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Concept of information technology of monitoring and decision-making support

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ABSTRACT

Presented concept of information technology monitoring and decision support to determine the health of students. The preconditions of a concept formulated its goal and purpose.

Subject area concepts proposed to consider a set of problems, grouped into 8 categories, which in turn necessitates the application when creating technology basic principles from the principles of "first head" and "systems approach" to the principles of "interoperability" and "system integration".

The content of the information providing IT, its position in the segment of single information space, stages of creation. To evaluate the efficiency of the IT system developed proposed criteria.

Key words: medical information system, information technology, monitoring, stages of construction technology, concept, decision support subsystem, criteria, categories, health students

1. INTRODUCTION

Information technologies in biology and medicine (ITBM) – it is a set of means, methods and algorithms based on the characteristic features of information processes in biosystems, i.e. it is biologically and medically verified information product, that can be applied for solution of scientific and applied problems in subject domains of biology and medicine¹.

By another definition ITBM as a method it is a technology of obtaining new knowledge in the process of research, i. e. technology of obtaining data, information and its arrangement¹.

The object of ITBM – problems of biological and medical orientation, where biological and medical objects themselves act indirectly. The subject of ITBM – theoretically – algorithmic intellectualization of research process in subject domains of biology and medicine and development of medical information, including biotechnical, systems of diagnostics, forecast and monitoring (treatment).

The concept defines the preconditions, objectives, principles, stages of development and criteria of assessment, information technology monitoring and decision support to determine the state of health of students (ITM) for higher education institutions of Ukraine, mechanism of its creation and support, as well as expected social – economic medical effect.

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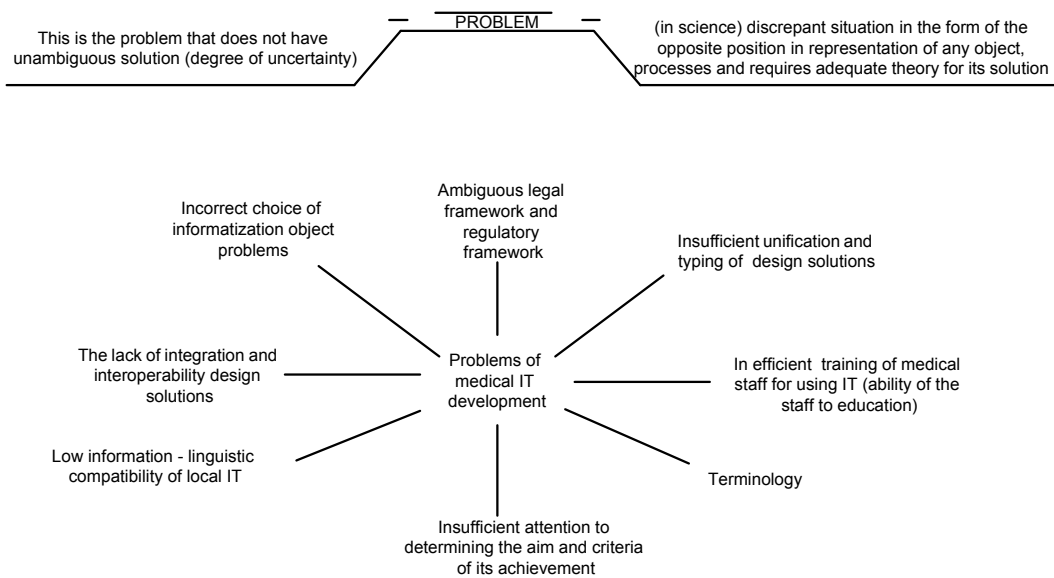


Figure 1. Scheme of information structural links of “Problem” category

2. PRECONDITIONS OF CONCEPT DEVELOPMENT

Nowadays there exist numerous theories, principles, approaches, criteria, regarding the development and assessment the efficiency of information technologies, built, also, by the principle of system approach. However, in this case, often situations occur, when for medical delusions making, we experience lack of knowledge, limited temporal resources, lack of the possibility to involve competent experts, incomplete information, regarding the state of the patient, errors of the physicians¹.

In general form, problems, blocking the development and creation of high efficient medical systems and technologies in Ukraine, are determined as:

Lack of consistency, continuity and complexity of the process of high efficient medical information systems (MIS) and technologies (MIT) creation.

