E-Learning Design and Didactic’ Usability

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Abstract—Article dedicated to substantiation of basic points of learning environment build concept in which reflected special characteristic of trainee and trainer interaction and learning materials creation. Organization of training environment according with didactic’ usability concept will give possibility to develop electronic multimedia complexes based on system-activity approach.

Index Terms—didactic’ usability, educational technology, electronic publishing, learning system, multimedia communication.

I. INTRODUCTION

In global information economy and development of Internet the ways of trainee and teacher’s communication changing during the learning process. There are special support systems of the learning process and learning environment, in which the teacher acts not as the simple compiler of knowledge, but organizes interaction of a trainee with such environment. In this direction the organization and interactivity maintenance of such interaction is important. However techniques of interactive learning creation which exist in the traditional economy, in such conditions lose the effectiveness.

That is why new educational principles appeared in the information economy: anticipatory preparation of individuals for the uncertain conditions; continuing education; lifelong learning and learning for life; vertical integration: between different educational stages, different levels and disciplines within certain stages; focus on self-education, self-discipline, self-rating; learning personalization; flexibility and diversity of teaching content and technologies; learning skills’ improvement.

In this specify conditions educational process requires: competence approach, learning personalization; profound action approach, key competencies formation, emphasis shift to the student’s self-dependency; material presentation variability, individual learning paths; development of students’ independency, research activity skills’ training. So, we need the new approach to e-learning design.

It is necessary to build learning environment according to the modern concept usability [1], fixed in ISO standards, assuming presence of such software property maintenance which provides its efficiency, productivity and subjective user’s satisfaction.

We understand usability, on the one hand, as convenience of learning environment for the user that lies within the limits of the classical concept usability. It is reached by developing of such tools in the environment which allow adapting it as much as possible under features of intelligence and perception of the user, providing fast and unimpeded access to the information and its optimum mastering.

On the other hand, we are entering the concept of didactics’ usability which assumes presence in learning environment such quantity of pedagogical technologies, didactic methods and tools which will allow to arrange space under any trainee, in view of its psychological, mental and emotional features.

Just as the talented teacher possesses the whole set of didactic tools which provide various ways of submission of the information, the organizations of a feedback, the control of knowledge mastering and receptions by a trainee of skills, learning environment should provide the same variety of qualities and their adjustment for a trainee.

In this sense under didactics’ usability we understand not simply quality of the interface and ways of representation of the information as those, and quality of the most educational process, which realize through the interactive cooperation between trainee and learning environment.

We consider didactics’ usability as some property consisting from five components: abilities to provide motivation, to create a favorable emotional background for perception of knowledge, ability to adjust on type of intelligence prevailing at a trainee, efficiency of formation demanded competences, realizations of the activity approach to training.

II. MAIN POINT OF THE LEARNING ENVIRONMENT CONCEPT BASED ON DIDACTIC’ USABILITY

A. Learning environment

Some authors provides approaches to didactic material development [2], other works are focused on didactic methodology in e-learning [3] and tools of e-didactics [4]. In our research, according to the didactic’ usability concept, we suppose that learning environment – the system, which elements allow to support the above mentioned five components.

Every element of the learning environment is provided with relevant functions. Tasks that student takes on interacting with learning environment are:

- Understanding and learning the theory and methodology of solving considered problems;
- Learning discipline facts;
- Acquaintance with recommended literature and other modern literature;
- Mastering skills of combining theory with practice while production situations’ consideration, problems’ solving, carrying out calculations during task processing;
- Skills’ formation of logic, structure, style of material statement in the papers and during public performances,
ability to sound the opinion, to exercise information generalization and to infer.

To support this interaction we need to implement innovative components in the learning process. First of it - conversational interaction between trainer and trainee, as well as between students. Second - rapid delivery of the electronic teaching materials to the students and quick access to the knowledge bases posted on the educational institution site. Third - laboratory workshop performance in virtual labs and researches with access to the real laboratory equipment. Fourth - remote testing of trainee’s knowledge.

