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Control of Knowledge of Programming in the Digital Educational Resources on the Basis of Expert Systems Theory

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Abstract: Monitoring and evaluation of student's knowledge is one of the main issues of organization of the educational process. Since, the creation of expert systems associated with the identification of declarative knowledge (facts and ideas), structural knowledge (knowledge about the mutual relations between the concepts and memory) and procedural knowledge (how to apply the previous), the expert system can also work as a learning tools. Digital educational resources have been designed to meet the educational requirements for the drawing up of control-measuring materials. This study discusses the issues of organization of the control of knowledge on programming in the digital educational resources that have been implemented on the basis of expert systems theory. This study also explains that the holding of the control of knowledge on programming using digital educational resources as teaching tools helps to logical and critical thinking, imagination and self-training.

INTRODUCTION

In modern conditions of e-learning (learning with the use of information-communication technologies) research of traditional means and methods of training organizations tend intellectualization the process control knowledge. Numerous studies by Rodrigues and others show a professional interest of scientists in the application of expert system as a tool to assist students in improving problem-solving abilities.

It should be noted that the computer including programming and knowledge representation as a matter of scientific thinking arises in connection with the method of storage and processing. Programming a subject area of informatics requires formalization and modeling of

knowledge. It is known that the main purpose of science is the selection of the submission of specific and generalized knowledge, information and facts to accumulate and meaningful information processing in a computer. Identification of learning and developing skills in the learning of programming level must be reduced to the definition of the mathematical model, algorithm development, programming, debugging and resolving problems[1]. To implement the control of knowledge in the development of the algorithm and the program code on the basics of programming is the most effective utilization of IT technologies for education in particular as digital educational resources[2]. Interactive and multimedia digital educational resources are one of the quality parameters of modern electronic didactics. Multimedia and visual presentation of the material used in the digital educational resources and the relationship of the various components of the course, the complexity and interactivity allow deeper master training, enhance the ability of using modern computer technology[2].

Currently, control of programming knowledge is carried out by testing software developed by students. Since, the organization of knowledge control procedures on programming is reduced only to check the knowledge and final results of educational activity, the test materials to determine the quality of software products developed by students must be complete, valid, sufficient[3]. To do this, control of knowledge proposed to take place in the programming process[4]. Control of knowledge in programming enables you to implement training and Didactic knowledge control functions. However, scientifically investigated enough[5].

Most of the published studies on the control of knowledge, based on the theory of expert systems. The use of expert systems as a tool of knowledge studied by scientists[4, 6]. In this study, the researchers describe the use and development tool of expert system for non-specialists in the field of programming in the study «An expert system manipulating knowledge to help human learners into virtual environment» Lopez-Cuadrado presented the expertise to manipulate the system to help students in a virtual environment. To determine the level of knowledge and skills we use the theory of expert systems as a tool for learning. For multimedia and visual presentation of the studied academic material we have developed digital educational resources on the basis of the theory of expert systems which allow not only colorful and interesting to present the material under study but also an effective way to implement the control of knowledge of students.

In developed digital educational resources along with multimedia, interactive animation content function block assignments and a testing unit.

Using the designers to create e-content, allows you to create a variety of electronic didactic collections with comfortable LMS. We have developed, interactive multimedia digital educational resources include three components:

- The theoretical part, fully matching the content of the discipline
- Practical part (interactive tasks, interactive models, interactive puzzles, crossword puzzles, etc.)
- Coaching unit (test items)

The digital educational resources implemented alternative forms of presentation, exercises, knowledge control which cover the learning activities that guide students to use knowledge and skills acquired as part of this discipline. The developed digital educational resources include interactive practical exercises that allow students to consolidate learning material to develop the skills obtained. Checking the achievements of students by means of various types of tests (Table 1).

