted as a document or a set of documents. Such a model is practically possible to be implemented only in electronic form, since copying and management of paper copies (comparing them, for example) will be significantly more expensive.

It is necessary to introduce the requirement for the formulation of opinions that are protected as quotes, in the form of a set of certain symbols and a terminology series (notations, regular expressions, words for the description) for completeness of the picture. If the opinion falls under a particular code of the IPC or specialist classifier, the author (or member of the project team that verifies the source) refers it to this code. The classifier serves as the basis for the formation of standardized terminology and designations. If someone else (in the other work) wants to formulate the same opinion, then he is forced to use and fall under the same classifier, because he works in the same area, and, consequently, the directory/dictionary/standard will be one and the same. To ensure unambiguous identification of synonyms and homonyms, the dictionary should contain a synonym row for each section of the classifier.

The described system is essentially similar to a system of protection of intellectual property, expanded by documentary confirmation of authenticity. The choice of the IPC or another classifier, even of the IHE's own development, is not critical until there are defined rules for establishing unambiguous correspondence between the classifiers. It is clear that the first version of such rules should be formulated at the initial stages of the development of the IRS.

This idea is used as a basis for standardization within corporate information systems and in general in standardization systems; the latter can be a starting point-base for bringing the entire volume of publications to one look.

The model of scientific work after a problem statement would look as follows in a technical IHE: the search for sources, establishing their reliability, creating new knowledge, which may consist in refining or extending already existing, with appropriate documentary fixation and properly documented expertise, updating the IRS, publishing new scientific results and putting them into SEISs in the form of reliable sources.

The learning process is different from the scientific in a way that the creation of new knowledge is usually not expected. A student studies, with or without an IRS, reliable source data and knowledge-based documents, which contain knowledge, is involved in determining the reliability of the sources by conducting experimental studies with appropriate accumulation and processing under the guidance of the teacher of source data. Students and IHE employees are project team members. The teacher plays the role of mentor in the project team and expert in determining the correct use of knowledge and conduction a research. Expert work is properly documented and is obligatory for the teacher.

In order to obtain source data, the student must create his own physical or computer model or model of the object under investigation or use the existing one. Correctly recorded source information of student work expands the selection of information on which knowledge is based.

Working with reliable sources raises the problem of evaluating the results of a student's academic work. In fact, work can be done correctly and its results are counted and added to the SEIS and IRS or the results are not counted (the job is incorrect).

In the proposed model of the work of IHE the role of methodological changes is changing. The methodology is reduced to the instructions for working with the IHE information system, an explanation of the role and methods of using the IRS and the SEIS as a whole. The student must choose methods and information for the work independently using the IRS and the SEIS.

The technology of the functioning of the IRS can be based on the wiki engine or on the technologies of the development of linked pages (such as tagging). The combination of web technologies with classifiers and dictionaries is inherent in the various classes of corporate information systems. Taking into account the possibility of various ways of developing scientific research and the formation of project teams, adaptive case management (ACM) is considered as the optimal concept of the information system for the project activity.

For functioning of the described model of the IHE's work, the technical and organizational support of personalized production is required, described in [11, 14].

The subsystem of the knowledge base of the training system for drilling equipment design was developed by the group of authors of the Department of Engineering and Computer Graphics of the IFNTUOG. The proposed development is aimed at forming the graphic competence of the future engineers and achieving a new quality of educational technologies and operational content of a single information environment in accordance with the achievements of modern science and technology.

In order to ensure the possibility of further expansion of the system, its adaptation to the use of the network is based on the use of language (Hyper Text Markup Language). An interactive training complex is decided to form on a set of HTML documents.

When creating information training system for drilling equipment design, the block-modular principle was used, the system was created in the form of separate elements (most often, files), which form the logical and hierarchical structure. This makes it easy to differentiate sections and system modules. The texts contain the necessary hypertext links that reflect the keywords, terms, basic concepts, normative materials, etc. The graphic material is presented in the *.jpg format and electronic models were created using the CAD AutoDesk Inventor, "KOMPAS".

Information system for drilling equipment design:

- provides information exchange, using archives of electronic documents, databases, specialized directories and software;
- allows to choose typical drilling equipment, which consists of standard or typical elements and knots (drilling tools, drill pipes, couplings, nipples, flanges, fasteners, etc.) for familiarization;
- enables to receive reference data for design development (mechanical properties of materials, types of connections, etc.);
- acquaints with existing general requirements and normative documents before designing various design documents;
- enables to familiarize oneself with the typical design of elements in 3D models.

The basic block of the system acquaints users with existing general requirements and normative documents before designing various design documents, enables to choose typical drilling equipment and the necessary information for its construction and design.

System components:

- reference books on standards for the design of various design documents and text explanatory information to them;
- base of standard sizes of the elements of the drilling equipment, which consists of normative documents, which are valid on the territory of Ukraine for each item of equipment with its characteristics;
- catalogs of typical drilling equipment in the form of a set of basic aggregates, including: drill string, lifting mechanism, swivel, pump-circulation system with developed design documentation;
- 3D models of individual typical units.

