

ABSTRACT
of the doctoral thesis for the degree of Doctor of Philosophy (PhD) in
the specialty 8D06101 - «Information systems (by industry)»

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INFORMATION TECHNOLOGY TO SUPPORT
PERSONALIZED LEARNING BASED ON THE DIGITAL
COMPETENCE MODEL

General characteristics of the research. The dissertation work touches upon the problems of digitalization of education and is devoted to the development of information technologies to support personalized learning with a focus on the development of digital competencies. The dissertation proposes a conceptual model for the implementation of personalized learning based on a logical-structural approach, also models and algorithms of information technology support for personalized learning are developed, the architecture of the personalized learning educational platform with an intelligent decision-making module based on recommendations for the formation of a learning program is designed and its software is implemented.

Key words: personalized learning, digital competencies, logical-structural approach, conceptual model of personalized learning implementation, algorithm for the formation of a learning program, learner's profile, a production model for assessing course compliance, the architecture of the personalized learning educational platform.

The relevance of the research. The development of an innovative economy as a priority direction of Kazakhstan's industrial policy involves the active learning of young specialists with a high level of competence in various subject areas. In this case, the restructuring of the school education system requires special attention, since the school lays the foundation for innovative development and digital transformation of the national economy.

In Kazakhstan, serious attention is paid at the state level to the tasks of informatization of education and the transition to new advanced learning technologies. According to the State Program for the Development of Science and Education for 2020-2025 and the State Program "Digital Kazakhstan", the development of digital educational resources, digital environments and online course platforms, automation of services are important tasks that allow the implementation of a mixed learning format. The traditional learning model is gradually ceasing to work as the needs of the digital society change. The education system of Kazakhstan strives to change it towards a personalized approach. The personalized learning format is aimed at designing the learning process, where teaching methods and styles "work" for the learner and adapt to his needs. This approach is also the basis of the updated content of competence-oriented programs implemented in secondary schools of Kazakhstan.

Various projects aimed at developing the personalization of learning using

various platform solutions are being researched and implemented in higher educational institutions, where learners can determine their level of knowledge and choose their own learning trajectory using artificial intelligence. These studies, aimed at using the technological advantages of e-learning and improving its quality, have become acutely in demand in the context of the pandemic limitations of COVID-19. The papers propose various solutions regarding personalization technologies in e-learning systems of higher education, while the application of these approaches in school education remains unexplored. There are such topical issues as the development of the digital educational environment in schools, the modeling of learners' digital competencies, the construction of personal learning trajectories in the school digital environment, as well as the development of information technologies, models and algorithms that allow adapting learning programs to the personal characteristics of learners. The application of the logical-structural approach and methods of decision theory, statistical processing of information together opened up new prospects for the study of these issues. Thus, the relevance of the dissertation work is connected with the solution of the problem of developing information technology to support personalized learning with a focus on the development of digital competencies, which allows improving the quality and efficiency of the educational process in schools of the Republic of Kazakhstan.

The object of research is the process of implementing personalized learning with the support of information technology.

The subject of the research is the models and architecture of information technology to support personalized learning.

The research goal.

The purpose of the study is to develop information technology to support personalized learning with a focus on the development of digital competencies, which allows to improve the quality and efficiency of the educational process in schools of the Republic of Kazakhstan.

Research objectives.

To achieve this goal, the following tasks are formulated:

- to conduct a comparative analysis of existing approaches of personalized learning and modern digital educational environments;
- to develop a conceptual model for the implementation of personalized learning based on a logical-structural approach;
- to develop a model of digital competencies for the formation of a learning program of an educational platform for personalized learning;
- to develop a production model for assessing the compliance of the course package with the personal characteristics of the learner;
- to develop a universal algorithm for the formation of a learning program that allows you to master the established competencies and takes into account the personal characteristics of the learner;
- design the architecture of an educational platform to support personalized learning for high school learners;
- to develop software for an educational platform that supports personalized learning in high school with a focus on the development of digital competencies.

The main research methods.

The scientific results of the dissertation work were obtained on the basis of methods of decision theory, logical-structural method, the methods of expert assessments, the methods of statistical information processing, the method of analyzing hierarchies and the method of fuzzy logic.

The scientific novelty of the dissertation research concluded in the fact that for the first time an intelligent algorithm has been proposed for the formation of a learning program that allows mastering the established competencies and taking into account the personal characteristics of the learner, thereby contributing to the organization of information technology to support a personalized learning format.