Insufficient system study of the problems, dealing with the design of software – engineering medical complexes and systems.

Low professional level of knowledge of medical staff in the domain of computerization, automation and information support of diagnostic treatment and rehabilitation processes.

Lack at decision-making support subsystems, used by physician, adapted to practical application, medical expert systems and control technologies of multiformat and multidimensional data.

Lack, on the state level, of the system and techniques of determining medical, social and technical efficiency of MIS and MIT.

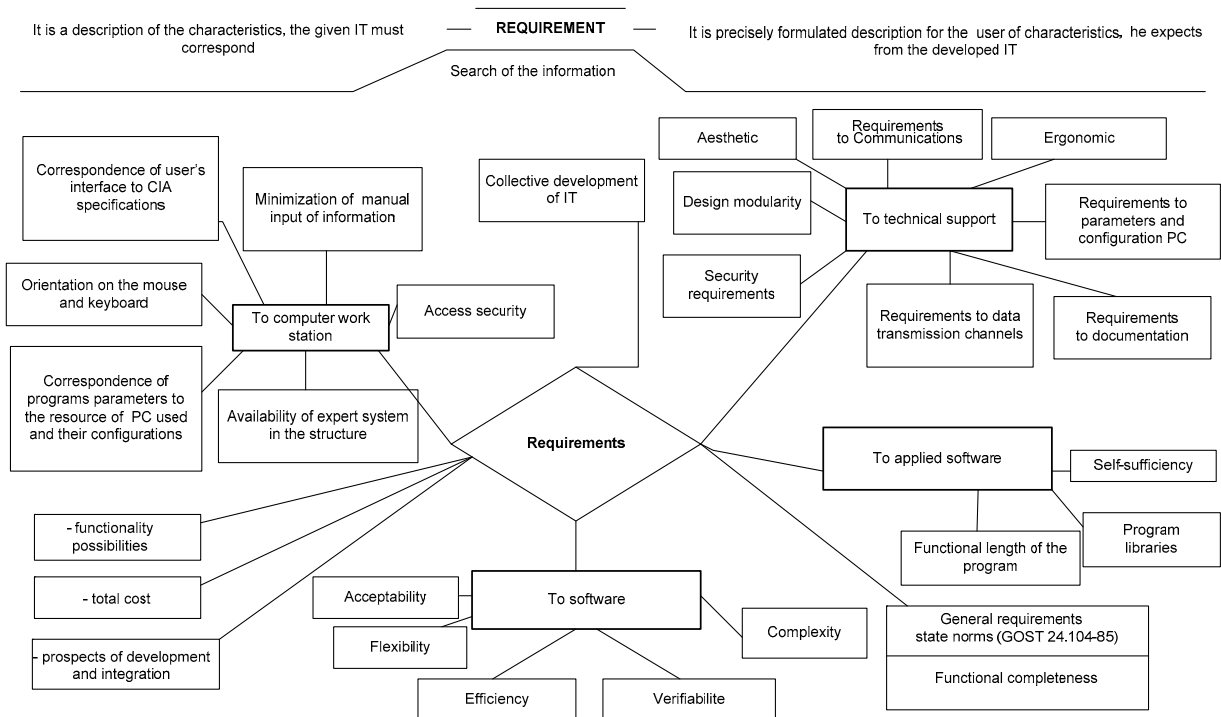


Figure 2. Scheme of information - structural links of "requirements" category

3. AIM AND DESIGNATION OF ITM

The main aim of Technology development is determination, provision and support of the level of individual and population health of students during the whole period at the study at higher education establishments of Ukraine, this aim could be achieved: by means of optimal organization of educational process in accordance with sanitary norms and hygienic requirements; rational organization of physical activity of the students; organization of qualitative nutrition of the students, organization of pre-doctor revealing of the factors and groups of risk of diseases, development among students; provision of timely and qualitative medical aid; constant monitoring of physical state health; qualitative and adequate adaptation of the students to changes of the environment.

Information Technology is intended for consistent solution of the following problems; realization of screening and preventive examinations of students health and forecasting of possible result of the treatment or rehabilitation, using differential diagnostic features, factors and indices; prescription of optimal complex at preventive, medical and rehabilitative measures, depending on general physical and mental state, degree at functional disorders expression, forecast at clinical – social results; creating at data base of the examined students, with the possibility of correction data during these reviews; formation of statistical accounts by the results of examination and rehabilitation; creating of diagnosis, forecast and rehabilitation measures pattern, that are recommended for printing or data storage².

