



## **DEVELOPMENT OF MATHEMATICAL METHODS AND ALGORITHMS FOR CREATING AN INTELLECTUAL SYSTEM OF TARGETED ACCOMMODATION OF THE HIGHER EDUCATION OF THE INSTITUTIONS**

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<b>Article history:</b>	<b>Abstract:</b>
<b>Received:</b> July 8 <sup>th</sup> 2021 <b>Accepted:</b> August 10 <sup>th</sup> 2021 <b>Published:</b> September 22 <sup>th</sup> 2021	The development of computer technology provides great opportunities for modernizing the learning process. Many new concepts have entered modern practice: a single educational space, a single educational information environment, a virtual university, massive open online courses.
<b>Keywords:</b> Educational information environment, virtual university, unified educational space, unified educational information, massive open online courses.	

### **INTRODUCTION**

G.A. Ball, E.I. Mashbits, L.V. Zaitseva, L.P. Novitsky, L.A. Rastrigin, Erenshtein M.Kh., Yu.I. Lobanov A.D. Selivanov, V.V. Sedin, V.S. Tokareva, E.N. Pashkin, A.N. Pechnikov. The development of network technologies and the spread of the Internet have opened up new educational opportunities, creating the preconditions for the development of distance learning and intelligent learning systems. Massive open online courses and platforms have appeared and entered the practice of education, providing opportunities for the development of distance learning programs. One of the modern teaching aids using computer technologies are network banks of practical assignments, which are widely used in preparing schoolchildren for the Unified State Exam [1,4,6]. However, the solution of all tasks contained in such a bank requires a lot of time due to the large number of tasks of the same type. Currently, there are no algorithms for choosing the optimal set of tasks sufficient to achieve the set goals. The intensive development of electronic education (Electronic learning, E-learning) is due to its availability, flexibility, and a variety of tools used. Systems have been created that allow organizing and managing the e-learning process (Learning management systems, LMS - learning management systems).

Among such training systems, one can single out the CADIS system, which is currently used in some higher educational institutions, the AOSMIKRO system, which provides remote access, the ability to automatically analyze responses, and allows you to collect and process statistics of work in the system. Blackboard Learn information solutions, E-Learning Server 4G software products, which allow you to create training courses, tests, training modules, conduct

webinars and video conferencing, motivate students and track their activity are widely known [5,8].

Systems of this kind are independent of the specific subject learning environment. However, their versatility does not allow taking into account the individual characteristics of students and teachers when organizing classes. The development of training courses and the maintenance of the system are time consuming and costly. The effectiveness of the created courses depends on the capabilities of its developers and can only be investigated in the course of their functioning [6,7].

Another disadvantage of modern automated training systems is their focus on theoretical material, insufficient variety of didactic tools, the need to attract programmers to adapt and modify the system, which reduces its availability and economic feasibility.

Modern adaptive learning systems based on the use of intelligent technologies do not have these drawbacks, however, they have a limited scope of application, since the learning process in various subject areas is significantly different.

Currently, there are studies aimed at automating the organization and management of learning in the distance education system based on artificial intelligence technologies. To organize the work of training systems, methods of fuzzy logic and artificial neural networks, genetic algorithms are widely used. GA Samigulina has developed an expert system based on artificial immune systems, which makes it possible to assess the intellectual potential of a student and, on this basis, propose an individual training program. A.V. Zubov and T.S. Denisova proposed the development of an expert Internet system for distance learning, which has the ability to analyze its effectiveness on the basis



of tests developed by experts in this field. V.G. Nikitin and E.Yu. Berdnikovich developed multimedia courses with elements of adaptive testing.

The currently existing methods of automating the development and optimization of training courses in systems are not effective enough and are characterized by a narrow focus associated with a specific subject area. In view of the exceptional variety of practical situations that arise when solving the problem of creating and optimizing training courses, it is of paramount importance to study system relationships between parameters in order to build a model of a training system and synthesize information technologies that provide flexible adjustment for various subject areas.

Also, problematic issues arise in the development of algorithmic and software for the procedures for automating the creation and optimization of training courses within the framework of the system using computer technologies.

The relevance of the study is determined by the need to improve the efficiency of solving the problem of automating the development and optimization of training courses based on the introduction of new information technologies in various spheres of human life.

