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PREFACE

Welcome to XIVth International Scientific and Technical Conference **Computer Sciences and Information Technologies** CSIT 2019, which is organized by IEEE Ukraine Section, IEEE West Ukraine AP/ED/MTT/CPMT/SSC Societies Joint Chapter, Lviv Polytechnic National University, Institute of Computer Science and Information Technologies, supported by Technical University of Lodz Poland, Institute of Information Technologies, patronized by Ministry of Education and Science of Ukraine.

The international conference **Computer Sciences and Information Technologies**, established in 2004, is annually organized with the principal aim to discuss modern trends in computer sciences, information technologies, applied linguistics, and others related areas. To achieve this goal, various aspects of computer science will be presented in such major topics:

- Artificial Intelligence
- Cyber-Physical Systems
- Software Engineering
- Applied Linguistics
- Intelligent Management Technologies
- Mathematical Modeling
- Big Data and Data Science
- ICT in Higher Education
- Data and Knowledge Engineering
- Project Management

CSIT 2019 Program Committee evaluated over 250 submitted papers from China, Czech Republic, France, India, Ireland, Japan, Kazakhstan, Poland, Serbia, Turkey, Slovakia, Spain, and Ukraine to crystallize a high-level technical program of oral presentations. To continue previous successful practice, CSIT 2019 hosts three international scientific workshops: *International Workshop on Inductive Modelling IWIM-2019*, *International Workshop on Project Management IWPM 2019*, and *International Workshop on Information modeling, Data and knowledge engineering IWIMDKE 2019*, all supported by IEEE.

The sincerest, boundless gratitude of organizers is sent to members of International Program Committee, who supported CSIT 2019 conference by participating in it, their comprehensive reviews allowed the conference to participate in the promotion of science and technological excellence. It should be proudly mentioned, that some papers are common for several institutions, and even countries, involved in the conference. Such examples of international cooperation, that we have noticed in papers, submitted this year, has inspired CSIT 2019 International Program Committee and Organizing Committee to encourage the cooperation.

Conference CSIT 2019 and satellite Workshops will be held in Lviv which is the largest city in Western Ukraine and the seventh largest city in the country overall. The historical heart of Lviv city is famous for its old buildings. The city center is on the UNESCO World Heritage List.

Lviv is one of the most important cultural centers of Ukraine, famous for art, literature, music and theatre. It hosts more than 100 festivals annually, has 60 museums and 10 theatres. With regard to its urban fabric and architecture, Lviv is an outstanding example of the fusion of the architectural and artistic traditions of Central and Eastern Europe with those of Italy and Germany. The CSIT 2019 conference will be held in early autumn, and Lviv will be at its best: the city is famous for its welcoming and hospitality, its beautiful parks, diverse cuisine, fascinating history and charismatic architecture. Please, be sure of our warmest gratitude for you interest and participation in the conference.

We are looking forward to welcoming you in Lviv and at CSIT 2019!

Sincerely yours,

Mykola Medykovskyy
Director of Institute of Computer Sciences and Information Technologies of Lviv Polytechnic National University, Ukraine
CSIT 2019 Executive Chair

Lviv 2019

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APPLIED LINGUISTICS

ICT IN HIGHER EDUCATION

INTERNATIONAL WORKSHOP ON PROJECT MANAGEMENT

Models of Behavior of Agents in the Learning Management System

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Abstract—The urgency of the research. The behavior of agents as components of a learning management systems is being investigated at all stages of the life cycle of creating and using a software product. Learning management systems are characterized by the fact that the scenarios of their operation is associated with various aspects of educational activity. Directions of functional, emotional and motivational behavior of users are especially relevant. In addition, it is expedient to introduce software agents for the detection and prevention of crisis situations.

Target setting. The purpose of research is deal with the close relationship between the behavior of users and the results of their activities in blended learning. The results obtained will test the basic functions of the system and identify their impact on user behavior.

Actual scientific researchers and issues analysis. Recent research in various fields of science and practice focuses on user behavior, as well as the formation of special software modules (agents) that detect the problem moments of the system and warn the user. The algorithms of human-machine interaction, communications between users of information systems are studied by scientists from various fields of science and technology. Models of behavior of agents of the management training systems allow to verify the requirements to the system at different stages of the life cycle. For example, to identify the crisis moments of functioning, to consider organizational, motivational and emotional aspects.

Uninvestigated problems. We have to focus the opinion on issues that require more detailed research and adaptation for learning management systems. They are: the definition of agents of information systems and their features in learning management systems; consideration of the system as a complex agent; definition of the main agent circuits of the electronic information environment on the basis of the training management system; models of agent behavior patterns and their relevance in the interfaces of program modules and user instructions.

