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Data processing in interactive training methods on the basis of web technologies

Web-oriented technologies become more used in educational activities due to the integration of comprehensive professional knowledge, abilities and skills using network information technologies of the educational systems. The work proposes the creation of professional orientation support systems on the basis of websites of general secondary education institutions and profile departments. The cognitive and situational simulation shall be the basis of these systems. Combining these two technologies, the new approach to studying the learning material, enabling for processes and phenomena modelling to study the new learning material and the application environment, which is close to the real, as well as to solve the typical professional tasks, is received.

Key words: *data processing, education, production, educational process, web technologies.*

Formulation of the problem and the relevance of the study

Today, information technologies are the basis for all human activities. The associated cognitive processes and phenomena constitute no exception. Increasingly often, the information technologies modelling object become the processes and phenomena associated with cognitive activity rights. At the same time, special attention is paid to the development and improvement of the forms and methods of education and training activities. One of the priority directions of training is the solution to problems related to the quality organization of the learning process and educational services. Today's students need inclusive education, where some forms of knowledge are supplemented with others but do not exclude or reject them [1]. In this regard, the use of innovative technologies in the management of educational and training activities is relevant.

Interaction of the work with the important scientific and practical tasks

The professional knowledge of students is formed at studying many different disciplines, including humanitarian, fundamental and professional ones, causing the use of

different mathematical apparatus in the educational process and knowledge representation methods, varying from the ones necessary for the solution of the production problems. There is a need to improve professional knowledge and skills through new forms of study. The today education is being reorganized and modernized, in particular concerning the training of specialists for employment by the profession, who have the up-to-date knowledge and skills relevant to the educational programs and the production needs. However, this training process is to start with general education institutions. Therefore, now, special attention is paid to the development and improvement of the forms and methods of administering study activities in educational systems. The reforms of higher education are aimed at improvement of the educational services using modern information systems and technologies. Informatization has had a great effect on the study process. New approaches to the study based on information and communication technologies can intensify the educational process and improve the perception, understanding and depth of the vast arrays of knowledge.

Analysis of the recent researches and publications

The analysis of modern information technologies in educational systems has shown that it is the most effective way of managing knowledge and processes. The paper [2] reveals the process of using new information technologies for training and cognitive activity of students for the study of personal computers and computer systems. The papers [3, 4] show the importance of introduction of information and communication technologies methods and means into the education system and the creation of computer-oriented information and communication environment on this basis, as well as the basic components of the educational process, which are influenced by the implementation of information and communication technologies of educational purposes, and the modern purposes of education informatization. Web technologies out of the modern information technologies attract considerable interest. A student has Internet access with any gadget available, such as smartphones, Pocket PC, laptop, tablet, etc. This way, application of web technologies for training and educational activity enables multiple views of educational material, with returning to complicated concepts and calculations, or vice versa, going to the next page if everything is clear.

The papers [4–6] show, that web-oriented technologies become more used in educational activities due to the integration of comprehensive professional knowledge, abilities and skills using network information technologies of the educational systems. It should also be noted that modern information technologies with an application of the web-resources allow for regular cyber-communication of the secondary and high school teachers with students [7].

Selection of the previously unsettled parts
of the general problem of this article

To use the above features of web technologies in the educational system, the work proposes the creation of professional orientation support systems on the basis of web-sites of general secondary education institutions and profile departments. The cognitive and situational simulation shall be the basis of these systems. Cognitive modelling

causes the most effective decisions or scenarios of real events. It considers the concepts, factors, quantitative and qualitative indicators of a particular situation.

In its turn, the situational modelling is a method of research where the studied system is replaced by a model giving rather an accurate description of the real system.

By combining these two technologies, we will have a new approach to studying the learning material, enabling for processes and phenomena modelling to study the new learning material and the application environment, which is close to the real, as well as to solve the typical professional tasks.

Novelty. The paper proposes an approach to the creation of the decision support systems that ensure the integration of educational systems, which, unlike the existing ones, uses the network information technologies between educational systems and the integration of network information technologies with standardized education technologies.

The work methodological significance lies in the point that the proposed approach is a scientific and methodological basis for the integration of information and technology solutions in educational systems. On this basis the education supporting systems have been developed and implemented using modern network technologies.

The objective of the article: the estimation of the possibility of processes and phenomena cognitive modelling in interactive training methods for a new approach to study the learning material using web technologies.

Statement of the basic material

The work proposes the creation of support systems for professional orientation as an educational web-portal, using information and communication technologies, based on the sites of primary departments of learning. This system is implemented through the site of the Department of Land Administration and Geoinformation Systems of O.M. Beketov National University of Urban Economy in Kharkiv [8].

The portal gives an approach to the game (quiz) study of disciplines. This approach is based on cognitive modelling [9, 10], that is, modelling processes and phenomena to learn new educational material on the chosen profession. Considering the nature of cognitive modelling, we assume that the creation of game (quiz) models make the subject field more interesting for the pupils and students. We will show the application of cognitive modelling on the example of a geography quiz. The quiz is based on the outstanding work «On the Diversity of the World» by Marco Polo [11].