Overview and works analysis: In terms of smart-educational role of the tutor is automated through intellectualization of training activities in the digital resources. These research results are described in works by Yusupov[5] which are devoted to the adaptive neural network technology training and control of knowledge of students on the course the basics of programming. As a knowledge representation model, it offers a semantic network built on the basis of a logical graph structure of the discipline. In the works provides an assessment of the complexity of the semantic network in the training system which is represented as a directed graph whose vertices correspond to the concepts of the subject area being studied discipline and arc set ratio “defined concept-defining concept “between them. Shihnabieva uses adaptive semantic models for representation and control of knowledge in education systems. Srecko etc., studied using intellectual analyze student data management solution system for higher education institutions.

Control of knowledge in programming: Methodology for teaching programming-can be defined as the science of programming as an academic subject and the laws of the learning process of students the programming of different groups and levels of training[7]. In his research and findings, we rely on new

Table 1: Examples of tasks in the test form affecting the programming area

The forms of test tasks	Examples of Programming tests
I. The tasks of the "choice of the correct answer." It includes the following options: A simple choice (one correct answer out of 4-5) Difficult choice (two or more correct answers from 4-5) A simple choice in the set (one correct answer of 6-15) Selection of a plurality of complex (two or more correct answers of 6-15) Selection of the most accurate answer Finish the sentence.	This Programs {Translators } Implementers 1) Translators 4) handles 2) implementers 5) browsers 3) calculators 6) processors
II. Tasks such as "addition - set from the keyboard." It includes the following options: The insertion of one or a number of words Inserting a group of words or numbers (no more than three words) A set of formulas and other characters	Performingany C++program STARTS WITH Features
III. Tasks type of "The establishment of compliance" It includes the following options: Correspondence between concepts and definitions Sorting and classification on multiple grounds	Type of data DIAPASON 1) real A) 2.9E-39 .. 1.7E+38 2) single B) 1.5E -45.. 3.4E+38 3) double C) 5.0E-324 .. 1.7E+308 4) extended D) 3.04E-4932 .. 1.1E+4932 5) comp E) E-263 .. E263-1 F) 0… 645 G) -128…128 K) -256…256
IV. Tasks such as "sequencing" and "in the process of understanding, logical-semantic relations". It includes the following options: Establishment of a chronological sequence of events Establish a logical (semantic) relationships between objects	PROGRAM when you enter one of the symbols: E or Y is displayed on the N word "Yes" and when you enter N or N - word "no" coherent program writing: ,] ch : Char ; ,] 'n','N' : WriteLn ('Нет'); ,] end. ,] begin ,] ReadLn (ch) ; ,] case ch of ,] 'y','Y' : WriteLn ('Да') ,] var ,] end

methods in teaching programming, pedagogy, psychology, mathematics and partially generalized practical experience programming teachers. Different teaching methods and their effectiveness is considered in studies[8] which allowed us to use them in digital educational resources. Programming training considered by Worshi which revealed problems of teaching programming, research methods in teaching programming, programming opredelnie level. In a study Wong revealed how a computer game can be used as a tool for teaching and learning of object-oriented programming in high school.

The research by Alonso *et al*.[2] is a representation of the researchers practical experience of teaching programming and the possibility of using design patterns in teaching programming. In accordance with the performed analysis procedures and techniques of teaching programming. An important task of learning object-oriented programming in high schools is to prepare students to continue their education in the work[9]. The education they desire for continuous replenishment of their knowledge in the chosen direction through self-education as is the continuous development and improvement of object-oriented languages, creating new, more efficient programming languages and technologies. Due to these developed digital educational resources on the basis of the theory of expert systems will enable students: improving programming languages, analyze their knowledge with the use of effective forms of control.

Digital education resource refers to the method of monitoring the educational progress of students through assessing the academic skills directly. Among the basic academic skills that can be measured directly by Digital Education Resource are reading, spelling, expressing writing and mathematical concepts. Sometimes Digital Education Resource is used in monitoring the skills of readiness in a student by providing the student with timed samples, briefs and probes with academic materials drawn from the curriculum of the school[10]. Besides, Digital Education Resource can be used to measure the individual mastery and acquisition of academic skills to ascertain the

ability of the child in comprehending the academic skills[11]. This method of assessment helps the instructor determine how prepared the student is to progress to the next level of learning with the school curriculum[7]. Digital Education Resource helps instructors to conduct a close monitor on the rate of progress of the students on academic skills through a simple, reliable and statistical approach. They have proved to be a very powerful tool of measuring the academic progress of students by assessing the level of mastery of the basic skills from the student's curriculum. This makes it an effective tool in assessing the long term and short term academic progress registered by a student[12].

