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Application of System Analysis Method in the Program of Web-Oriented Education

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Abstract. The article deals with the problems of the mathematical construct of the process of acquiring knowledge and the trajectory of learning in web-oriented education. Private and general categories are expressed, the decomposition method in relation to the formalization of the process of teaching the web technologies or through web systems is applied, the importance of the need to implement expert subsystems of activity analysis in a browser window during testing or interactive interaction is expressed and substantiated. The process of the activation formula for the acquisition of knowledge is expressed, the essential role of feedback and the dialogue system for supporting the choice of behaviour strategy in the interactive pool of web-based education is indicated on the example of a game developed for students of a higher educational institution.

INTRODUCTION

The implementation of modern means of ensuring the continuous educational process is associated with a number of systemic problems related to the process of implementation of didactic and heuristic processes in the educational environment.

By a virtual educational environment for web-based learning, we mean a system that consists of basic elements and connections between them.

As the basis of the system, we consider the means of its implementation - the software component, in particular, the means of providing viewing of hypertext and multimedia information [1,2].

And if we consider the virtual environment as the basis of the educational environment, it becomes obvious that it differs from the real environment through a number of properties featured only to it [3].

These properties include:

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- uncertainty - the lack of opportunities to predict the stability of software on the part of the end user - the student;
- emergence;
- negentropy - it manifests itself quite often in expert and training systems in a virtualized environment

They do not allow to express the passing of cognitive tests despite attempts to universalize human-machine interaction, changes in structural and functional parts, and the integration of strong and weak artificial intelligence into interface elements.

In our opinion, this is determined by the compliance and simplicity of essential web-based learning systems, which, in fact, is confirmed by the rather weakly expressed antagonistic nature of the testing environments - the participants in the information exchange are not, antagonists (opponents) in the usual sense of the word, since the machine part of processing of the results of human activity towards the subject of study are always strictly determined, as well as the learning process and its results.

Problem Statement: Lack of a Mathematical Construct of the Knowledge Acquisition Process

Despite the different coefficient of specificity (k), the modern didactics of teaching the web disciplines in higher and secondary schools, in the classroom in specialized circles and laboratories is graded close to the normal distribution of the learning function (F (g * k)), where g is the activation function of the educational activity.

The aim of the study is to build models for the use of new constructs of educational activity in a web-based programming environment, represented by a layer of hypertext markup in the framework of HTML5 using the example of teaching technology based on the construct of the CSS Grid layout system [4,5].

First of all, a formal model of the process of obtaining and perceiving knowledge for the model, which can be used in the analysis of training systems within the framework of the “white box” concept shall be defined [6].

In this regard, the process of acquiring knowledge is considered through a formalized mathematical construct, which is used in general systems theory and systems analysis, and is well known as a mathematical finite set, which we denote as A, the elements of which are the product of the designated activation function (F (g * k)). It can be denoted both by a non-zero vector of a certain dimension, and by a unit vector, and, in the simplest case, by an array consisting of descriptors of a qualitative assessment according to the received cognitive skills from the side of the implementation object (studied in the process of independent assessment) in combination with a unit information exchange (lesson, lesson, module - M):

$$A = \bigcup F(g * k) , \quad (1)$$

Reasonable interpretation of the process of acquiring knowledge and competencies is rarely expressed in mathematical and formal models (see Formula 1), and statistical analysis of courses in a virtual environment is not often the subject of research in the scientific field. This is due to the fact that the trajectory of acquiring knowledge, due to the peculiarities of the interpretation of knowledge by the student and the teacher, by different types of equipment and the language of instruction, is different for everyone.

However, the existing priority of research on the use of modern means of analysis and synthesis of management and organizational decisions in the direction of studying the nature of personality does not change the main thing - the process of representing knowledge in a form ready for direct perception, but only affects the effectiveness of individual categories of students.

On the one hand, this makes it possible to come to faster and more easily readable indicators of performance in scalar terms, however, it does not affect the cybernetic and cyberphysical nature of the source of knowledge - i.e. on the virtual environment, mediated through a completely physical object of perception [7,8,9].

This is primarily due to the activation function F (g * k) - which undergoes linearization and loses the opportunity for trial and error on the part of the subject (which is typical for test dialogue control systems - the modus of modern distance learning systems).