The rules of the quiz are as follows: the route of Marco Polo is a set of «marked» points. Each «marker» corresponds to the number and name of a city or a place where Marco Polo, the traveller, stayed (or stopped). Clicking on the «marker» deploys a page with the area features (population, culture, nature, flora, fauna, peculiarities of the area, etc.). A player should carefully read the game plot and independently answer the questions. A click on the corresponding «marker» opens a system of questions on each Marco Polo follow-up point.

The game training applies the situational modelling techniques, that is, one should create a situational model [12, 13], studying of which shall allow learning the subject field, close to the real one, as well as solving typical professional tasks.

The main goals of the quiz are:

— activation of educational activities of pupils and students through the use of interactive training methods;

— improvement of the efficiency of educational activities of geography school teachers through the integration of educational material of geography textbooks and multimedia presentation of historical geographical discoveries processes, phenomena and events;

— improvement of the efficiency of certain disciplines teaching staff in higher education institutions through the combined teaching method that includes both interactive and historical components;

— expanding the pupils' and students' horizons their interest in further study of geography through acknowledgement of connection of historical events and geographical discoveries made by famous travellers;

— gaining of new knowledge by pupils and students in the field of creation of geographic information systems and technologies.

The formal representation of the quiz cognitive model is shown below:

$$M(V) = \langle M(Fb), M(mt), M(CO), M(vo) \rangle,$$

where $M(V)$ is a game model or a cognitive map of the game, $M(Fb)$ is a model of the game plot, $M(mt)$ is a travel route model; $M(CO)$ is a declarative (descriptive) model, $M(vo)$ is a model of the question-answering relationship between the players and the game administrator.

The cognitive map is a cognitive model of a high generalization level. The game covers declarative (descriptive) and procedural (algorithmic) knowledge. The declarative knowledge includes general historical facts. Procedural knowledge includes procedures for grading playing students. The attribute data is data that specifies the coordinates or locations of the objects or data describing the quantitative and qualitative characteristics of spatial objects.

In a generalized form with certain constraints and assumptions, such a model can be represented graphically (see Fig. 1).

The game background includes declarative (descriptive) and procedural (algorithmic) knowledge. The quiz declarative knowledge includes general historical facts. The procedural knowledge includes assessment procedures for quiz participating pupils and students.

Besides, it is assumed that the cognitive model has three levels of generalization.

1) $W\uparrow$ — the high level of generalization (the level of play and scenario);

2) W — the average level of generalizations (the level of the plot);

3) $W\downarrow$ — the low level of generalization (the level of the hero (heroes) of the plot).

The high level of generalization requires application of meta-mathematics methods, in particular, the categories and functors theory, the average level requires the presentation of knowledge in the form of a semantic-ontological network, and the low level requires the generalization of a model that can be built on the basis of logical methods of representing knowledge, namely, using the calculation of statements, predicates, the construction of formal theories and fuzzy logic.
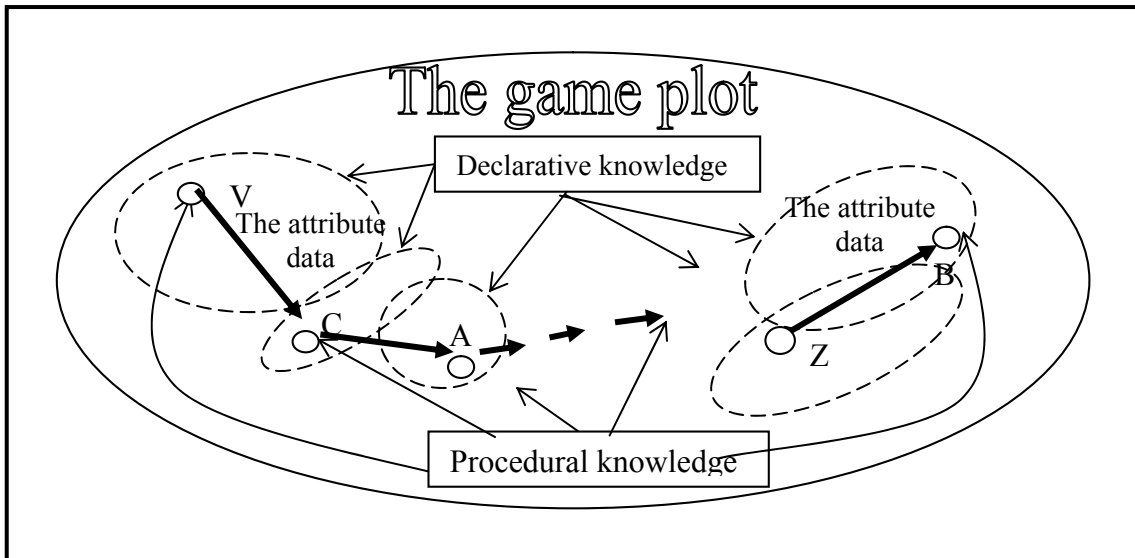
Fig. 1. A cognitive model of a high generalization level (a cognitive map)

Further to the basic procedures of a formalization technology, the general state of the world can be represented by a K category, consisting of subcategories $K_i, i = \overline{1,n}$, characterizing the events in individual cities (e.g. Fig. 1 considers the cities where Marco Polo travelled in the 13th century, namely: V — the city of Venice of the Roman Empire, C — the island of Crete of the Roman Empire, A — the city of Akko of the Mongol Empire, Z — the city of Zhangjie of the Mongol Empire; B — the city of Beijing of the Mongol Empire).