The Digital Education Resource are usually administered using standardized conditions so as to ensure that an instructor gives consistent directions when a particular Digital Education Resource probe is under assessment.

The process of conducting Digital Education Resource is usually timed and is meant to last for at least one or a maximum of five minutes[13]. However, the exact duration of the Digital Education Resource will depend on the skill that the instructor wants to measure[14]. The score or performance of the child is gauged by the fluency, accuracy of performing the task or the speed with which the student undertakes the task. The ease with which Digital Education Resource can be administered makes them reliable for weekly assessment. The weekly results are then charted and this gives the academic progress recorded by the student towards achieving the target of the instructor[15].

Digital Education Resource is helpful for parents because the test is conducted frequently thus giving the weekly report on the progress of the student[16]. As such, it is an accurate tool of ascertaining the rate of progress for a particular student in a particular year. It is also used to ascertain how successful the instructions the student was given worked in line with the curriculum of the student. This gives the instructor an opportunity to change the method of teaching if the student is not performing as per the targets of the instructor[17]. Digital Education Resource also outline the amount of instruction that a student would need, so as to achieve academic skills and goals as set by the instructor[8].

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MATERIALS AND METHODS

Information content of digital educational resources: In the development of digital educational resources for the control of knowledge of students on the basis of expert systems as a criterion of effectiveness, we have identified the depth of the development of the subject the student, completeness and strength of the assimilation of knowledge and level of study of theoretical material and practical skills. To achieve the goal of training a computerized learning system taken into account the properties of the trainee in the parameters of the model student[18]. We used to build the field of knowledge-based semantic networks for the implementation of digital educational resources control programming knowledge-based theory of expert systems[19]. The advantage of semantic networks as a model of knowledge representation and direct the process of learning is a clear description of the subject area, flexibility, adaptability to learner goals[14]. However, the visibility of a property with the increasing size and complexity of communications knowledge domain is lost. Furthermore, considerable difficulties arise various kinds of processing exceptions[20]. To overcome these problems using hierarchical networks describe the method (emphasis on their local subnet, located on different levels) (Fig. 1).

So, at the top level we have a concept of class, then placed below the level of generalization of the concept and at the lowest level-specific (basic) concepts. The number of levels of the hierarchical model domain knowledge depends on the degree of detail concepts. The concepts of the subject area of generic interconnected relationships[1]. This approach to the organization of knowledge in the development of intelligent tutoring systems science can dramatically shorten the learning curve[21]. Model in a hierarchical semantic network as the logical structure of the studied subject area also shows the sequence of presentation of educational material (Fig. 1 and 2).

Fig. 1: Concept maps with various computer resources[8]

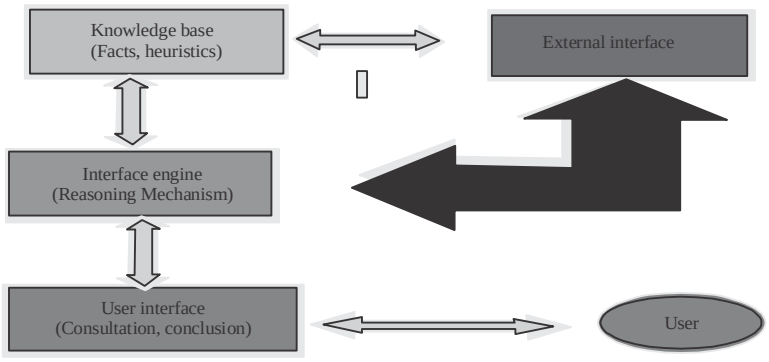

Fig. 2: The various interfaces used in the network model[2]