The main tendencies in development E-learning and creation of the information space for education purposes are: information and education technology integration, educational space virtualization, creating conditions for life-long learning. In this way educational space formed as a hypermedia and support interaction between tutor and trainee on the basis of communication technologies. It leads to using technologies of Wiki, I-Semantica and blogs. A new learning tool appears such as digital bags and E-Portfolio, media editions, presentations and virtual tours, real-time videoconferencing. Nowadays we see also new learning technologies: Web-based learning, mobile learning.

B. Training support system

Therefore there is a problem of methodology development of creation of such teaching materials which would allow to organize interactive dialogue of the trainee with the training environment and would provide its most comfortable maintenance for effective adoption of the studied material. For solving this problem the concept of an electronic multimedia complex (EMC) creation which includes two components is offered: the methodological basis of EMC’s content creation, based on modern achievements of didactics and the methodological basis of EMC’s designing as information system of training process support. Below the main points of the concept listed and explained.

Educational space is formed as a training support system, which core is the multimedia electronic complex.

EMC creation begins with architectural designing. Architectural designing is the designing intended for preparation of the general specifications, defined by needs and wishes trainees and trainers and used on the subsequent design stages and designing of EMC. Architectural designing occurs from top to bottom and defines each detail as function of the whole. Therefore architecture of EMC represents functional display of training system from the point of view of trainees, who are become users.

The learning support system is based on the approach proposed by Oleksandr Pushkar [5]. Implementation of cognitive schemes transfer technology is effected basing on the training support system (TSS) given in Fig 1. A sequence of microscenarios, formed in a relevant module of the training support system, is built into the general scenario in compliance with the described concept.

In case of using the training support system (TSS), the final act of choosing an alternative solution of the

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**Figure 1. Structure of Training Support System (TSS)**
probable situation is preceded by a long and information-intensive process of structuring this situation, design of some elements of the perceived subject field.

Electronic multimedia complex that provides functionality of the learning support system should have properties, listed below.

To support information model of the problem area and provide quick and contention-based access to its elements - the expansion of student’s memory function. To support generation of the goals and unconventional alternatives by student - the trainee intuition (unconscious experience) activation function. Indicate possible directions to retrieve and analyze information, which might be linked indirectly with the issue and take into account factors of human behavior and decision’s social conditionality - behavioral aspect support function. Ensure creation, storage and use of the structural-visual models that describe some aspects of the study domain, function of the visual modeling tool support. Keep knowledge of the prior issues, tasks and methods of dealing with them; ensure active student interaction - the function of storing and activation of the student experience. Ensure for trainee possibility of choosing sequence of the semantic units’ studying, skills learning, choosing of the tools for teaching material’s cognition - the function of the education individualization.

C. Development of Electronic Multimedia Complex

By developing EMC the system-activity approach is carried out within which the teaching material is structured on topics and inside of the topic – on structurally-semantic units. Each topic begins with the list of those problems lie within the range of professional competence of the expert and which solutions are provided with the knowledge and skills received as a result of material studying. Moreover the presence of the list of knowledge and skills which will receive the trainee as a result of studying the material is necessary.

Content of the electronic multimedia complex is formed on the basis of modules. Each module is oriented on supporting certain sphere of the specialist’s activities, this sphere is determined according to the structure shown in Fig. 2. One of the didactic mechanisms of the electronic multimedia complex is interactive model of the competences.

The competence model is the presentation of competences [6], which allows to show connection between behavioral and professional components of human activities.

The structure of the competence models’ basis of each electronic multimedia complex is supposed to include three groups of models: competence models related to the problem area of the studied discipline; competence models in learning and skills’ development (let call them models of educational competences). Use of this models’ group is oriented on mastering efficient learning methods during study of each discipline. The interdisciplinary skills’ models formed cross-disciplinary.

