The Development and Implementation of an Adaptive, Interactive Distance Learning Complex

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Abstract – This article provides an analysis of the current state and development of distance learning systems based on adaptive and interactive technologies. The skeleton and information - software schemes distance learning system based on modern teaching requirements for the systems of this class. Characteristics of diagnostic modules of knowledge and virtual training complexes in the structure of distance learning.

Index Terms – system of distance learning, online course, adaptability, learning management system, interactive, diagnostic knowledge, computer training complex, learning management system, content, tutor, diagnostic knowledge, computer training complex

The introduction of distance learning methods in the educational process of higher education institutions of Ukraine is still characterized by slow, local disposition of software and tools development for the implementation of tasks in the absence of requirements for standardization and certification of software control environments distance learning and design online courses.

Unfortunately, not all proponents and enthusiasts of the transition to distance learning in Ukraine, seriously and thoroughly study the world experience in this innovative field. The result is a large number of tools that are narrowly specialized, not committed by their functional purpose, do not take account of recent developments in pedagogy, psychology, measurement pedagogical theory, information and communication technologies (ICT). As a consequence, such a distance learning system have weak persistence, low competitive ability is the inability in a short time with maximum efficiency to be integrated into the learning process of higher education institutions with different learning directions.

It should take into account historical, social and political features of the Ukraine and the current state system of higher education in the country. In our view, it is necessary to turn attention into the following factors:

1. Not enough support for the development of distance learning and education system at the state level, which is expressed in the absence of the target material investments, relevant legislation, standards development and certification organizations of both individual distance courses, as well as distance learning systems as a whole.

2. Many of the private higher education institutions, which in times of crisis are looking for any ways to survive and see the speedy provision way out from this situation in low-quality services in the field of distance education.

3. The absence of a systematic approach to the development and implementation of distance learning in practice of the higher education institutions.

4. The huge gap between research in the field of ICT and distance learning and their practical value.

5. Not enough emphasis on the features and differences of methods and algorithms of distance learning for higher education institutions with various learning directions.

6. Reluctance to use the personal approach by increasing the motivational factors, skills in the distance learning process based on social constructivism under the guidance of an experienced instructor (tutor).

7. The absence of social research for potential consumers of services in the distance-learning sphere. It does not take into account the experience of leading universities in the world, which are the centers of the effective implementation and active use of innovative ideas for long life learning.

8. The absence of advocacy and information support for the possibility of using tangible benefits of control systems of distance learning process (Learning Management Systems) and CMS (Content Management Systems) object-oriented level, which have a modular structure, open code and distributed free of charge.

Today most of the existing distance courses in the structure of the distance learning are divided into two disjoint classes by type of provision of knowledge to the user [1].

1. Electronic textbooks, which in its structure similar to their paper-based prototypes for adaptation to the Internet and on-screen viewing, has a system of hypertext navigation and usually means self-learning.

In this case, no need to conceptually and substantially revise the structure and content of distance courses in its manufacture, but the absence of such resources is their static nature, the absence of adaptation of educational
material to the level of the user's knowledge and his academic targets, which may be called inflexible content.

2. Adaptive distance courses, whose main feature is the ability to adaptation the quality of teaching material and the sequence of courses to the level of student’s training, his preferences and goals.

Development of quality adaptive resources of LMS is a complex problem that requires participation in its decision of experts from different knowledge fields, the availability of flexible knowledge-representation models and mechanisms for their adaptation to a particular user, as well as creation adequate tools to development them.

To solve the task of creating optimal distance courses for the appointment, filling and functional purpose should be to define the concept of adaptation. In relation to the distance learning systems, the adaptation is correction of the course, which has several aspects:

1. Adapting to the current needs of a particular student.
2. Adaptation to the student’s current state.
3. Adapting to the selected for the study of the problem sphere.
4. Adapting to the solving task.

Thus, the adaptive LMS can be defined as its ability of adaptation. This class of systems is sometimes equated with intellectual LMS. However, in [2] describes the difference between development technologies of adaptive and intelligent LMS.