Information content of digital educational resources, the control of knowledge of students on the programming on the basis of expert systems theory is implemented a sequence of the following steps:

- For the considered discipline stands out the list of topics on which you need to spend control of knowledge
- The model of semantic network for each theme with the above mentioned requirements
- The selected concepts are presented as facts
- On the basis of these facts are derived hypothesis
- Component correspondence table "hypothesis-the events"
- Determine the probability of confirmation and refutation of hypotheses that are expertise and are recorded as rules in the knowledge base

As a result, it highlighted the basics techniques for the development of semantic networks of digital educational content-filling learning control of knowledge resources on the basis of expert systems theory:

- Developed a model of semantic networks should adequately reflect the knowledge in the study
- Domain in accordance with the requirements of state educational standards and job training programs of universities

The main stages of the semantic web development model in the development of tasks for the control of knowledge is necessary to divide the contents of the discipline into separate relatively autonomous threads, implement selection of important concepts of this topic, highlight the general and specific properties and attributes of concepts and objects subject area, the definition of links and ideas between these areas[22].

It shall be the structuring of knowledge and forms of differentiation of tasks for various forms of training sessions on programming (tasks in the test form, practical and logical tasks, checklists).

The main sources of information for the educational content of semantic networks are state educational standards and model curricula, learning and teaching methodical literature. Note that when building the semantic web content assignments for the control of knowledge should adhere to the following rules (Fig. 2):

- The semantic content of the network can have only one root node (the proper name of a structured themes)
- Group of vertices on the same level as is done by some- or ground (common base)
- Connection (orientation ribs) performed only in the direction from the root to the top (bottom-up)

Milestones with knowledge are: extraction of knowledge from various sources (including the formalization of high-quality knowledge and integration of knowledge); acquisition of knowledge of professionals (including the organization of work with experts, evaluation and formalization and coordination of knowledge); knowledge representation (here we use the knowledge model representation of the system and knowledge base); Knowledge manipulation (including recruiting, classification, generalization of knowledge and output of knowledge); arguments and explanations using the knowledge[2, 23] (Fig. 3).

The system test tasks formulated on the basis of the method thesaurus system concepts of the course[7]. Thesaurus method allows the so-called primary classification and structuring, i.e., separation of a certain set of objects (set) in the classes. As noted earlier (Fig. 4)

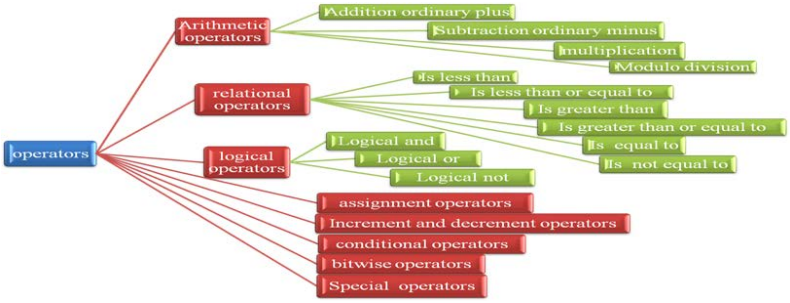

Fig. 3: Detail of a semantic network, "Classification of the operators"

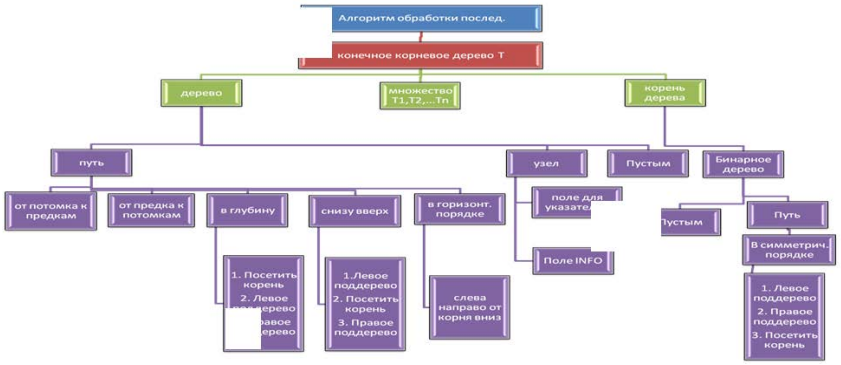

Fig. 4: Detail of a semantic network "sequence processing algorithm"