Scientific provisions and results presented for defense of dissertation:

1. A conceptual model for the implementation of personalized learning based on a logical-structural approach that defines the main content of information technology to support personalized learning format;
2. A universal algorithm for the formation of a learning program that allows to master the established competencies and takes into account the personal characteristics of the learner;
3. The software architecture of the personalized learning educational platform with an intelligent decision-making module based on recommendations for the formation of a learning program.

Practical significance of the research.

As a result of the conducted research, an architectural solution was proposed, models and algorithms of information technology to support personalized learning were implemented in the software package. The results obtained in the form of models and algorithms can be used as elements of an information system for the formation of personal learning trajectories. The model of digital competencies of high school students is a new product in the field of school education and can serve as a guideline for revising the curricula of secondary schools in the context of digital transformation in order to increase the competitiveness of school graduates of the Republic of Kazakhstan.

The research results are used in the network of Nazarbayev Intellectual Schools of the Republic of Kazakhstan, with the 2 acts of implementation. The author's certificate for the personalized digital platform software has been obtained.

Approbation of the research.

The main provisions and results of the work were reported and approved at the following international and scientific conferences: VI International Scientific and Practical Conference of students and young Scientists (Kazakhstan, Ust-Kamenogorsk, 2019); "4th International Symposium on Multidisciplinary Studies and Innovative Technologies" (Turkey, 2020); VI International scientific and technical conference of bachelor and master students and young scientists «Creativity of young people - innovative development of Kazakhstan» (Kazakhstan, Ust-Kamenogorsk, 2020); XXXIII International Scientific and Practical Teleconference "Advances in Science and Technology" (Russia, Moscow, 2020); YSPC "Science of Higher Schools 2021" (Kazakhstan, Shymkent, 2021);

YSPC "Digitalization as a factor in the development of science and education" (Russia, Petrozavodsk, 2021), IV All-Russian Tutor Scientific and Practical Conference "Implementation of the Federal State Educational Standard as a mechanism for the development of professional competence of a teacher: innovative technologies, tutor practices" (Russia, Krasnodar, 2022).

Publications.

12 scientific papers have been published on the topic of the dissertation, including 1 article in the journal included in the Scopus database (CiteScore percentile equal to 30%), 3 articles in publications recommended by the Committee for Control in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan, 1 article in the scientific journal "National Association of Scientists (NAS)" (Russia), 7 – in the proceedings of international conferences (1 of them in the Scopus database). There is also 1 certificate of state registration of the personalized educational platform software.

The structure and scope of the dissertation work.

The dissertation consists of an introduction, four sections, a conclusion, a list of used sources of 154 titles, set out on 127 pages of computer text, includes 66 figures, 20 tables and 6 appendices.

The introduction substantiates the relevance of the research topic, purpose, object, subject, tasks and methods of research, scientific novelty, scientific provisions, practical value and implementation of the results of the work, provides information about publications and approbation of the work.

The first section provides an overview and analysis of the current state of the issue of the introduction of personalized learning in the educational process of educational institutions in general and in the Republic of Kazakhstan in particular in the conditions of informatization of education. The review and comparative analysis of the competence approach of educational programs of schools of the Republic of Kazakhstan, existing domestic and foreign digital environments and platforms, the global framework of digital competencies to determine the set of competencies for high school students.

The second section presents the results of a study devoted to the development of a conceptual model for the implementation of personalized learning and a methodology for using a logical-structural approach for its development. Based on the conceptual model, at the planning stage, projects of a logical-structural matrix and calendar plans were developed.

The third section of the dissertation is devoted to the development of models and algorithms for personalized learning. A structural model of the learners profile has been developed, including basic and special profiles; a model of digital competencies of high school students and an algorithm for its development; a base of rules for assessing the compliance of the learning course with the learner's personal characteristics based on the use of a fuzzy logic model. The general structure of the adaptation of the content of the programs made it possible to build a universal algorithm for the formation of the learning program, which makes it possible to master the established competencies and takes into account the personal characteristics of the learner.

The fourth section of the dissertation presents the software implementation of information technology to support personalized learning in the form of an educational platform. The architecture of the educational platform to support personalized learning for high school students is designed and the functional, software and information support of the developed personalized learning platform is described.

In conclusion, the results of the executed work are summed up within the framework of the dissertation work.

The content of the dissertation concluded with a list of used sources and annexes.