At the present stage of development before undergoing a process of merging these technologies and systems. The key technologies that provide design and development of adaptive and intelligent systems today include:
- Adaptive presentation of educational material;
- Adaptive navigation support in distance courses;
- Construction of adaptive sequence (programming) of course;
- Mining solutions;
- Online support in solving problems;
- Support in solving problems by examples;
- Adaptive collaboration support.

In addition, adaptive and intelligent LMS should be based on known didactic principles [3]:
- Prioritization of pedagogical approach in designing the educational process in LMS;
- Flexibility and agility;
- Pedagogical appropriateness of applying new information technologies;
- Taking into account the starting level of education;
- Correspondence a teacher technology training to selected models and types of distance education used data teacher or educational institution.
- Freedom of choice of student’s educational content.
- Security of information circulating in the LMS;
- Not antagonistic of distance learning education to existing forms;
- Modularity;
- Interactivity;
- Economic efficiency and accessibility of various categories of the population;
- Intensification.

Take account of the report’s theme dwell on the principles of modularity and interactivity.

The basis of the modular design principle of LMS put the separation distance courses on the functional modules, which combine learning content and technology of mastering them. Each individual module creates a complete view of a particular subject sphere. This allows from a set of independent modules to form the learning program that respondents individual or group needs.

Assignments of the module through the organization of individual self-study student and accompanying counseling teachers, as well as work in small groups.

During all stages of the module is supported by a strong feedback and gives all materials for self-control.

The principle of interactivity involves the interaction of all subjects with each other and using the available means and methods. Interactivity represents one of the fundamental characteristics of the learning process - the interactions. It is regarded as the evaluation and communication technologies themselves, and as a criterion for the quality and effectiveness of training programs.

If you have to interact with each other, especially teachers and students, and this interaction is carried out by using various means of telecommunication - the e-mail, teleconferences, the dialogues in real time, etc.

High levels of interactivity are also distinct and network information resources used as a means DO - electronic books, to search for information on the network, etc. The development of new teaching methods based on modern ICT (giper-technology, artificial intelligence, multimedia) is a realization of the principle of interactivity in new forms.

In [4] pointed out that the remote adaptive interactive systems should ensure that all types of (institutional form) classes within the institution of higher education - lectures, seminars, practical and laboratory work, research work, self education, course and diploma design, test, examinations, as well as innovative methods of teaching in the form of joint Wiki - projects and the social - their applications.

For didactic purposes the individual modules of interactive distance learning adaptive systems can provide a different end goal - a normal delivery of information content, the formation of knowledge and skills, retention of knowledge, monitoring and diagnosis of knowledge, generalizations and advanced level of knowledge and skills.
According to the analysis of domestic and foreign information sources, including the Internet, the most common structure is an adaptive remote interactive complex should include five major interrelated sections: guidance (organizational) information, communication, supervisory and motivational. The relationship between these blocks remote adaptive interactive complex and their basic functionality are shown in Fig. 1.

The organizational unit is the most dynamic and mobile part of the complex. It is a powerful toolkit tutor in the organization of individual trajectories of learning adapted to the level of knowledge of each student. Its content is a map of the concepts of distance learning in a particular subject area in order to achieve the maximum level of knowledge and skills of each student. This is a prototype technology programming adaptive sequence distance course in Intelligent Systems. Designing a specified part the complex is considerably easier with the advent of systems management and monitoring of the learning process (LMS).

Certain complex issues are methodological and didactic approaches when creating a standardized structure and optimal filling teaching materials information block DAIK.

The communicative power is a complex element of feedback between tutor and subjects of study. Traditional form of communication is the communicative organization of teleconferences, consultations on the individual modules of disciplines through e-mail, distributed seminars in real time using chat forums and using systems and ICQ, Skype. A new form of virtual communication are remote classrooms for the practical and laboratory work, which require insertion of large intellectual potential developers of such complexes, especially for teaching students of technical specialties, and specialized software [5].