Currently, there is no unified theory of formalization of the educational process in many components. This study is aimed at solving the problem of formalizing the educational process in several components using algorithms and methods of artificial intelligence.

### **THE PURPOSE OF THE WORK AND THE MAIN TASKS**

The aim of the work is to develop and study a model of formalization of the educational process using methods and algorithms of artificial intelligence. To achieve this goal, it is necessary to solve the following tasks:

1. To develop a mathematical model of the educational system for the filling of the curriculum of higher educational institutions
2. Create algorithms for optimizing the structure of the theoretical and the content of the practical parts of the training course and artificial immune systems for their implementation.
3. To develop special software that implements the developed algorithms.

### **MATERIAL AND METHODS**

When solving the set tasks, the methods of discrete mathematics, neural networks, artificial immune system, methods of mathematical modeling and object-oriented programming were used.

**Scientific novelty.** The scientific novelty of the research is as follows:

1. To develop a mathematical model of the training system, which is distinguished by the formalization of the educational process and allows you to receive new training courses.
2. To develop algorithms for optimizing the structure of the theoretical and the content of the practical components of the training course, which are distinguished by the use of an artificial immune system and allow determining their best structure.
3. Creation of special software, characterized by combining the described methods into a single system, which made it possible to simplify the task of developing and optimizing training courses and assessing the test results of students.

### **DISCUSSION**

The work is theoretical and practical. In the work, a mathematical model of the training system has been created, a study of the model using the theory of algebras and binary relations has been carried out, and algorithms for optimizing its individual components have been developed.

The practical value of the work lies in the possibility of using the developed algorithms in software for a training system based on intelligent methods.

1. Research, including with the help of computer technology, information processes, information needs of collective and individual users.
13. Application of bionic principles, methods and models in information technology.

The development of hardware and software provides great opportunities for modernizing the learning process. There are more and more methodological concepts associated with the use of computer technologies in teaching: a unified educational space, a unified educational information environment, a virtual university, massive open online courses. The term Electronic learning (E-learning) integrates various concepts related to the use of information and communication technologies in education (such as computer learning, adaptive learning system, automated learning system, distance learning, interactive learning, online learning, etc.). NS.)

### **ACKNOWLEDGEMENT**

The intensive development of e-education is due to its availability, flexibility, and the variety of means used. Students are offered a large number of information resources: training and monitoring systems, video recordings, electronic libraries and much more. Electronic teaching aids are used not only in educational institutions, but also where special training is carried out: at large enterprises, military and civil organizations.



The first training systems appeared almost immediately after the spread of computers. The first training courses, created using computer technology, were characterized by a small number of methodological functions, delegating a leading role in the educational process to a teacher [8, 9].

At the next stage of development of computer learning systems, the search for researchers was directed to the creation of learning models based on cognitive psychology and programmed learning, created by B. Skinner and N. Crowder [1,8]

The creation of modern automated training systems (ATS) has become a major stage in the development of computer training tools. Significant successes have been achieved in the implementation of learning management algorithms, ensuring dialogue interaction in the educational process.

During this period, much attention is paid to finding ways to optimize the management of an automated training system in order to increase the efficiency of its work. These problems remain in the center of attention of the developers of computer training systems at the present time [1,5].

In the 70s, research was being conducted on the possibilities of using ideas and methods developed by that time in the field of artificial intelligence in the creation of automated training systems. Success has been achieved in the study of ways of representing knowledge in the subject area based on the ideas of artificial intelligence[7,8,9,10,11,12].

In the early 80s, computer learning systems based on artificial intelligence technologies appeared, containing, in addition to formalized subject knowledge, expert knowledge from the chosen field [1,12]. The use of intelligent technologies has changed the approach to the design of training systems: it became necessary to build a student model, a learning process, a subject area as the basis for building a learning process. The complexity of the development and implementation of such systems was until recently an obstacle in their distribution. The multimedia tools that appeared at the same time contributed to the spread of teaching systems that use sound files and graphics in teaching[9,10,11,12].

Development of tools for the development of learning systems continued, research was carried out on models of explanation, automatic formation of the subject area [4,6].