4. DETERMINATION OF SUBJECT DOMAIN OF THE TECHNOLOGY

The whole set of existing problems is grouper into 8 categories.

Category “Insufficient unification and typing of design solutions”.

The problem of the given category restrain the spreading of efficient and reliable IT, increase capital investments in design, decrease operation reliability.

Category “Inefficient training of the staff for IT usage” defines problems, connected with human factor, when low level of training and errors of the staff in the spheres, connected with vital activity of the human being (medicine, education, etc) could lead to disastrous consequences.

Category “Insufficient attention to determining objective and criteria of its attainment, as well as the previous one, is largely stipulated by the level of training but not of operating staff, but the developers of the corresponding technology”.

Category “Law information – linguistic compatibility of local IT”, belongs to the group of problems, solution of which requires joint efforts of rather narrow specialists in the sphere of linguistics and philology, programming and data and knowledge bases design, local networks both on the stage of development and on the stage of implementation and industrial realization.

Category “Insufficient integration and compatibility of design solutions” are largely correlated with in category “insufficient unification and typing of design solutions”, but the difference is that its problems as a rule, appear at the early stages of its design, whereas, problems of the previous category occur at final stages of the development and at operation stages.

Category “Terminology” includes problems that may be caused not only by the content and designation of the term but its misuse and incorrect interpretation.

Category “Authorization” is the process that grants or denies the right to use certain resources and has four main phases: first, it checks, if the user is the person, whom he is introduced, and second – it authorizes the usage of the resources, proceeding from identification and functions of the user.

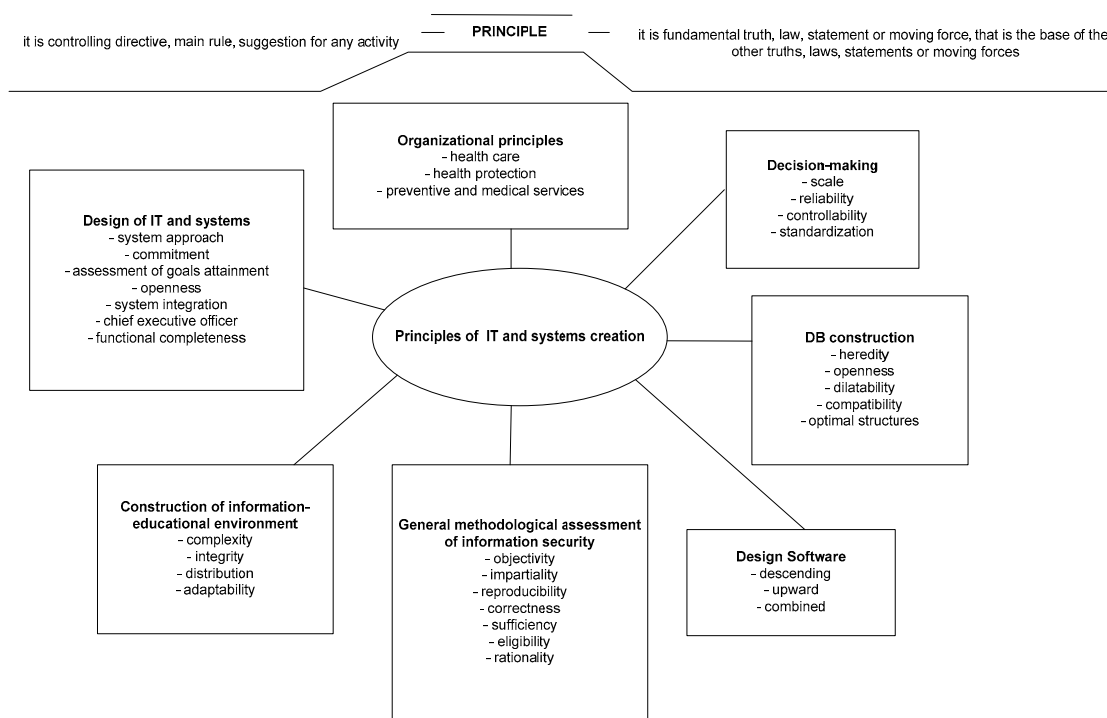


Fig 3. Scheme of information- structural links of “Principles” category

5. PRINCIPLE OF IT DEVELOPMENT

First executive principle. The success of the development and implementation of NIS greatly depends on the degree of participation in this process of the first executive officer, his qualification and understanding of the subject domain, responsibility of decision-making and realization of new decisions.