Formalization of the Process of Obtaining Knowledge for the Construct of Learning Web Technology

In tasks devoted to teaching modern web technologies for designing the websites, the student is faced with a pronounced, but not always obvious, hierarchy of components and their parameters, a complex gradation of the activation training function, and the allocation of trees of systems and subsystems (see Fig. 1).

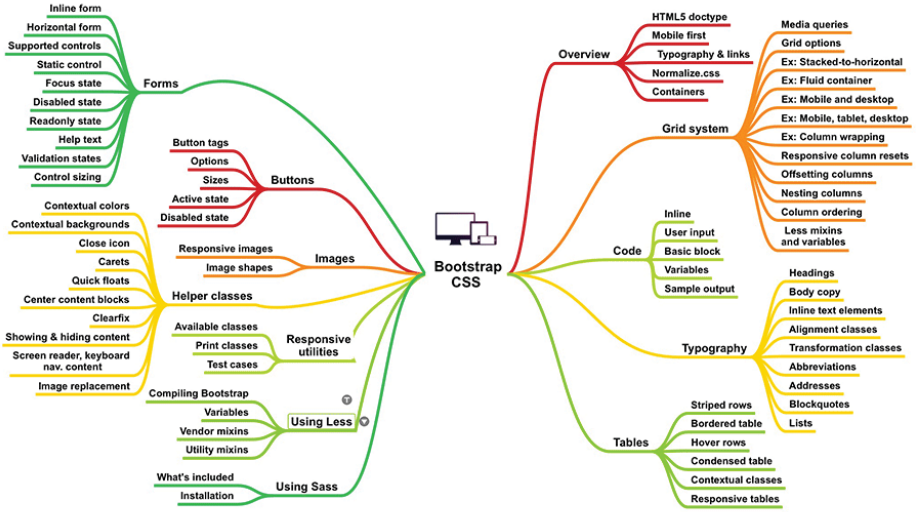

FIGURE 1. Decomposition of educational technology of web-based learning (on example of CSS Bootstrap).

In this connection, we would like to emphasize the importance of a taken into account policy of tracking of all user actions in the learning process using manipulators and other means of information input in order to generate adaptive feedback in the course of studying a specific web technology. In other words it is needed to be able to track the student behaviour strategy on an element of the active window in the viewport of a web page, taking into account the complexity of the organization (as shown in CSS Bootstrap) of the web markup (see Fig. 2).

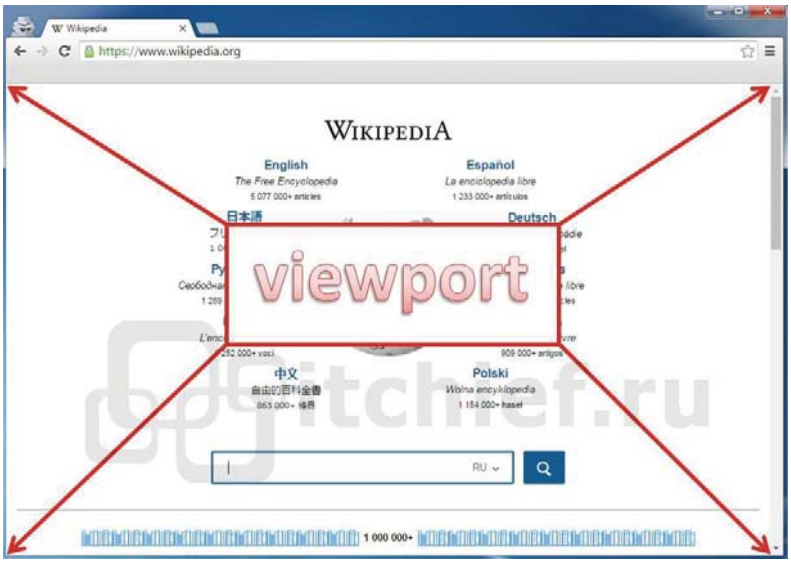

FIGURE 2. View area as an object of implementation of methods for assessment of student invariant behaviour in web-based learning.

We propose to implement an analytical form of an invariant strategy of behaviour (tracked activity of the mouse pointer) through the method of systems analysis, taking into account the generalization in the form of a formalization of the game with "nature", which eliminates the problem of an objective assessment of the learning process, we . This method is used in solving problems of game theory tied to the Hurwitz criteria, which makes the following requirements for the situation (in our case, the state of the web markup of the active window of the training system), in which a decision is made:

- nothing is known about the likelihood of the appearance of this or that "state of nature";
- it is necessary to reckon with the appearance of this or that state;
- only a small number of solutions are implemented;
- some risk is allowed.

