Requirements for learning automated information system

O L Servetnik¹,³, A A Pletukhina¹, O V Velts¹, E N Novikova¹ and E N Tsyganko²

¹ Informatics Department, North Caucasus Federal University, Pushkin str., 1, Stavropol, 355017, Russia
² Department of foreign languages, Admiral F. F. Ushakov State Maritime University, Lenin str., 93, Novorossiysk, 353918, Russia
³ E-mail: oxana.servetnik@yandex.ru

Abstract. It includes: the authors analyze the requirements applicable to an intelligent learning automated information system to enhance the efficiency of educational process, as well as consider new artificial intelligence used in educational automated information systems. The authors also propose classification of the information technologies used in the educational process to enhance its effectiveness. The set of requirements for learning automated information systems and their implementation example proposed by the authors can be relevant and useful, both for the program designers of automated systems and for teachers using elements of distance learning at a university in the context of education digitalization.

1. Introduction
Reform of Russian education in the conditions of developing the information society initiated the development of new educational technologies. One of the priority directions for the development of education is the digitalization of educational process at the University. Its role is increasing in connection with Russia's entry into the world educational information space.

One of the least developed fields in using computer technology is creating and using educational informational system with elements of artificial intelligence. This would enhance the effectiveness of training students in various disciplines, and help teachers in their professional activities. In this regard, the current idea of educational development is to build and use the integrated universal education of the automated information system with elements of artificial intelligence. Such a system would expand the possibilities of individual approach to students.

Today the use of new information technologies in learning automated information systems (LAIS) and creation of intellectual LAIS lie at the core of IT-based education. Currently, education and self-study represent a rapidly growing area of artificial intelligence. This area of artificial intelligence includes models, methods and algorithms, focused on automatic accumulation of knowledge on the basis of data analysis and generalization [1].

Intelligent learning automated information systems are based on work in the field of artificial intelligence. Research in the field of artificial intelligence is focused on development and implementation of computer programs that can simulate or replicate those human activities that require thinking, some skill and experience.

The main purpose of developing and using of automated information systems at the University is improving the educational process, taking into account the student's identity, his degree of preparedness,
the stock of knowledge, as well as automation of teaching activity of teachers that can be achieved through the use of new information technologies.

Thus, the developing and using of automated information systems intellectual training is the foundation of digitalization of the education system that promotes the transition from an industrial to an information society.

2. Results and discussion

As the training of AIS for development and use in educational process of higher education there was designed a learning automated information system «UNIVERSITY» with the following elements of artificial intelligence: knowledge base, intelligent interface and conclusive program.

Intellectual automated information systems are especially effective in application with formidably formalized tasks, i.e. tasks, in which it is hard to identify all of its elements and to set the relationships between them [2].

Figure 1 shows the structure of the LAIS with the artificial intelligence, which has the following main components: a) user – a specialist in the subject area, for which the system is designed; b) knowledge engineer – the artificial intelligence expert, acting as an intermediate buffer between the specialists of the given subject area and the knowledge base; c) user interface – a set of programs that implement the user dialogue with LAIS at the stage of both information input and retrieval of results; d) knowledge base – the core of intelligent automated educational information system, which is a body of knowledge in the subject area saved on the storage media in the form understandable to user; e) solver – a program that simulates the reasoning of the user based on the knowledge available in the knowledge base; f) intellectual editor of the knowledge base – the program, offering to the knowledge engineer an ability to create a knowledge base in a dialogue mode, which includes a system of cascading menus, knowledge representation language template, tips and other service tools to facilitate the work with the base [2].

![Figure 1. Structure of LAIS with artificial intelligence.](image)

The knowledge base is a storage and repository of knowledge in a particular subject area resulting from the teachers’ performance. The knowledge base contains the information necessary for understanding, forming and solving educational problems. The concept of solution obtaining procedures is closely related to knowledge. In the knowledge processing systems such a procedure is called inferencing program (solver) [3].

The solver is the main functional component of intelligent LAIS designed to form inferences and decisions based on knowledge, which is stored in the knowledge base. This is a computer code that supports the methodology for processing information from the knowledge base, production and presentation of conclusions and recommendations. The solver manages system tasks through the formation and organization of the series of steps taken to resolve the problems.