For example, the competence of complex decision-making requires knowledge, abilities and skills from two or three or even more disciplines. It’s impossible to form such competences only by using multimedia electronic complex for a single discipline. We need to establish some connection between them or to use specially designed situations, business games, in which the theoretical basis will be multimedia electronic complexes for relevant disciplines.

Generalized competence model is built on basis of general approach proposed in [6] and shown in Fig. 3.

Educational competences help to students get knowledge and skills the most efficiency way. In the frame of these competences we teach students, firstly, to think over given and read material. We propose to use for this special techniques, such as: preparing brief summary or problem area issues and submit them to blog; drawing up the topic mindmap and lectures in MindMap; abstracting articles; drawing up the plan for just studied content; listing control questions ,task-oriented questions and keywords for the topic.

Secondly, we need to teach trainee to think systematically trough the analytical thinking training – built structure of lecture, topic, subject area on basis of the content analysis; training multidimensional view of the topic, problem, subject area fragment (systems analysis’ aspects); connect topics, lectures, articles with other sciences; perform semantic analysis of lectures, topics (in accordance with the scheme reflecting the lecture’s structure). Thirdly, we propose to develop associative thinking, thinking by analogy and verbal intelligence. Storage of the textual content of the studied topic by way of keyword chains’ formation (color selection in the electronic version of the teaching material).

Beside above mentioned techniques, trainee need to develop several skills: combining knowledge from different subject areas, topic discussing speaking the professional language, holding debates, summarizing separate elements or fragments of knowledge, topics,
courses, the spheres of knowledge, representing principles while studying topic or subject, making forecast of the changing (growth) of the certain phenomenon, event, areas of technology, spheres of knowledge, certain technologies. 

Also very important to develop of multiple points of view on the base of problem area representation (metaphors and symbols, making change in the representative principles, synthesis of representative channels, material’s presentation in the multimedia systems) 

Information retrieval realized through working with search engines or search keys, abstracting of collected relevant materials. One more skill we need to dive trainee is the skill of writing, which they learned through writing abstracts, projects, research works, presentations, diplomas. 

The most effective didactic tools for training educational competences we see in blogs in Internet, connected with multimedia electronic editions. Blogs’ usage in the educational process - the notion of "use of technologies for delivering content" should also include the use of technologies for the purpose of creating students’ own content. Blogs are the way to get feedback that helps students in the knowledge design, thinking skills’ development.

One of the most important educational competencies is the goal setting ability. That’s why in general the process of student work with multimedia electronic complex should be considered as the permanent process of competence development of human goal setting.

EMC’s development begins with the hierarchical structure compiling which establishes conformity between the tasks of expert activity, the content of its activity; the knowledge and skills which a trainee receives and the content of the teaching material of discipline or separate modules 

Within general mechanism of planning curriculum of the specialty and content of certain courses the expert model play one of significant parts. The notion of "expert" in this context will be interpreted in the wide sense and let consider expert as a man who is able to get during work activity required results for a fixed range of production conditions on basis of using skills, abilities, principles, instructions of personality-psychological qualities in the process of ensuring the activities’ effectiveness above certain fixed level. 

The analysis shows that the expert models described in the literature specialist include following characteristics [7]:
• expert requirements – are defined by working place and organization type. Usually considered through list of functions and duties; 
• necessary knowledge and skills. Two types of knowledge are considered - general-theoretical and special; 
• special social and psychological qualities.

Basing on the given above interpretation of the notion of "expert", let give formal definition of the expert model.

The expert model is the tuple $M_{sp} =< E_n, V, U >$ with the set $E_n =\{e_{nk}\}_{k \in K}$ of regulatory competences, the set $V =\{v_{nk}\}_{k \in K}$ of indicators of the level of adaptation or competence displaying $U =\{u_{g}\}_{g \in G} -$ the set of the controlled parameters’ values for the specialist from management system.