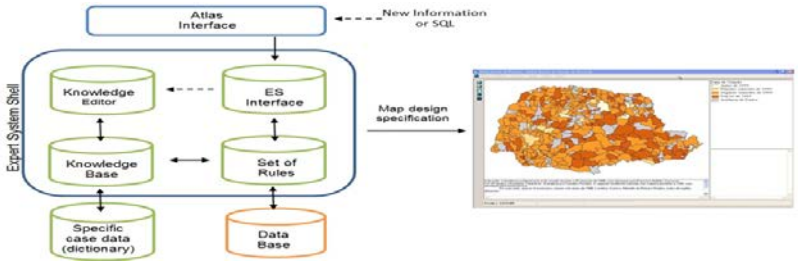

Fig. 5: Concept relationship between the electronic teachings

systematization and structuring of concepts is considered from the perspective of semantic modeling. Formal requirements to be considered when building thesaurus programming system of concepts highlighted in the work by Trevia. consistency hierarchical-each concept has its own level as a key element to a higher level axiomatic (in the thesaurus as a system of knowledge includes concepts that cannot be defined in the system boundaries, their definitions are accepted as axioms The system of concepts (tezaurus.) Should consist of two types of elements-concepts and relationships between them.

Based on the consideration of substantive requirements that apply to the thesaurus fragments were isolated (Fig. 5):

- Completeness or adequacy of the domain, i.e., thesaurus must contain all the basic
- Programming concepts for the possibility of constructing a system of concepts and themes of the divisions
- Visibility-view thesaurus based training and the level of academic hours training of trainees
- Connection-that is the concept should be linked
- Expandability-the ability to add new elements to the thesaurus for changes or ons domain

When forming the thesaurus "tree" objects are the concepts and structure of the tree shows how they. They were linked. Consider a common position during the formation of the thesaurus "tree":

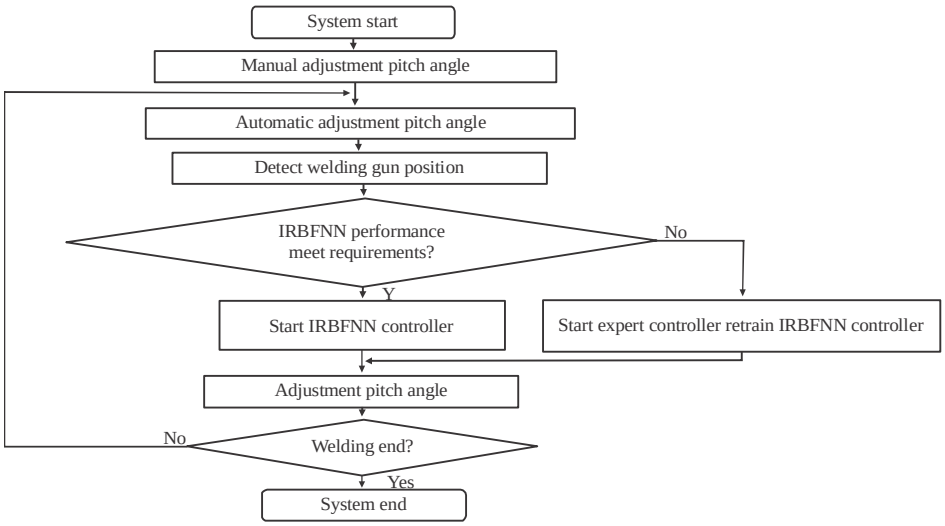

Fig. 6: Links between the defining concepts of the logical connection between the domain

Table 2: Assimilation of notions

Notion	+	-	Total occurring concepts in interactive tasks	No. of interactive tasks
Statement	3	1	3	1, 3, 4, 5,
Defining a class	1	4	4	7, 8, 9, 10, 11