The components of the system can be used in preparing specialists of different levels and specialties, as well as methods of constructing drilling equipment, and the acquired knowledge and skills will enable to implement projects that are as close as possible to the real ones.

Hence, IRS in the SEIS of the IHE is a dynamic structure that will be developed with each scientific work done in the IHE or external one. THE SEIS is a shell that will ensure the effective functioning of the IHE with the use of IT achievements. The basis of the operation of the SEIS is the electronic document flow system, built on the concept of ACM.

The described models of scientific and educational work in fact provide a project approach to managing the joint work. The introduction of such a model of management will necessitate the use of methods of project-based learning.

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With the use of reliable sources, the significance of the classification system of knowledge increases. The proposed use of definitions means that the basis of the information space is the system of document flow of IHE, which for most IHEs, at least in Ukraine, means the need for significant reengineering of business processes. The SEIS with the IRS, technical and organizational support of personalized production, expert assessment of teachers are values that will ensure the demand of IHE services in the current labor market and the spread of IT.

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МОДЕЛЬ ІНФОРМАЦІЙНОГО ПРОСТОРУ ДЛЯ ІННОВАЦІЙНО-ПРОЕКТНОЇ ДІЯЛЬНОСТІ В УНІВЕРСИТЕТІ

Вступ. В умовах широкого використання мережевих технологій для доступу до інформації університет втрачає роль єдиного джерела знань. Прості інтерфейси отримання знань, за потреби, дають можливість швидкої самоосвіти у процесі реалізації виробничих чи побутових завдань. Критично необхідним стає переосмислення ролі й місця університету у підготовці інженерів та науковців, а також осучаснення моделей використання університетами досягнень сучасних інформаційних технологій.

Проблематика. Студенти слабко залучені до науково-інноваційної діяльності, оскільки модель організації роботи закладу вищої освіти відокремлює навчальний процес від інших активностей.

Мета. Розробити модель науково-навчального інформаційного простору для інноваційно-проектної діяльності спільноти науково-педагогічних працівників та студентів університету.

Матеріали й методи. Використано методи логічного та порівняльного аналізу.

Результати. На основі аналізу достовірних джерел розроблено модель інтегрованого науково-навчального інформаційного простору технічного закладу вищої освіти. З урахуванням можливості різних шляхів розвитку наукового пошуку та необхідності формування відповідних проектних команд, запропоновано базувати інформаційну систему для проектної діяльності на основі концепції «adaptive case management». Розроблено підсистему бази знань навчальної системи проектування бурового обладнання.

Висновки. Описані моделі наукової та навчальної роботи фактично передбачають проектний підхід до організації спільної роботи науково-педагогічних працівників та студентства. Запровадження такої моделі управління зумовлює необхідність використання методів проектно-орієнтованого навчання. Подальші дослідження буде спрямовано на розробку способів впровадження проектно-орієнтованого навчання у навчальний процес закладу вищої освіти у межах чинного законодавства та нормативно-правового поля.

Ключові слова: науково-навчальний інформаційний простір, науково-інноваційна діяльність, університет, інформаційна система.

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МОДЕЛЬ ИНФОРМАЦИОННОГО ПРОСТРАНСТВА ДЛЯ ИННОВАЦИОННО-ПРОЕКТНОЙ ДЕЯТЕЛЬНОСТИ В УНИВЕРСИТЕТЕ

Введение. В условиях широкого использования сетевых технологий для доступа к информации университет теряет роль единственного источника знаний. Простые интерфейсы получения знаний, при необходимости, дают возможность быстрого самообразования в процессе реализации производственных или бытовых задач. Критически необходимым становится переосмысление роли и места университета в подготовке инженеров и ученых, а также модернизация моделей использования университетами достижений современных информационных технологий.

Проблематика. Студенты слабо вовлечены в научно-инновационную деятельность, поскольку модель организации работы высшего учебного заведения отделяет учебный процесс от других активностей.

Цель. Разработать модель научно-учебного информационного пространства для инновационно-проектной деятельности сообщества научно-педагогических работников и студентов университета.

Материалы и методы. Использованы методы логического и сравнительного анализа.

Результаты. На основании анализа достоверных источников разработана модель интегрированного научно-учебного информационного пространства технического высшего учебного заведения. С учетом возможности различных путей развития научного поиска и необходимости формирования соответствующих проектных команд, предложено базировать информационную систему для проектной деятельности на основании концепции «adaptive case management». Разработано подсистему базы знаний учебной системы проектирования бурового оборудования.

Выводы. Описанные модели научной и учебной работы фактически предусматривают проектный подход к организации совместной работы научно-педагогических работников и студенчества. Внедрение такой модели управления вызывает необходимость использования методов проектно-ориентированного обучения. Дальнейшие исследования будут направлены на разработку способов внедрения проектно-ориентированного обучения в учебный процесс высшего учебного заведения в рамках существующего законодательства и нормативно-правового поля.

Ключевые слова: научно-учебное информационное пространство, научно-инновационная деятельность, университет, информационная система.