If, according to the accepted criterion, it is recommended to use several strategies of behaviour on the part of the student, then the choice between them can be made according to an additional criterion, for example, the mean square deviations of winning outcomes can be compared [10].

In a game with nature, only one player (the decision-maker) consciously acts. "Nature" is the second player, but not the opponent of the first player, since she deliberately does not act against the first player, does not pursue specific goals in the game and is indifferent to the outcome of the game. Therefore, the term "nature" characterizes some kind of objective reality, which shall not be taken literally, although sometimes it really characterizes the state of nature.

The study of games with nature shall begin with the construction of a payment matrix, the constituents of which are formally selected in the calculation formula (2).

Let's consider an interactive task, which is currently being implemented by us in the process of creating an online project for an educational course "Mathematical Apparatus of Game Theory and Utility Theory" in the framework of HTML5 and CSS Grid in the form of a web portal [11].

The circle on the starting square is a marker that can move to other squares in the row. At each stage of the puzzle, the marker can be moved by the number of squares, indicated by an integer in the square that it currently occupies. The marker can move left or right along the row, but cannot move beyond either end. For example, the only valid first move is to move the marker three squares to the right, because there is no space to move three squares to the left. The object of the puzzle is to move the marker to 0 at the far end of the row. In this configuration, the puzzle can be solved by making the following set of moves (see Fig. 3).

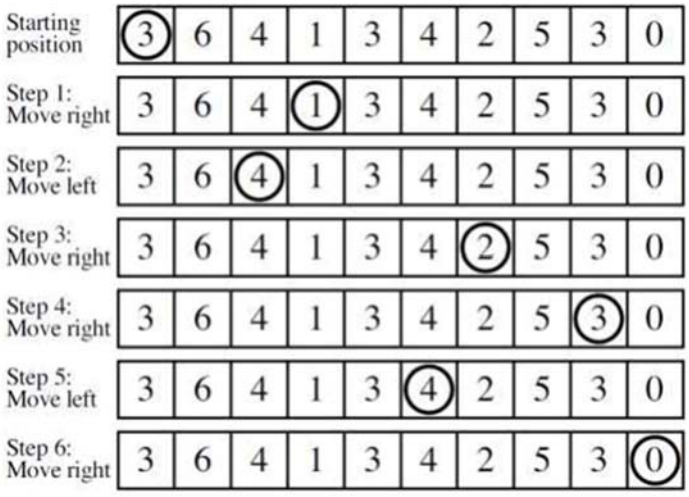

FIGURE 3. Developed outline for interactive play in a web-oriented training course.

It is supposed that one of the above criteria for the success of completing the task recommends the student to choose strategies (sets) A_1 or A_2 as if $l_p = l_0 = 0.5$ (equally possible). Such strategies can express, for example, two (or more) variants of playing an interactive game (collecting a puzzle in the active browser window):

```
Function SolvePuzzle(int start, int squares[]){
  if(squares[start]==0)
   return;
  else{
   cout<<squares[start]<<" ";
   if(squares[start]%2==0)
   return SolvePuzzle( start+squares[start],squares);
  else
   return SolvePuzzle( start-squares[start],squares);
  }
}
Function main(){
  int arraytest[] = { 3, 6, 4, 1, 3, 4, 2, 5, 3, 0 };
SolvePuzzle(arraytest[0],arraytest);
  return 0;
}
```

Then, having calculated the calculation of the standard deviations lI by writing in the code of the page of the JS script, it is possible to recommend to choose the strategy A2 from the two strategies. This strategy has lower value of the standard deviation (formula 2 represents the decomposition of a certain, pseudo-random payment matrix of values of the intensity of pressing on the element of the active window from 0 to nine):

$$s_1^2 = \frac{1}{4}(1^2 + 4^2 + 5^2 + 9^2) - \left(\frac{1+4+5+9}{4}\right)^2 = 8.1875$$
$$s_2^2 = \frac{1}{4}(3^2 + 3^2 + 5^2 + 8^2) - \left(\frac{3+3+5+8}{4}\right)^2 = 4.1875\ , \quad (2)$$
$$s_1 = \sqrt{8.1875} = 2.861 > s_2 = \sqrt{4.1875} = 2.046$$

An abundance of recommendations for choosing a criterion: if even a minimal risk is unacceptable in some situations, then Wald's criterion shall be applied; if a certain risk is quite acceptable, then the Savage criterion can be used.