To provide interaction between the artificial intelligence and LAIS, the latter should have a means of communication with the user, i.e. the interface. The interface provides opportunity to work with the knowledge base and the solver using a high-level language, close to professional language of experts in the educational field. The main purpose of the LAIS creation and its utilization in educational process
of a higher educational institution consists in improving the efficiency of educational process taking into account the individuality of the learner, the degree of his preparedness, mental vocabulary, as well as automation of teacher’s activity, which can be achieved by using new information technologies [4].

The main purpose when designing and using educational LAIS with the artificial intelligence can be implemented, given that LAIS is based on new information technologies, which can be classified as follows [5]:

1. In terms of coverage of educational tasks, LAIS includes the following software tools: training program in the form of an electronic textbook; testing program, which conducts testing of students based on the test tasks contained within the knowledge base; simulator program, which includes test questions; checking program; demonstration, information and reference programs; and intellectual support. The following is used as intellectual support: «command shell» and a knowledge base filled with knowledge from a specific subject area; solver operating with this knowledge and giving appropriate recommendations to students and teachers; and an intelligent user interface, providing graphical and interactive user-machine interface [6].

2. In terms of class of the implemented technological operations: word processor used to create electronic textbooks by teachers; database management system, which contains knowledge in various subject areas of the educational process, and a set of test tasks; multimedia and hypertext systems; and popular browsers.

3. By type of user interface: dialog interface, which enables bilateral exchange of information between user-student (or user-teacher) and the computer in the form of questions and answers.

4. According to the network building method: local network provides connection between multiple computers within the computer classroom.

5. Depending on covered subject areas: education, which includes students’ learning activity and the teachers’ pedagogical activity.

Special ergonomic requirements were developed for design of LAIS with artificial intelligence. The LAIS ergonomic requirements should:

- be focused on the Microsoft Windows operating environment, i.e. to contain the same type of screen forms and control objects as the Microsoft Windows operating system;
- have a convenient interface that implements the dialogue between the user and LAIS at the stage of both information input and retrieval of results;
- be reliable, i.e. to ensure the safety of the computer devices, software, and stored data.

The main goal of developing and using the learning automated information systems (LAIS) in educational process of higher education institution is an increase in educational process efficiency taking into account identity of the student, degree of his readiness, stock of knowledge and also automation of pedagogical activity of the teacher which can be achieved when new information technologies are used in it [7].

Basing on the requirements to intellectual LAIS, it may be assumed that the main goal of designing and using the educational LAIS with elements of artificial intelligence will be reached subject to the LAIS using new information technologies, which can be classified as follows.

By degree of coverage of educational tasks it includes the following software:

- learning program in the form of the electronic textbook and questions for self-examination of knowledge of students;
- testing program that on the basis of the test tasks, being contained in the knowledge base «Teacher», carries out testing of students on each theme of the subject and also on the group of subjects included in each colloquium;
- the simulator program which is presented by control questions on each theme of the subject;
- the monitor program which exercises progress checking and summative assessment of knowledge of students and grades it;
- the demonstration program which clearly demonstrates to the student the training material and also the correct answers in case the student finds it difficult to answer the question posed;
information resources which give reference information on request of students and teachers;
intellectual support.

For designing LAIS with elements of artificial intelligence there were developed ergonomic requirements which are as follows:

1. To be based on Microsoft Windows environment, i.e. to contain the same set of screens and control objects, as the Microsoft Windows operating system [8].

2. To have a convenient interface, implementing dialog of the user with LAIS both at the information input, and the obtaining results stages. The convenient user interface is achieved by using graphic interface through the use of screen forms containing control objects.

The standard graphical user interface of the LAIS should meet the following requirements:

- support the information technology of the user's work with the system – contain menu items familiar and understandable to the user, corresponding to the processing functions, located in the natural sequence of use;
- focus on the student user and the teacher user who communicate with the program at the external interaction level;
- graphic objects retain their standardized purpose and location on the screen.

3. To provide dialog user interaction mode, organized so that to exchange messages affecting data processing and providing instant feedback to the user.