When distance learning is widely used test control, which should take into account the additional function of identifying the student's personality, which makes not possible falsification of training. To determine the accuracy of results mastering the fundamentals of a discipline perspective should be considered as rating control which takes into account all the intermediate results of testing, students' activity in the study modules of discipline, self-fulfilling common tasks and tasks of high complexity and scientific direction. Today's learning management system (Learning Management System) type of object-oriented environment LMS Moodle (Modular Object-Oriented Dynamic Learning Environment) provides developers with remote almost unlimited possibilities for the implementation of the supervisory unit because they can organize and collect the results of diagnostic knowledge level of students, and also maintains a database of current activity of each student for each entry in the system under its own password.

But we should not underestimate the possibility of its own development of remote diagnostics of knowledge of students, since their development can be addressed by new algorithms to create adaptive testing platform, the achievements in the field of testers and the theory of pedagogical dimensions.

Fig. 2 shows a general block diagram of an adaptive remote interactive complex, which is implemented for students majoring in Control Systems and Automation "on the software with open source.

P-induced block diagram can be understood that the LMS Moodle is structured and rich functionality, allows to design and interconnected motivational, information and communication blocks, blocks access control and adaptation of the complex. Thus, LMS Moodle is a central core of an adaptive interactive remote and complex, as supplemented by specialized software becomes a powerful tool for organizing students' individual education based on modern pedagogical theories [6].

The complex is completed, developed in-house staff from the center of distance learning and a branch of UNESCO Chair "New Information Technologies in Education for All" in Galytska Academy, with remote diagnostics level for the rating of students' knowledge of control d-tester and adaptive testing a-tester, virtual
Development and application of virtual laboratory stands and computer simulators is particularly important task in the design and operation of interactive training courses for students of technical specialties.

Employees of the branch of UNESCO Chair "New information technologies in education for all" help teachers and students of the department of computer technologies in control systems and automation in the organization of educational process, namely the development of virtual laboratory stands and computer training complexes.

Generally there are following types of computer simulators [7]:

1) E-examiner. Its main feature - the replacement real examiner in the strictly regulated areas (safety of different industries, traffic rules, etc.);

2) Static (or dynamic-logical) simulators. The main feature: the absence in such programs, physical and mathematical models of processes occurring in the system, and strict procedures;

3) Dynamic simulators. Are based on a mathematical model of real physical processes and therefore most useful for quality training;

4) Console simulators. They also computer hardware is present (control panel simulators). The computer in this case replaces the real control object;

5) Modern computer technology allows creating dialogue training programs simulators, which include animated, audio and video files, which strengthens the feeling of reality when dealing with this type of simulators.

Currently the authors are working on a computer training complex for operators of gas-pumping aggregates, which is a direct simulator-imitator of operator and two functionally related subsystems – training and attestation. The relationship between these elements can be represented in general structural scheme of computer training complex (CTC) (Fig. 3).

The complex is completed, developed in-house staff from the center of distance learning and a branch of UNESCO Chair "New Information Multifunctional CTC can be considered the most perspective systems that are currently in use. In them – the model of real objects constructed using specialized three-dimensional modeling programs, they also have the opportunity to influence them by the operator, have "active" reference and diagnostic tools of professional knowledge and skills of future specialists [8].

Theoretical and practical training is conducted here in a single environment. The operator, studying the work of the automatic control system of gas-pumping aggregate refers to the reference material presented in the form of functioning algorithms of gas-pumping aggregate. After reviewing the relevant materials for a better understanding of the structure and operation modes of gas-pumping aggregate the operator moves to the training subsystem of CTC which is a set of educational videos that demonstrate the structure and modes of gas-pumping aggregate. After viewing the videos operator may apply to the operators’ simulator-imitator that simulates the control panel of automatic control system of gas-pumping aggregate.

Operator’s simulator is animated multimedia imitator designed to simulate changes of the physical equipment states (instruments, devices) under different conditions of gas-pumping aggregate, creating the illusion of action from the physical hardware.