The research objective is to shape the behavior patterns of agents in the information management education system.

The statement of basic materials. This research includes refinement of such basic definitions as the e-learning management system; the agent; the agent behavior pattern. Such definitions allow us to use the theory of mirrors and to determine the main contours of the functioning of the information system for blended learning in an educational institution. Detailed models are formed for the module of test final control and portfolio of the teacher. Formalized mathematical and informational models are the basis for studying of users behavior and the research basis of university blended learning system functioning. The implementation of the system modules was carried out according to the concept of "Electronic University". The JetIQ VNTU system is implemented as a multi-agent learning system.

Conclusions. The practical result of the exploration is the bundle of formalized models, definition of contours of the blended learning system and its modules. The checklist of the main processes of user behavior patterns and their description in user instructions forms the basis for analyzing of the existence of programing modules (agents) for warning, reminding and helping the user to work in particularly risky moments.

Keywords—electronic information environment, blended learning, e-learning management system, agent behavior pattern, Zachman card, activity trajectory, JetIQ-project.

I. URGENCY OF THE RESEARCH

The emphasis on human behavior, the response to the signals of the external and internal information environment, the use of agents of artificial intelligence for helping, reminding, identifying crisis situations and their prevention is the subject of research by scientists in various fields of science and technology. Thus, behavioral economics examines consumer behavior patterns, emphasizes the processes of

decision-making under the influence of psychological, social, cognitive and emotional factors [1]. Research in the direction of developing adaptive interfaces, increasing the effectiveness of human-machine interaction also occurs at the intersection of design, engineering, marketing and psychology [2]. The urgency of the research for e-learning management systems is also confirmed by the active use of modern teaching methods, systems of blended learning, the development of automation systems for educational processes [3 - 5]. The experience of introducing e-learning management systems in higher education institutions suggests, that one of the most time consuming and problematic stages is to train users and make changes to the organization of the educational process. The developed models will allow to adapt the system to the needs of users.

II. Target Setting

The main settings are: crossing of various spheres of science and technology, balancing the needs of users of various target groups and the possibilities of program modules, determine the complex approach to modeling the behavior of agents of the management training system. Establishing a complex "from general to detailed" will enable to form a model of the education management system which is based on the main target functions and capabilities. Detailed modeling behavior of software agents and users will be the basis for testing and organizing the implementation of the system.

III. Actual Scientific Researches and Issues Analysis

Actual scientific researches and issues analysis. A number of scientific studies contains a number of common models of the educational environment, the trajectory of learning; algorithms for the introduction of distance and mixed learning systems. Always relevant are the study of systems, the use of a systematic approach to building an electronic information environment [6; 7]. Questions of the formation of the content of the management system of education and interaction of students among themselves, the student-teacher remain issues of relevance. student - electronic materials. The agent approach to structuring the training management system is also actively developing. Similarly, information systems of various types in the electronic educational environment also introduce program agents, elements of artificial intelligence. For the formation of user behavior patterns, actual research results on simulation of training management systems, in particular adaptive systems, were analyzed [9]. The questions of essence and understanding of behavioral models are considered. In addition, materials from the pedagogical and UX-design are analyzed [2]. The analysis of the reviewed scientific papers indicates that for the formation of agent models of user behavior in the management system of training, it is necessary to use a systematic approach and combine the results of research in various fields of science and technology.

IV. Uninvestigated Parts of General Matters Defining

User behavior in the education management system is economically feasible. For a student it is a goal of learning, obtaining knowledge and skills, their use in educational and real projects of professional activity. For a teacher - is the performance of their duties, creation of author's methods and electronic resources and own brand teacher. For methodologists, managers, important questions are the optimization of information processing processes, reporting materials and interaction with managing organizations (for example, the ministry or department). Thus, the general model of the management education system should take into account the results of the research of the adapted system and taking into account the system agent approach.

V. The Research Objective

The main purpose of this research is to develop models of behavior of agents of the system. The simulation is carried out by taking into account the functional, motivational and emotional contours of the management education system. The resulting models are the basis for introducing adapted modifications to the system module and user training.