The interactive mode is organized according to the created scenario, for which there are defined:

- the starting point of the dialogue;
- the initiator of the dialogue – a person or a subsystem;
- the content of the dialogue – in a screen form, with the corresponding controlled objects located on it: message texts, user information input fields; lists of possible choices for selection, buttons, etc.

- the subsystem response to the completion of the dialogue.

4. To have reliability, i.e. guarantee the safety of computer devices, software, stored data.

As a result of the decomposition, a functional structure of the EIS was developed, in which the student subsystem and the teacher subsystem were singled out.

The subsystem «Student» is intended for use by students in the educational process of the university (figure 2).

As a result of the further decomposition of the subsystem «Student», in accordance with the tasks set, the following subsystems were identified [9]:

1. Registering subsystem is designed for registration of students in the LAIS «UNIVERSITY». All input parameters of the student go to the knowledge base «Teacher».

2. Training subsystem is designed to teach students a specific discipline and presented with an electronic textbook and a set of questions for self-examination of students’ knowledge. A general outline of the electronic textbook structure was developed and presented (figure 3). The electronic textbook uses active teaching methods. When designing an electronic textbook, the following requirements were taken into account: informational contents, operational efficiency, feedback, dosing of educational material, individual pace and management of training. The electronic textbook is based on the scenario in which the «computer – student» dialogue is built.

3. Testing subsystem - offers a system of test tasks for the student from the knowledge base named «Teacher» (part of the artificial intelligence) to determine the level of knowledge. The system of test tasks is formed by the teacher by using the «Teacher» subsystem.

4. Controlling subsystem – is designed to determine the level of students' knowledge in current discipline. The controlling subsystem includes an element of artificial intelligence – the special «solver» that analyzes current situation, rates the student and gives the student an appropriate recommendation.

5. Help subsystem provides for the student the correct answers from the knowledge base of «Teacher» at the stage of self-control.
6. Consultation subsystem - provides an opportunity for the student to ask questions to the teacher and get answers from him. Questions and answers are stored in the «Teacher» knowledge base.

Subsystem «Teacher» is intended for use by teachers in their teaching activity (figure 4). In accordance with the tasks being solved in the subsystem «Teacher» the following subsystems have been selected:

1. Registering performs registration of teachers in the LAIS «University». All input parameters of the teacher go to the «Teacher» knowledge base.

![Structure of the subsystem «Student»](image)

**Figure 2.** Structure of the subsystem «Student». 
Figure 3. General scheme of the electronic textbook structure, where hypertext links between web pages are indicated by arrows.
Figure 4. Structure of the subsystem «Teacher».
2. «Electronic textbook» includes creation and editing of an electronic textbook. Electronic textbooks created by teachers are saved in the subsystem «Shell». Availability of electronic textbooks on different subjects in LAIS «University» is a key point in computer based education for students. The electronic textbook provides assistance in the self-study of the discipline and combines properties of regular textbook, reference-book, book of problems and laboratory course. It is not an alternative, but an addition to traditional forms of education, and does not replace the student’s work with books, lecture notes, collection of problems and exercises, etc. The electronic textbook is designed not only to preserve all the advantages of a book or a study-guide, but also to make full use of modern information technology provided by computer. We developed pedagogical requirements for teachers to be taken into account when creating an electronic textbook.

3. System «Tests» is designed to create and edit test tasks and contains following subsystems: creating tests, editing test, a reference subsystem (provides reference information for making up tests), control subsystem (searches for erroneous situations while tests are being drawn up). When drawing up test tasks, teachers should take into account that correctly made tests must comply with a number of requirements, i.e. they must be: relatively short-term, unambiguous, correct, brief, informational, standard. When being developed the test tasks should meet the following criteria: efficiency, reliability, differentiation, and correspond to the test performance indicator. When preparing materials for test control the teachers should follow some rules related to the content and location of correct and incorrect answers. The formed test tasks are included into the knowledge base «Teacher».

4. System «Consulting» conducts consultation of teacher with students.

5. System «Teachers Queries» is designed to select information from the knowledge base «Teacher» to view learning activities of each student at all stages in the subsystem «Student»: «Electronic textbook», «Test questions», «Testing», «Colloquium № 1», «Colloquium № 2». However, teacher can make queries according to following selection criteria: output of information by the student’s name entered, by the entered name of the group, by the entered date, by the entered name of the subject and the theme name (except for the step «Electronic textbook»)[10].