Their main feature is the most complete reproduction of the appearance of physical devices (front panels, scales, switches and other elements of display and recording devices) and their controls (buttons, toggle switches, switches) as well as the motion of individual elements according to user's actions on the basis of creating animated objects and complex scenes. Here the operator can do some virtual action (start the aggregate, stop, transfer to the idle mode, etc.), while watching the values of key parameters and indicators of pumping gas. The simulator-imitator consists of 12 main windows, transitions between which can be done by a computer mouse or function keys F1-F12.

The task of the training process is reproducing as normal operation so extreme situations in the gas-pumping aggregate functioning, which require the operator to find the optimal solution in the short time that it forms the so-called operational thinking. After working with the simulator-imitator, operator goes to the attestation subsystem of gas-pumping aggregate.

Attestation subsystem is a set of psychological and psycho-diagnostic tests to check the health, psychological and physiological qualities of operators. To check the level
of proficiency and readiness (professional knowledge and skills) is a separate test unit.

For junior specialists is a test unit for testing their proficiency. If specialist passes it successfully – he is allowed for further testing. In the case of the failed testing, he issued a message that his physiological quality does not meet the standards of his duties as operator.

Then operator can go to the test block that verifies his knowledge and skills with the real object. If the operator does not pass this test, the CTC takes him to the education subsystem for further study of the gas-pumping aggregate functioning. When the test is passed successful go to the third unit, which includes tests to check the current operator state (check physical, mental and psychological state of operator). In case of negative test results this operator must be temporarily dismissed from his duties.

For more experienced operators and employees is possibility directly to go to the second block of tests for checking their knowledge and skills with real object and then check your current state of readiness.

As a result of successful completion of all test operator receives message on his readiness to work [8,9].

Therefore, the computer training complex of gas-pumping aggregate includes elements of all types of simulators, except for console simulator.

For the development of structural units of information, situational and problem-blocks used content management system (CMS) eXeLearning based Free Open Source. Information blocks are developed using this software can be imported into any LMS in SCORM-format.

Using their own systems of diagnosing the level of students' knowledge increases the efficiency and adequacy of the evaluation of the level of knowledge and skills of students in the control points of passage of distance learning.

As a result of testing system's work during almost four years, there was a necessity considerably to complete the information security algorithms. The specific of the Web-oriented systems foresees the use of the so-called HTML-forms for "intercourse" over the Internet. By virtue of the nature it requires to utilize some service information in an order to control the process of passing knowledge's control.

Some popular web-oriented learning management systems have some bugs: in some of them in a programmatic code of Web (HTML) page inserted service information. Use of the reception means that the analysis code web-page can give correct answers to some test without knowledge of the material.

The analysis of the developed system was that the registrar of tasks to the closed question type first (in many cases) record the correct answer and incorrect. In the system and in others (for example in LMS Moodle) database structure provides for each of replies unique identifier which can accurately determine the answer. In this specific problem the correct options are smaller number than incorrect ID options. A page with test questions in LMS Moodle are shown on Fig. 4 and HTML-code are shown on Fig. 5.

As the Fig. 5 (a red selection box appears over region where the service information), just a simple analysis to quickly identify the correct answer. This reception is quite simple, which in turn simplifies the code on the server side for the analysis of responses, but as described above is not ideal.

It should be noted that the problem is typical for almost all systems, but for some there is even more random approach, namely, the web-page code inserted even no replies ID's in the database, and setting the signs correct / incorrect answers. Second admission generally unsuitable under any circumstances, as a user with 100% s likely indicates the correct answer.

According to the above results of analysis systems, necessitated considerable portfolio. It was proposed several algorithms for information security, namely in the code generated web-page inserting not unique identifiers of responses, and a consistent indices array. In Fig. 6 and 7 shown d-tester™ testing subsystem and HTML-code web-pages, respectively.
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SUMMARY

The proposed method of designing distance learning systems based on adaptive algorithms and the interactive phase is testing and implementation in the departments' "Knowledge documents" and information activities "Galitska Academy" and "Computer Technology in Control Systems and Automation" Ivano-Frankivsk national technical university of oil and gas. In this remote adaptive interactive systems are structural elements of distance learning system of higher education in general.

REFERENCES