It is possible to recommend student to apply alternately different criteria and different options for behaviour simultaneously in process of management.

After that, , it is necessary to select a certain final decision as the optimal one among several options selected in this way. This decision will be accepted by the system as the final one [12].

CONCLUSION

Thus, having considered a specific task and applying the methods of system analysis in the work, it was concluded that the most important thing in web-based learning (interactive learning using a browser) is the speed of the feedback from the system itself to the registered click - transition - repetition of a certain action. The use of native tools for assessment of the behavior and activity in the virtual space allows teaching strategic planning and thinking, enhancing the synergistic effect of using modern information and communication technologies, the capabilities of modern HTML-browsers, didactic techniques in interactive learning.

REFERENCES

1. E. I. Tikhomirova, *Assessment of the quality of e-teaching of the students of the college of the Ural State University of Economics to astronomy* (Izhevsk: Izhevsk State Technical University named after M.T. Kalashnikov, 2021), pp. 180-186.
2. S. V. Elovskaya and T. N. Chernyaeva, *Saratov University Periodical. New series. Educational acmeology series. Development psycology* **8(1) (**Saratov: Saratov State National Research University named after N.G. Chernishevskiy, 2019), pp. 83-87.
3. M. V. Minova, *Actual problems of the general theory of language, translation, intercultural communication and methods of foreign languages teaching* (Moscow: Moscow State Pedagogical University, 2018), pp. 53-56.
4. G. N. Gimatdinova, *Actual problems of teaching methods for computer science and mathematics in a modern school* (Moscow: Moscow State Pedagogical University, 2020), pp. 276-280.

5. A. R. Gaiduk et al., *South-West State University periodical* **23(5)** (Kursk: South-West State University, 2019), pp. 129-144.
6. M. S. Chistyakov, *Society, culture, human in digital age: Media-economics, media-politics, media-culture: collection of papers* edited by O. V. Arkhipkova and A.I. Klimina, Peresvet Scientific and Research Center association (Saint Petersburg: Foraprint, 2020), pp. 7-12.
7. A. V. Yumashev, T. N. Gorobets, O. I. Admakin, G. G. Kuzminov and I. V. Nefedova, Indian Journal of Science and Technology. **9(19)** 93911 (2016). doi: 10.17485/ijst/2016/v9i19/93911.
8. T. Zhang, Z. A. Shaikh, A. V. Yumashev and M. Chłąd, Applied Model of E-Learning in the Framework of Education for Sustainable Development. Sustainability. **12** 6420 (2020). doi: 10.3390/SU12166420.
9. E. Lavrov, N. Barchenko, N. Pasko and I. Borozenec, Eastern-European Journal of Enterprise Technologies. Ser. "Information technology" (Kharkov) **2(2)** 86 4-13 (2017). DOI: 10.15587/1729-4061.2017.97718.
10. E. A. Lavrov, P. I. Paderno, A. A. Volosiuk, N. B. Pasko, and V. I. Kyzenko, *In Proceedings of 2019 3rd International Conference on Control in Technical Systems, CTS 2019.* 144-147, 2019). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/CTS48763.2019.8973294.
11. D. I. Fakhertdinova, V. D. Munister, A. L. Zolkin, A. V. Knishov and M. Yu. Speranskiy, *Application of discrete mathematics, tetralogic and architecture of superscalar systems in measurement metrology of automated control systems IOP Conference Series Krasnoyarsk Science and Technology City Hall* (Krasnoyarsk, Russian Federation, 2021) **22009**. DOI: 10.1088/1742-6596/1889/2/022009.
12. A. L. Zolkin, A. N. Kornetov, V. A. Mironchuk, D. R. Giniyatullina and G. V. Ryabkova, Journal of Physics: Conference Series. Krasnoyarsk Science and Technology City Hall (Krasnoyarsk, Russian Federation) **12228** (2020). DOI: 10.1088/1742-6596/1691/1/012228.