3. Conclusion

Thus, the set of requirements for AIS today must take into account the complexity and versatility of the educational process at a university, the peculiarities of interaction between subjects of the educational process, as well as the capabilities of modern information technologies and the rapid development of artificial intelligence in the context of education digitalization. The design and use of intelligent learning automated information systems enhances the efficiency of educational process at higher education institutions, as well as serves the basis for informational support of education that contributes to the transition from an industrial to an information society [11, 12].

Therefore LAIS «UNIVERSITY» with elements of artificial intelligence creates a favorable learning environment for all students, makes it possible to obtain theoretical knowledge (electronic textbooks) and certain practical skills (training programs), as well as to evaluate their training with the help of testing and monitoring programs. The needs of teachers in the LAIS should be supplied by special programs that allow teachers who are not experts in programming to create new or edit and complement existing training programs, keep logbooks, make reports [13].

References

[1] Zenkina S, Pankratova O, Konopko E and Ardeev A 2018 Model of organization of network project-research students activities in collaboration with city-forming enterprises Proc. of the 2018 multidisciplinary Symp. on computer science and ICT pp 290-6

[2] Galkina V A, Hvostova I P and Servetnik O L 2012 Use of artificial intelligence in the educational automated information systems Scientific and technical journal «Knowledge-intensive Technologies» 7 pp 48-51

[3] Hvostova I P and Servetnik O L 2012 Functional structure of the educational automated information system with elements of artificial intelligence Bulletin of the North Caucasian
federal university 4 pp 27-31

[4] Zenkina S, Suvorova T, Pankratova O and Filimanyuk L 2019 The method of design of electronic advanced training courses for the development of information competence of the teacher. Proc. of SLET-2019 - Int. Scientific Conf. Innovative Approaches to the Application of Digital Technologies in Education and Research pp 366-75

[5] Goodwin K Dr. 2012 Use of Tablet Technology in the Classroom. NSW Curriculum and Learning Innovation Centre

[6] Pankratova O P, Konopko E A, Nemkov R M and Mezentseva OS 2018 The preparation of a modern computer science teacher with the help of resource-saving technologies and green it implementation Proc. of the 2018 multidisciplinary Symp. on computer science and ICT pp 222-8

[7] Prey J C 2010 Tablet PC Technologies in Education Computer, IEEE Computer Society 40(9) pp 34-40

[8] Bogatyreva Y, Privalov A, Romanov V and Konopko E 2019 The organization of scientific research work of students in the conditions of the digital environment in the modern universities Proc. of SLET-2019 - Int. Scientific Conf. Innovative Approaches to the Application of Digital Technologies in Education and Research pp 95-103

[9] Servetnik O L, Hvostova I P and Velts O V 2018 Learning automated information system as a means of forming professional competence of an engineer Problems of modern pedagogical education 60(1) pp 261-265

[10] Servetnik O L and Hvostova I P 2012 Analysis of factors affecting the requirements for professional competence of a modern engineer Science and education: scientific publication of Bauman Moscow state technical University 3 p102

[11] Kononova N, Shiryaeva N, Oblasova I and A Pletukhina 2019 The Use of Augmented Reality Technology in the Educational Process Proc. of SLET-2019 - Int. Scientific Conf. Innovative Approaches to the Application of Digital Technologies in Education and Research DOI: http://ceur-ws.org

[12] Konopko E, Pankratova O, Nersesyan E and Abdullaev J 2019 Training of teachers for professional activity in the educational space Proc. of SLET-2019 - Int. Scientific Conf. Innovative Approaches to the Application of Digital Technologies in Education and Research pp 205-12

[13] Pankratova O, Abdullaev J A and Konopko E 2020 The development and implementation of the online course «IT interaction in the digital economy». Proc. of the 2nd Int. Scientific Conf. "Modern Management Trends and the Digital Economy: from Regional Development to Global Economic Growth" (MTDE 2020), (April 16-17, 2020, Institute of Digital Economics, Yekaterinburg, Russia. Published by Atlantis Press SARL. Advances in Economics, Business and Management Research) 138 pp 171-6