- Each subject area in this case, the programming has handles
- Descriptors is fundamental concepts, they are the synthesis of many other concepts
- Definitions-objects thesaurus “tree”, they are linked. Some concepts include myself others
- Links between the defining concepts of the logical connection between the domain objects

In scheme 3 for instance, the model illustrates the programming paradigm. Descriptor 1 (statement) is the concept of the first level[13]. This includes the concept of 1 (Decision making) which is a second-level concept. The concept 1 includes the notion 2 (Simple if statement) which is the concept of the third level. This concept includes the notion of 3 (The if ... else statement) is the notion of the fourth level, containing, respectively, the concept of 4 (The switch statement) and the concept of 5 (Nesting of if ... else statement) belonging to the fifth level. In turn, the concept of 1 (Decision making) associated with the handle 2 (Defining a class). It turns out for the assimilation of-or the concept of the handle 2 is necessary to assimilate all the concepts of chain descriptor 1[24].

Realization of the thesaurus “tree” to analyze the responses trainee carried out on the condition that the student has fulfilled interactive tasks and the results were stored in a database. On the basis of right and wrong assignments, you can determine which concepts he could be identified and which are not. Next, a table of 2 for the definition of the concepts of assimilation. As it is also possible to determine the “strength” of assimilation. This thesaurus interactive job processing method can be represented as follows (Fig. 6):

// Description
The object type = (the concept)
// Object data
level concepts
\concepts Index // serial number in the thesaurus “tree”
Communication with other concepts
identified
The number of interactive activities with the positive response
The number of interactive activities with a negative response

This view of the data used for analysis and synthesis, moving in the direction of links from one concept to another is about “a picture of Knowledge” student. Here, you can view a sequence of strings learned and undigested knowledge[14]. The data thus generated give us inherent data with expert system. Next, after the analysis carried out interactive tasks issued a recommendation that is taking into account the results of this interactive tasks (input data described in a thesaurus “tree” and tables) to select a row of the array (the output). The string is the recommendation of the student and the teacher at the same time a clue. Moreover, the recommendations as much as the student gave wrong answers. Therefore, when compiling the thesaurus “tree”, the following steps have been identified (Table 2):

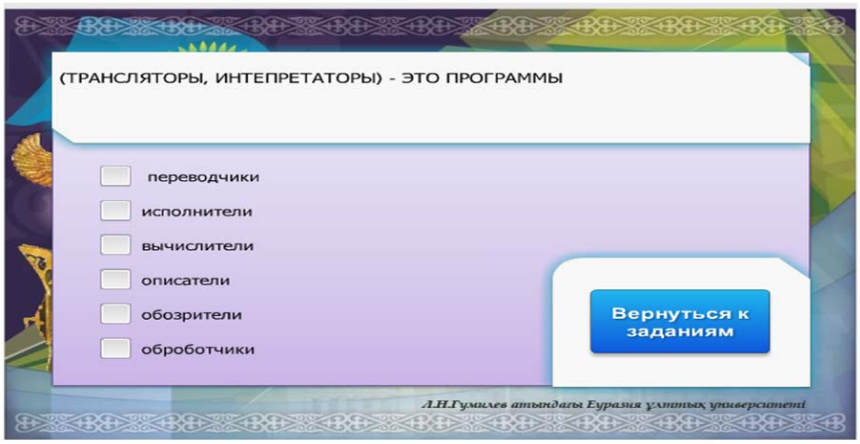

Fig. 7: Tasks such as “choose the correct answer”