Let us consider the algorithm of semantic and ontological network construction. First, we shall consider the semantic network. By definition, a semantic network is a model of knowledge representing through a network of nodes connected through arcs, where nodes correspond to concepts or objects, and arcs — for relations between nodes. In the case of the Marco Polo route, the network nodes bear a semantic load, both qualitative and quantitative.

For example, the names of the cities and their characteristics (location, affiliation with the state, geographical coordinates, elevation of the location above the sea level, etc.).

The semantic networks can use the cause-and-effect, time and other types of relations. Formally, a semantic network is written by a suite as follows:

$$S(C) = \langle E, U \rangle,$$

where $\{V, C, A, \ldots, Z, B\} \in E,$ and U is the set of relations between the vertices of the semantic network.

The second step is to build an ontological model itself. The ontological models are important for cognitive modelling [14, 15] as they specify the terminology and terms interrelation. It should be noted that the game (quiz) plot contains the historical scenario with events of the 13th century.

Therefore, the content part of the study material cannot contain terms and definitions that appeared after that time.

Formally, the ontological model is written by a suite as follows:

$$M(O) = \langle T, A, D, P \rangle,$$

where T is the final set of terms describing the subject domain; A is the alphabet of relations existing between the ontology terms; D is the final set of terms interpretations; P is the final set of logical conclusion axioms.

The third step is to put the semantic network in line with the ontological models:

$$G \subseteq S(C) \times M(O),$$

this results in a variety of pairs that increase the semantic loading of the knowledge representation model and improve knowledge reliability. Thus, we can say that we obtain a new knowledge representation model the form of a semantic and ontological network:

$$M(CO) = \langle S(C), M(O) \rangle.$$

The illustration of the route of Marco Polo, which is built on the basis of the semantic and ontological network is shown in Fig. 2.

Fig. 2. The illustration of the route of Marco Polo, which is built on the basis
of the semantic and ontological network

The models that can be based on the logical methods of representing knowledge, namely, using the calculation of statements, predicates, the construction of formal theories and fuzzy logic can be allocated to the low generalization level.

The other approach to the application of the web-oriented technologies [16, 17] in interactive training methods is the use of an experimental method of independent game learning, involving the independent study of any content material and gaining the relevant knowledge, skills and abilities.

To evaluate the possibility of using the experimental method of self-study while playing, the students of the second year of the Department of Land Administration and Geoinformation Systems of O.M. Beketov National University of Urban Economy in Kharkiv were invited to participate in a pedagogical experiment in the autumn semester of the academic year 2018/2019, which was implemented under the course «Mathematical Processing of Geodetic Measurements». The game legend called «Snow Leopard» was the basis of the pedagogical experiment (Fig. 3).

Fig. 3. The pedagogical experiment demonstration screenshot in the original website language

The main purpose of the pedagogical experiment is to evaluate the possibility of students to study the training material and consolidate it solving practical problems independently, outside the curriculum, before the onset of a new semester.

The basis of the experiment participants' interface was the route of students' ascend to the top of knowledge (according to Everest legend). The entire route is divided into two types of stops.

The first type of stop corresponds to the study of theoretical material using manuals [18, 19]. During the study of the theoretical material, the students went to the second type of stops, but obtained the individual tasks from the manual [20], the solution of which confirmed the absorption of the knowledge. The experiment managers evaluated the individual tasks solutions and executed the grading. Thus, students advanced on the mountain path by studying the theoretical material and solidifying it with the solution of practical problems.

The educational research has an important motivational component through the game and competitive form of the experiment. The student receives scores for the successful study of the theoretical material and the implementation of practical tasks. There

are also bonus points from the teacher, given to the experiment participants for achievements during the experiment. For example, good task design, early execution, etc. Participants of the experiment, which according to the results of the training will receive positive marks, issue the diplomas of the participants of the pedagogical experiment.

The examination of the works after the semester termination showed that each student coped with the task one way or another. The analysis of 33 students, showed that the introduction of the experimental method of self-study while playing increased absolute success by 6,7 % and high-quality success — by 11,5 %, which suggests the expediency of this method.

Conclusions

The work studies the cognitive modelling in interactive training methods using web technologies. The use of the web technologies in educational systems for the new approach to the game study of educational material, involving the independent study of any content material and the gaining the relevant knowledge, skills and abilities was proposed. The peculiarities of the game training process using the proposed approaches, available for application at general secondary education institutions and universities at independent or remote self-education have been shown.

Therefore, the methods of teaching and management of learning processes need further development and improvement through the systems for the intellectual support of these processes based on the existing infrastructure of educational networks, using modern information systems and technologies.

Prospects for using research results. The main provisions and results of the work shall be used in educational systems at independent or distance learning.

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