Principle of purposefulness. Purposefulness – it is availability of final objective to be attained, in this case, we mean the information image of MIS objective state, which is determined by desirable set state of its outputs.

Principle of assessment of object attainment – basic feature of the system, according to which, one of the variants of its construction provides better, as compared with others, necessary result with the least losses of energy, recourses.

Principle of openness – provides the possibility of interaction with other MIS, ability to transfer the applied software on other platforms, etc.

Principle of adaptability – provides the availability in the developed system the means of adjustment on specific features of the given subject domain within the limits of functional possibilities of the system, direction of its development and determination of class of problems, providing the reaching of the set aim.

Principle of system approach – it is the main rule that enables to pull forward the problem and formulate the final aim of MIS and MIT development in specific medical applications, that provides the generation of the efficient strategy of its construction by the results of the comparative analysis of the alternatives.

Principle of system integration – provides integration of information resources of the Technology with information resources of other systems and technologies.

Principle of modularity – characterizes the rationality of Technology construction, using basic modules of algorithms, programs and rules of formation of more complex, pragmatically determined constructions.

Principle of centralized control – provides the control over development, implementation and support of the Technology on the base of the common technological policy with the account of state and adapted international standards in the sphere of medical information.

Principle of multiplicity of data input – confirm the function of the input and multiple usage of mitral information.

Principle of hardware – software and information compatibility of the technology with the existing MIS and MIT.

Principle of “normal pyramid” - is used of the construction of psychological test library.

6. INFORMATION SUPPORT OF THE TECHNOLOGY

IS – is a set of a single system of classification and coding of information, unified systems of documentation, schemes of information fluxes, circulation in the system or technology and methodology of DB^{1,3} mathematical support comprises algorithmic and software support. Software consists of:

- general software (OS, translators, tests, diagnostics),
- special (applied) software for automation of control processes in the given subject domain.

Engineering support – means of measuring, conversion, transfer, storage, processing, registration, input/output of information, etc.

Staff support – the set of methods of means, aimed at organization and training of the staff, measures, of aimed at further development and operation ability of the staff. Legal support is intended for regulation of the process of creation and operation and comprises the set of legal documents, with stating regulation relations aimed at formation, storage, processing of intermediate and resulting information³.

Linguistic support [LS] is the set of scientific – engineering terms and other language facilities, used in information system as well as rules of natural language formalization, that contain methods of compression and revealing of text information for improving the efficiency and automated processing of information³. Information security [IS] can be considerate as a) state (quality) of the defined object (data, information, man, risks, IT, etc); b) activity, aimed at provision of object state security⁴.

By other definition, IS – security of the information and infrastructure, supporting it, from random or planned influences of natural or artificial character, that could damage the subjects of information relations⁵⁻⁶.

7. IT IN THE SEGMENT OF INFORMATION SPACE

Segment of a single information space (SIS) of the Technology provides the collection and storage of: medical information, using unified system of qualification and coding; transfer of this information to other users within the limits of personalized access.

Within the range of the given segment system-wide services and applications are created, they provide: account and identification of students and medical staff; personalized account of rendering of emergency medical care; personalized account of the students, sent to hospital treatment or sanatorium and spa-treatment; student's electronic recording (form N025-310) with applications; results of clinical laboratory research and psycho-physical testing of the students.

8. STAGES OF ITM CREATION

For construction of the efficient information technology the "system of statements is suggested statement -1". The first stem in carrying out of any research aimed at creation of means, complexes, systems, technologies, etc, connected with people's health, must be accurate definition of the health itself, for diagnostics, provision and recovery of which means and "efforts me oriented".

"Statement -2" – "In the process of creation of various mathematical, information, hardware – software and other facilities for diagnostics, assessment, correction and rehabilitation of students' health, it is necessary to form or define system or matrix of risks, to be taken into account at the stage of design".