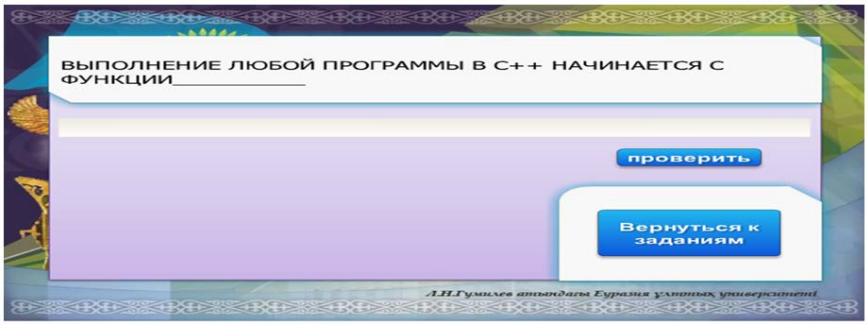

Fig. 8: Tasks such as :addition-set with keyboard”

- Analysis of the literature
- Identification based on analysis of the basic concepts of programming, taking into account the educational standard
- Dividing concepts into groups (by section and topic)
- Allocation of the connections between them

The digital educational resources are used:

- The tasks of the “choice of the correct answer”. It includes the following options
- A simple choice (one correct answer out of 4-5)
- Difficult choice (two or more correct answers from 4-5)
- A simple choice in the set (one correct answer of 6-15)
- Selection of a plurality of complex (two or more correct answers of 6-15)
- Selection of the most accurate answer
- Finish the sentence (Fig. 6)

Tasks such as “addition-set from the keyboard”. It includes the following options:

- The insertion of one or a number of words
- Inserting a group of words or numbers (no more than three words)
- A set of formulas and other signs (Fig. 7)

“Establishment of conformity” type jobs. It includes the following options:

- Correspondence between concepts and definitions
- Sorting and classification on multiple grounds (Fig. 8)

Tasks such as “sequencing” and “in the process of understanding, logical-semantic relations” (Fig. 9 and 10). It includes the following options:

- Establishment of a chronological sequence of events
- Establish a logical (semantic) relationships between objects

With the passage of a certain type of interactive job trainee a grade and are given the opportunity to repeat the theoretical material if necessary. The developed digital

Fig. 9: Tasks such a “the establishment of compliance”

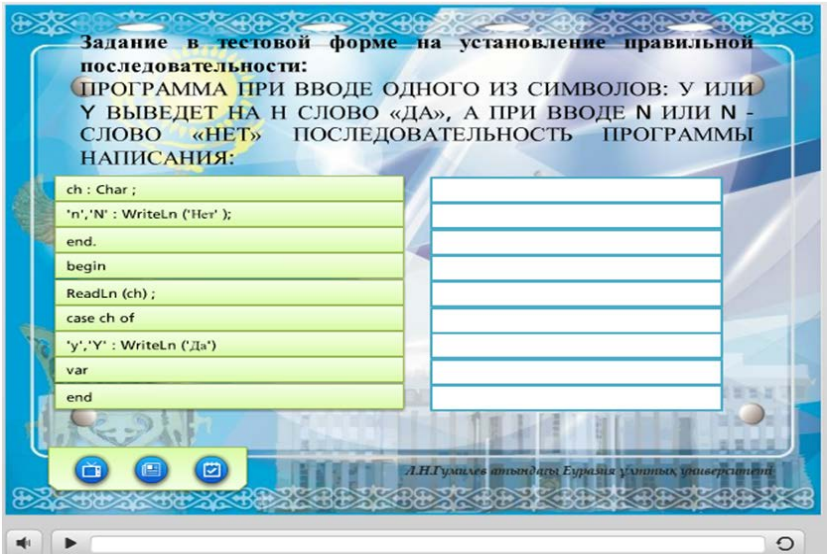

Fig. 10: Tasks such as “sequencing”

educational resources on the basis of expert systems theory to help students focus not only with consistency but also richness of the studied academic material[11].