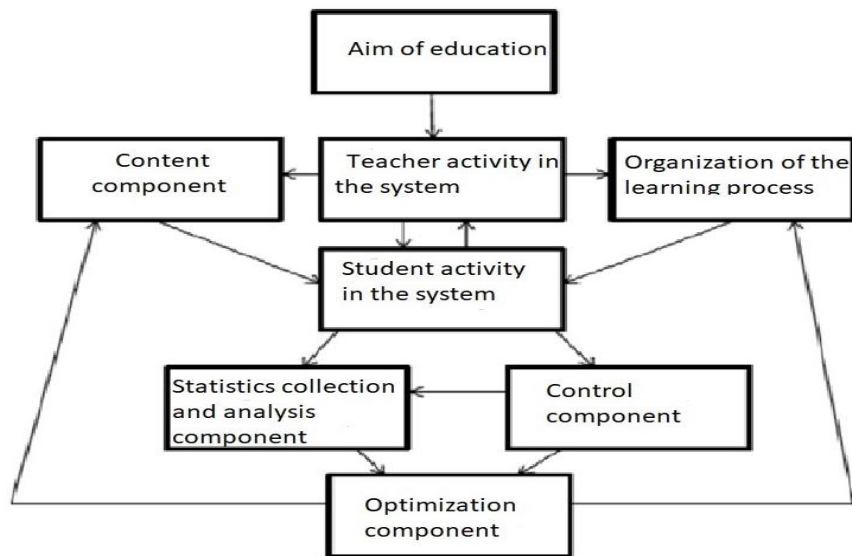


Fig1. Models of explanation

The expansion of the capabilities of personal computers and communication systems led to the emergence of multimedia, hypermedia and network learning technologies. [1,4,12]. By the mid-90s, there was a lag in the methodological support of teaching systems from the level of development of technical teaching aids. Most researchers point to this gap as a reason for the underutilization of computer learning opportunities [1,12].

Third generation standards (State Educational Standards - SES) have made significant changes in the process of developing curricula. Curriculum - a document that establishes the schedule of the educational process by weeks for the entire period of study, a list of academic disciplines (modules) and their distribution by semester, the complexity of disciplines (modules) in hours, the volume of classroom and



independent studies, the forms and timing of the organization of practices and the final state certification.

The SES requirements can be divided into formal and substantive. Formal requirements describe the requirements for volume (hours, weeks), for labor intensity (credits), for the structure of the curriculum (cycles, sections, compulsory disciplines). The substantive requirements of the standard describe the learning outcome: competencies, as well as knowledge, skills and ownership (KLV) that a graduate must have.

### RESULTS

The curriculum of the new generation, just like the curriculum of the previous generation, consists of disciplines or modules assigned to the semester and cycle (or section). But unlike the second generation standard, where the main task of developing the curriculum was to meet formal requirements, the main task when building a curriculum in accordance with the SES is the graduate's acquisition of the competencies defined in the standard and, possibly, expanded by the university (including the requirements of employers). In this regard, the task of forming a curriculum from competencies arises, and this significantly complicates the process of its development and verification. For each module, according to the authors of [6], input and output competencies are established, and the design of the student's learning path is based on the choice of those modules that form the competencies required by the graduate, and ordering them in accordance with the dependence of the modules on the input and output competencies.

The development of network technologies and the spread of the Internet have opened up new educational opportunities, creating the preconditions for the development of distance learning and intelligent learning systems. There are online libraries, Internet textbooks and testing tools. There are virtual training laboratories, resources that provide network access to unique equipment and various data processing tools, Internet portals that integrate network resources intended for e-learning. When solving the above problems, the following research methods were used:

1. Theoretical analysis, which was carried out with the aim of a comprehensive study of the state of the problem under consideration, identifying the degree of elaboration of the issue and determining the range of problems for their solution.
2. Statistical processing methods used for the primary and subsequent analysis of the data obtained, to identify the effectiveness of the experiment and for mathematically substantiated processing of the results.
3. Experimental work organized to verify the correctness of the developed principles and parameters, the effectiveness of the technology.

### CONCLUSION

A structural model of the training system has been developed. On the basis of the structural model, a mathematical model of the training system has been developed. The study of the model of the training system using the theory of algebras is carried out. Introduced operations of union, intersection of training courses, allowing you to get new courses on the basis of already.

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