"Statement 3" stage of the technology structure modeling must include the construction of the models of physical education of students with normal and poor level of health and obligatory usage of the criteria, aimed at determining in their organism the transition state from norm to pathology, it is not envisaged by any of the existing technologies; as well as development of information support of the process of dynamic monitoring over the students' health".

Stage 1. Preconditions for creation of ITM (problem analysis). Determination of working terminology and designations; formation of the system (matrix) of risks; formulation of the limitations on application.

Stage 2. Revealing of the hidden medical knowledge. Clarification of the output data. Determination of the subject domain.

Stage 3. Formulation of the aim and tasks of the research. Development of medical – technical requirements for the technology.

Stage 4. Development of software support for ITM. Selection of construction principles. Development of information – structural models of the disease, health, transitional state. Development of Technology assessment criteria. Algorithmic-program realization of mathematical models. Formation of data bases.

Stage 5. Modeling of the structure and components of ITM by means of IDEF standards. Construction of the architecture of the Technology. Development of the channel of the assessment of physical ability to work (CEPAW) and the channel of the assessment of students complex activity (CECA) of the students.

Stage 6. Development of the subsystem of decision-making support. The selection of the alternatives set. Correction of the subject domain. Formation of database analysis of the alternatives (the selection of the best decision among those, generated by the system). Development of decision-making algorithm for determination of students health state.

Stage 7. Correction-assessment state. Testing of IT (technical and clinical). Correction of the content and structure of the stages.

Assessment of the developed Technology and results of its implementation.

9. EFFICIENCY OF ITM IMPLEMENTATION

The expected social-economic and medical effects, include:

- decrease of disability rule and complications, due to medical errors, low level of promptness and reliability of regarding the state of students' health;

- decrease of additional expenses for treatment of the diseases, that were diagnosed late; expenses, connected with low level of opportuneness in rendering medical aid due to the lack of necessary importation; correction of the consequences of medical errors;
- decrease of medical aid cost due to the reduction of the amount of redundant laboratory investigations and their doubling, reduction of medical staff time, needed for search and access to the necessary information;
- increase of quality and availability of health care.

For quantitative assessment of the efficiency and information quality of information technologies, we will use complex of criteria, providing all-round assessment of IT:

Integral coefficient of intensity K_I for assessment of medical aid quality, provider by the doctors, is determined as the product of the coefficients of medical efficiency K_M , social satisfaction K_C , volume of the performed work K_V and economic efficiency K_E ⁷.

$$K_I = K_M \times K_C \times K_V \times K_E, \quad (1)$$

where:

$$K_M = \frac{N_1}{N}, \quad N_1 - \text{number of cases with obtained medical result, } N - \text{total number of assessed cases,}$$

$$K_C = \frac{N_2}{N}, \quad \text{where } N - \text{number of cases when the patient is satisfied with the quality of medical aid,}$$

$$K_E = \frac{E}{E_\Sigma}, \quad \text{where } E - \text{the obtained economic effect, } E_\Sigma - \text{total investments,}$$

$$K_V = \frac{V}{W}, \quad \text{where } V - \text{volume of virtually performed work, } W - \text{volume of planned work.}$$

Complex statistical criterion for assessment of IT efficiency.

$$E_I(t_n, t_o) = \frac{H_1(t_n, t_o) + H_2(t_n, t_o) - H_3(t_n, t_o)}{H(t_n, t_o)}, \quad (2)$$

where:

$H(t_n, t_o)$ – IT entropy from the beginning to the end of the control and monitoring process; $H_3(t_n, t_o)$ – residual IT entropy, $H_2(t_n, t_o)$ – IT entropy, stipulation by the patient, $H_1(t_n, t_o)$ – IT entropy, stipulated by the doctor, range of the criterion: 0-1.

Increasing the capacity of health health – %.

Reduction of the amount of doctors errors, %.

10. CONCLUSIONS

Scientifically – substantiated concept of the development of information systems and technologies is created, it is the base for the development on its base IT monitoring and decision making support for determination of students health state, the aim of which is determination and provision of suitable level of students' physical health during the whole period of study at higher education establishment⁸⁻¹². It could be reached by:

- providing timely and qualitative medical aid;

- means of differentiation of physical and psycho-emotional loads by means of optimization of structure and concept of educational process;
- constant monitoring of physical health state;
- qualitative and adequate adaptation of the students to changes of environmental conditions.

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