VI. The Statement of Basic Materials

The research and formation of the behavior models of agents is needed to begin with refining the main definitions. The development of training management systems is closely linked to the implementation of distance and mixed learning, the creation of the "e-university" environment. The definition of "learning management system" has different interpretations from scientists. There are authors who focus on the educational electronic environment and its functions and content. There are definitions that focus on the interface and the interaction of users and software modules. In the conditions of automation of educational processes in educational institutions the system of teaching management is the basis for the formation of the environment of the university (college, school) with has modules for providing access to electronic resources and opportunities for communicating between participants in the educational process and also for monitoring indicators of the main areas of activity. Learning management systems are multi-agent systems. Under the notion of the agent we will consider each of the participants in educational processes in the environment of the management training system. For example, it could be users or software modules. Agents in the learning management system can perceive information and reflect events that occur in the electronic environment. They could interpret data and influence on their further use. Agents are characterized by such properties as adaptability, autonomy, ability to communicate, colloquialism, ability to reason and mobility. Agents in the e-learning management system are users and software agents. Users are divided in lecturers, specialists, methodologists, students and administrators. Software agents can be divided into reminders and alarms (assistants) as well as program agents who carry out automated actions. Analysis of multi execute learning management system is shown by Zachman`s card (Table1). Such a map is an adapted and completed with lines of target user groups.

The general model of the learning management system can be represented as a set of interactions. This model is the basis of the "Electronic University" system. It is implemented as a modular system for managing teachers Jet IQ VNTU [9].

TABLE I. ADAPTIVE ZACHMAN`S CARD FOR LEARNING MANAGEMENT SYSTEM

Levels of Management		What	How	Where	Who	Why	Motivation	Models
Heads of the institution and the project "Electronic University"	Head	Educational Plans and Objects	Educational and management processes	Internal network, external public portal	Key departments and individuals	According to the curricula and timetables of the departments	Target benchmarks of the educational development strategy	Scope, context
	Scheduler	Conceptual Data Model	Educational and Management Process Model	Logistics Information Scheme	Target Users		Information Mirrors of the	Model "Electronic University"
Developers and IT managers	Architect	logical data model	architecture of software modules	Distributed Architecture Model	the user and his behavior at the architectural level	According to the life cycles of development and implementation; recognized events in educational managerial processes Its and	Mission and Targets of the IT Strategy for th Development of a Educational Institution and the Project "Electronic University"	Model LMS
	Evangelist	Context-logical data model	Model of content and interaction	The content of the system pages	the user and his behavior at the level of content and interaction			Detailed LMS
	Programmer	Software data model	Software code	Network Architecture	Detailed user access levels			Software model
Users	Student	Electronic resources communications, presentations monitoring of results of activity	Through personal electronic cabinet; public portal; special pages of departments; special software modules	Internal network external public portal	Student		Convenient, accessible, fast, modern.	Real Electronic University
	Teacher				Teacher			
	Specialist				Specialist			
	Methodist				Administrators with a certain level of access and capabilities in the system			
	Administrator							
	Dispatcher							
	Leader (dean, deputy dean, rector)							
The essence of the questions		**Data**	**Functions, processes**	**Network, disposition**	**People, organizations, relevant roles, context, content**	**Time, schedule**	**Motivation, generation of functional and emotional signals for action**	

The electronic information environment should be considered as a complex modular system by the formula [6]:

$$EIS = \langle z_p, z_{pl}, z_{r1..r2}, z_m \rangle,$$

z_p - the module of monitoring and control of current activity - management activity;

z_{pl} - the module of planned activity - educational, methodical and scientific activity;

z_r - the module of scenarios for the implementation of planned activities;

z_m - the module of the activity motive circuit.

Each component is a collection and interaction of sets:

$$Z = \langle A, ER, B \rangle$$

A - the set of agents (users and software modules);

ER - the set of electronic resources;

B - is the plurality of communications.

To evaluate the effectiveness of the model, we use the vector of coverage and automation of the activities of all participants in the educational and managerial processes of the educational institution. For this purpose, the mirror end is used. It is based on the law of adequacy of reflection [10]:

$$J_{spr} = R_k(J_{spr})J_{pr} = R_k(M_{spr})M_{pr},$$

Jspr - perception information;

Jpr- process information;

M_spr - measurement perceptions;

M_pr - - measurement parameters of processes;

Rk - relative saturation of electronic resources.

The linear approximation can be represented as follows:

$$J_{spr} = R_k J_{pr} = R_{k.} M_{pr}$$

The activity reflection can be represented as the amount of information flows per unit area of the information field.

$$O = dJ/dS/(dS)2,$$

O is the vector of the reflection flow of information;

S - coverage area (information field).

According to Gauss's theorem, the measurements can be defined as follows:

$$M = \oint_S OdS;$$

or

$$J_{pr} = \oint_S OdS;$$

Ospr= RkO - reflection intensity vector;

Ospr is a vector of coverage of the activity, its reflection for the perception of users.

According to the agent approach, the overall model of the management education system can be considered as the interaction of agents and electronic resources. Each of the defined contours of the system has its own characteristics and should be taken into account in the user behavior model.