Let consider the set of regulatory competences consisting of four subsets: 
- En1 – the subset of qualifying characteristics (knowledge, skills, professional qualifications, workmanship); 
- En2 - the subset of personal and socio-psychological qualities (the ability to enrich general and professional knowledge, entrepreneurial spirit, leadership, level of self-strictness, etc.); 
- En3 - psychological, psycho-physical qualities - psychogram (psycho-physical, intellectual and personal characteristics, working capacity, learning capability, perception, etc.); 
- En4 - formal indications (age, education level, professional development results, etc.). 

The structure of En out ofMsp defines the expert orientation on the subject field for production activities. The value of the levels $v_{nk} \in V$ determines various descriptions (variants) of expert model.

Formalization of the expert’s training process on the basis of electronic multimedia complex is rely on building the two chains of models (expert model, educational plans and discipline programs, competency models), which interact with each other.

We suggest three alternatives of the expert models: the model of "ideal", required expert; the education-oriented expert model; the model of graduated expert, that is, has actually reached level of regulatory competences’ results.

Formation of the qualifying characteristics’ set is carried out with the help of method based on the harmonization of the list of knowledge spheres specific for the activities in specified subject field and the list of the expert. List preparation is assisted by expert procedures. Lists of knowledge spheres and activities’ types are presented in the form of tree with a strong hierarchy.

D. Dialog Component of Training and Interactivity 

The set of the structures, allowing to realize the dialogue component of training and to organize its interactivity (MindMaps, charts of structurally-semantic units with hyperlinks and etc.) is imposed on substantial are of the teaching material.

Elements of trainee-EMC dialogue interaction should be realized through the didactic tools intended for interaction with all personality traits which can be divided into five groups: motivational, orientational, substantial-operational, emotional, volitional, valuation.

Each diagram component has hyperlink to the list relevant structural-semantic units (Fig. 4). In turn, each list element has hyperlink to the particular structural-semantic units of the educational unit.

Another example of the electronic multimedia complex’s structure is MindMap (Fig. 5).
Pictograms (or concepts) of the MindMap are connected to objects which can be called by the click (video, photos, presentations, text files - in the electronic multimedia complex or in the Internet). The mindmaps enhance, above all, the student’s ability to effectively store information, that is, to retain and comprehend it.

We need to implement the elements of interactive interaction electronic multimedia complex and students, they are built on the principles of the dialogue interaction between trainee and trainer.

Extensive type of accumulation of information volume is typical for traditional educational models and communication system. Pedagogical scenarios’ construction for electronic multimedia complexes should be based on the creative model of dialogue organization, whereby student transform semantic organization of available knowledge. Such result, as we think, might be achieved in electronic multimedia complex through the establishment of the fascination background during information units’ transferring. Fascination - is the emotional component of the information. Fascination play provocative role forcing student to go over to create their own ratings. Multimedia tools of the electronic multimedia complexes are provided with ample opportunities for fascination organization during student interactive interaction with electronic multimedia complexes.

Such means as evidences, quotes, examples, contrary instances, comparisons, controversy, arguments, emotions, humor, and casuistry can be used in order to provide content of textbook with completeness, logicality and cogency. Multifaceted information presentation allows to ensure the success of semantic knowledge unit’s learning.