RESULTS AND DISCUSSION

To solve the problem of determining the efficiency of the use of digital educational resources on the basis of the theory of expert systems have been implemented following experimental steps: search, states forming. In the search stage, the following activities:

- The collection and analysis of publications on methods of control of knowledge of students
- A comparative analysis of existing monitoring programs were identified shortcomings of their use during the control of knowledge
- Consider standards for the quality of the education system
- Introduction of the model curricula, state educational standards of specialties
- Studied manuals, scientific and technical, methodological literature for the control of student’s knowledge
- Student training program in the field of computer science of Kazakhstan and foreign universities as well as the means of information of the learning process system of computer courses

This study revealed that the use of digital educational resources on the basis of expert systems theory is effective because unlike many other monitoring programs allows the analysis of errors made by students and make recommendations to address them[7]. On ascertaining stage of the experiment were used research methods like

surveys, interviews with teachers and students. On the basis of the analysis of the survey results of teachers, specialists substantive content of digital educational resources on the basis of expert systems theory, noted 45% of respondents as a means to control the knowledge of using high importance by 70% of respondents[25].

In the formative stage in the final control was carried out during a training experiment. In the experiment, 115 students participated. At the end of the experimental group were compared with the control group. For each group of randomly selected 50 works. Processing results of the experiment was conducted using Pearson statistical test (chi-square), empirical value is calculated as follows:

$$X^2_{эMn} = N.M.\sum_{i=1}^{L}\frac{\left(\frac{n_i}{N}-\frac{m_i}{M}\right)^2}{n_i+m_i} \quad (1)$$

The results of measurements of levels of assimilation of experimental and control groups are shown in Fig. 34. Teaching experiment was conducted in the form of boundary control. Processing results of the experiment was conducted using Pearson statistical test (Chi-square), empirical value which is calculated by equation:

$$X^2_{эMn} = N.M.\sum_{i=1}^{L}\frac{\left(\frac{n_i}{N}-\frac{m_i}{M}\right)^2}{n_i+m_i} \quad (2)$$

The parameters of the experimental group (T = 50) after the end of the experiment: $n_1 = 4$, $n_2 = 9$, $n_3 = 22$, $n_4 = 15$, control group (M = 50): $m_1 = 14$, $m_2 = 18$, $m_3 = 10$, $m_4 = 8$. Substituting (Equation 1), we obtain:

$$\chi^2_{эмп} = 50\cdot 50\cdot\left[\begin{array}{l}\left(\frac{4}{50}-\frac{14}{50}\right)^2/(4+14)+\left(\frac{9}{50}-\frac{18}{50}\right)^2/(9+18)+\\ +\left(\frac{22}{50}-\frac{10}{50}\right)^2/(22+10)+\left(\frac{15}{50}-\frac{8}{50}\right)^2/(15+8)\end{array}\right]=14,5 \quad (3)$$

In this case L = 4. Consequently, L-1 = 3 (tabulated value $\chi^2_{0.05=7.82}$. Since, $\chi^2_{эмп} = 14,5 > 7,82 = \chi^2_{0.05}$, the results of the statistical data demonstrates the effectiveness of the use of digital educational resources, control of knowledge of students on the programming on the basis of expert systems theory[27]. As a result of the study the following results were obtained: Identified form of knowledge control (to establish the chronological sequence of events establish a logical (semantic) relationships between objects) used in digital educational resources on the basis of expert systems theory. Determine the substantive content of digital educational resources on the basis of expert systems theory.

Enter and used in the educational process as well as proof of the effectiveness of the use of digital educational resources, the control of knowledge of students on the programming based on the theory of expert systems in the learning process.

CONCLUSION

The results of the data analysis and conducted scientific-methodical and experimental sources has allowed us to identify the algorithm of forming control programming knowledge in digital educational resources on the basis of expert systems theory, the use of which has increased the efficiency of learning, mastering the knowledge and the issuance of recommendations for further study of educational material[28].

Considered our interactive buildings were constructed on the basis of the semantic model and approach tezaursnogo construction of basic concepts in the domain. To control the knowledge of digital educational resources on the basis of expert systems theory used in topical and common forms of control used in higher education. For example, to determine the correct sequence of operations for programming, selecting one or more correct answers, setting the correct match.

Prospects for further study of the process control programming knowledge in digital educational resources on the basis of expert systems theory is the systematization of the evaluation criteria of knowledge on modern software technology with the separation of the invariant and variable components of control-measuring materials as well as their computer implementation[29].

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