Thus, the functional loop includes the basic functions of a specified user and algorithms for their execution [11]. Among the activities in this contour, special attention is paid to the work of the user with the documents and the reliability of the information that is formed, stored and processed by the system. That is why, when working with documents, use special program agents that remind the user of the verification of all data before the export of documents to the electronic dean's office system. The functional contour also contains programmed reminder agents and links to the operating instructions in the system modules.

The organizational contour forms the conditions for the fulfillment of all the specified functions and coordinates the actions of the users with the norms of educational and managerial processes of the educational institution. This contour is provided and supported by official documents of educational and scientific-methodical activity at an educational institution. The motivational and emotional outlines are the most difficult to understand and implement. They are interwoven with each other. The motivational outline contains a variety of tools for motivating activities in the electronic information environment.

For example - for teachers and students it is convenient services of the schedule of classes; news opportunities for quick interaction with colleagues and students; automated support for repository publications; convenient services for creation of author's electronic resources

The emotional outline consists of a friendly interface; monitoring results; automatic filling of publications in the portfolio of the teacher; evaluation of teacher's activity, etc. Analysis of these contours requires the use of knowledge and skills in pedagogical design and the formation of the UX interface.

The contours of the portfolio model of the teacher, his behavior of representing a personal brand as a teacher, specialist, and scholar are presented by individual pages of the teacher's mini-portal and links to bibliometric resources, navigators of disciplines, repositories and project resources.

As a practical example, consider the behavior patterns of a teacher when creating test assignments and organizing the final control of higher education students through the module of test control.

At the creation level, the automated testing module can be

presented as:

$$M_c = < T_{pt}, T_{vt}, T_{dvt}, P >$$

M_c is an elemental basis for the creation of test tasks, which consists of a plurality of questions on topics T_pt a set of questions;

T_{pt}- set of answers to questions by topics (levels);

T_{vt} - the range of grading the correct answers;

P - the rules for the withdrawal of assessments for questions and the total assessment of the test, the preparation of the test, the organization of test control; assessment of students' knowledge by certain algorithms.

The presented sets participate in the functional contour. The set of rules, reminders, and errors in the actions of the user are motivational and emotional outlines.

The model of functioning of the control module determines the basic operations that allow achieving the goal of evaluation and can be represented as follows:

$$M_f = < O_{pt}, O_{vt}, P_{0\ldots1}, O_z >$$

M_f is a model of functioning; O_{pt} - dynamic operations of the choice of a plurality of questions; O_{vt} – dynamic operations of the process of forming possible responses and their evaluation; $P_{0\ldots1}$ - set of sequence of transitions during testing; O_z – operations of the algorithm of knowledge evaluation.

The development model M_r assumes the development of such attributes of the testing system as openness, mobility, system and information unity, complexity. This adaptive model contains procedures for adapting $A_{ad}$to changes in external conditions; the introduction of new A_{nt}technologies and feedback mechanisms Z_z:

$$M_r = < A_{ad}, A_{nt}, Z_z >$$

The objective function of the effectiveness of the knowledge assessment system (E) can be defined as a function of dependence on the a priori entropy H_s (determined by the level of knowledge and intuition of the student); entropy H_v (determined by the level of experience and intuition of the teacher, as well as the results of testing); compositional entropy H_k (determined by the algorithm of creating a test task), time control T and the number of tasks K [7, C. 20]

$$E = F(H_s, H_v, H_k, T, K) \rightarrow max$$

Such a model focuses on the functioning and motivation contours in the testing module.

Such a model focuses on the functioning and motivation contours in the testing module. Fig. 1 - View of Test- IQ module help page.

Fig. 1. View page with user instructions

An analysis of the instructions, models and experience will help to form check-lists of processes. The obtained results are the basis for improving the management of education system.

VII. Conclusions

The conducted researches allowed to form the models of behavior of the agents of the management system of training according to the managerial and educational processes. The resulting models are the basis for testing the operation of the system and the development of documentation. They are used to analyze each contour of system operation and user behavior in it. The results of the research have been tested during the implementation of the JetIQ VNTU management system also including the final control at Vinnytsia National Technical University. According to the results of approbation of the user behavior model while passing the final test control by the TestIQ software module, there were found a lot of necessary improvement tasks. In particular, to formulate recommendations for improving the quality assessment of the pool of test tasks, to introduce reminders of program agents at the nodes of the most common mistakes, to introduce a special simulation module for student work to test the test questions.

The plans for further research include the formation of visual behavior models and their analysis, in particular models of teacher portfolio for the development of their own brand.

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