### Table 1

<table>
<thead>
<tr>
<th>Didactic element of the learning process</th>
<th>Preparations for the course studying</th>
<th>List of references, through which students might look before course studying. It provides students with some ideas about knowledge sources to make them able consulting before the program start.</th>
<th>Students read information sources before the course studying.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation of benefits that student might and should get out of studying the particular instructive module</td>
<td>Bookmark which allows understanding the benefits studying of the particular instructive module must accompanies each topic</td>
<td>Formation of the motivational aim at studying of the instructive module</td>
<td>Organization of the efficient work with topic materials</td>
</tr>
<tr>
<td>Expansion of the textbook mechanism for those students who work with the package of preliminary course studying</td>
<td>The package which contains information, references, set of tasks and practical training with answers for them</td>
<td>Identified initial level assurance of course studying for the student group</td>
<td>Identify student into process of review and new ideas comprehendizing</td>
</tr>
<tr>
<td>Review and prior experimentation</td>
<td>Checklist of the preliminary course studying packages that contains required key concepts and statements from completed courses, notions and statements of the following course</td>
<td>Involve student into process of review and new ideas comprehendizing</td>
<td>Effective start of the course studying process that creates optimistic wave</td>
</tr>
<tr>
<td>Teaching methods’ recommendations</td>
<td>Student-friendly guidance that directs how to begin course studying and possible difficulties which may arise</td>
<td>Effective start of the course studying process that creates optimistic wave</td>
<td></td>
</tr>
<tr>
<td>Formation of the course studying motivational mechanisms</td>
<td>Positive comments on the topic and teaching techniques from past students.</td>
<td>Creation of the positive aim at topic studying</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 4.** Example of the chart of structural-semantic units of teaching topic’s material

In the beginning while attention is caught by the auspicious title, the central idea or action, which will make student look for it further, should be presented.

These interactions are efficient when they are implemented as a dialogue obviously or secretly. This means that the electronic multimedia complexes should become from knowledge transmitter to partner, who invites to follow his valuables.

Choice of the communication strategy’s scheme is based on one of the frames: “ring” text, in which beginning and end are agreed ideologically; phenomenon description - puzzle in the form of question, the main arguments put in the first section, less important – at the end of the section. Some authors were classify the basic pedagogic’ methods for e-learning in [8], in table 1 you can see our list of interactive tools in MEC.

**Figure 5.** Example of MindMap build in ConceptDraw MINDMAP
In conformity with didactic elements and results of learning process.

E. **Cognitiv Tasks and Learning Individualization**

For each discipline the great number of cognitive tasks is formed on the basis of typology. The typology includes five groups of tasks: objects comparison; match making of individual object to the general rules; grouping of objects; definition of the basis for grouping and recognition of objects. Tasks according to the level of complexity divide into three groups: stereotypic (reproducing), partially-searching (diagnostic) and creative (heuristic).

Tasks are created following such kind of typology: objects’ comparison; make single objects obey general rules and conclusions; objects’ grouping; objects’ grouping base location; objects’ detection.

All tasks have different levels of complexity: for each task it is possible to create three-level exercises: stereotype (playing), partially searching (diagnostic) and creative (heuristic).

While EMC’s designing and creation it’s necessary to maintain the training individualization. It’s carried out by adjustment on types of intelligence, differentiation of training speed, levels of tasks complexity, choice of tools of knowledge consolidation and skills formation. The set of tools designing principles of the organization of dialogue and concrete examples of their realization is offered.

Learning individualization is carried out using following mechanisms: multimedia complex tuning regarding intelligence type of the student (by Howard Gardner); training speed differentiation; choosing task’s level of complexity; choosing tools of knowledge adjusting and skills development.

**III. CONCLUSION**

Within the frame of this concept we proposed in e-learning design to develop and implement in the structure of EMC interactive multimedia tools, which realized didactic’ usability components, such as:

- Interactive simulators for basic knowledge and skills’ formation with the subsequent practicing of the key competencies for problems’ solving in the given subject area.
- Interactive research models (laboratory workshops, design efforts).
- Interactive tests with various tasks (sorting, object indication, classification, multiple choice answers).
- Tasks with research or heuristic nature.
- Step-by-step tasks and tasks with hints.

- Modules with video, accompanied with viewing knowledge verification after viewing them.
- Modules of virtual labs which allow making measurements, assembling equipment, determining failure causes, experimenting.
- Didactic computer games.
- Wiki-based electronic manuals’ creation.
- Educational virtual worlds’ creation.

Thus, proposed methodological basis of EMC’s content creation give us possibility to construct information system for training process support which helps to organize interactive dialogue between trainee and training environment and would provide the most comfortable maintenance for effective adoption of the learning material.

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