THE INTEGRATED PERSONALISED ADAPTIVE LEARNING SYSTEM IN THE EDUCATIONAL PROCESS TRAJECTORY

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Abstract

The higher education modernisation is currently underway, an important aspect of which is digital transformation. Digitalisation is driven by the digital society and the digital economy. A distinctive feature is the transition to a personalized and effective educational process in the developing electronic information and educational environment. At the same time, new scientific and pedagogical ideas are emerging about the role digitalisation can play in improving the quality of student learning. The approaches to personalised learning are mainly developed through the individual learning paths, providing the educational programmes with a personal set of modules and disciplines based on individual preferences or educational capabilities of students. Regarding the quality of education, it would be advisable to complement the models of individual educational trajectories within students' educational programmes with the models of subject-specific learning management providing automated formation of educational trajectories in an academic subject based on dynamic data analysis in the electronic information and educational environment. An essential practical outcome of the research is the creation of a methodological system on the basis of which any educational organisation can create its own subject-specific personalised adaptive learning systems and build personalised adaptive learning. The obtained practice-oriented results are applied in the regional system of higher education in the Republic of Tatarstan. Practical results of the research due to the universality of the theoretical base can be replicated in the system of higher education, as well as in the system of additional and secondary vocational education regardless of the subject area, applied software, learning management systems and technological solutions.

Keywords: individual educational trajectories, digitalisation, personalised adaptive learning, pedagogical design.

1 INTRODUCTION

The European Higher Education Area is currently undergoing modernisation, an important aspect of which is digital transformation. Digital transformation is driven by the digital society formation and the digital economy emergence. The distinctive feature of education digitalisation is the transition to a personalised and results-oriented educational process in an evolving electronic information and education environment. At the same time, new scientific and pedagogical ideas about the role that digitalization can play in improving the learning quality are being established [1].

The Presidential Decrees "On the Strategy for the Development of the Information Society in the Russian Federation for 2017-2030" and "On the National Development Goals of the Russian Federation for the period until 2030", the Priority Project "Modern Digital Educational Environment in the Russian Federation", as well as the Order of the Russian Government "On Approval of the Digital Economy of the Russian Federation" outline the need for digital transformation in education, including accelerated digital technology implementation, creation up-to-date and safe digital education. Epidemiological situation which has arisen due to the spread of a new coronavirus infection has demanded mass organization of online education in an electronic information and education environment, thus further accelerating the introduction of digital technologies in education, creating additional opportunities for the development of personalized E-learning [2].

Notwithstanding the growing interest in personalised E-learning, at present there are only a few practices of its implementation in the process of higher education students' learning. Approaches to the implementation of personalised learning are mainly developed through the models of individual learning paths, which provide the formation of educational programmes with a personal modules and disciplines based on individual preferences or learning students' capabilities [3], [4]. From the improving standpoint of the learning quality, it would be advisable to complement the individual learning paths models within

students' educational programmes with the models of subject-specific learning management ensuring automated formation of learning paths in the academic subject based on dynamic data analysis in the electronic information and education environment.

In this context, there are also individual practices and models for personalized educational process organization in online learning environment based on the adaptivity focused on static students' characteristics, which do not change during the study, such as style characteristics, physiological features, etc., which we will call *passive adaptivity*. From the learning perspective of quality improvement, it becomes clear that pedagogical design of educational process on the basis of adaptivity, which comprehensively takes into account dynamic students' characteristics, which can change during the study, including personal needs and goals, which we will call *active adaptivity*, is relevant [7], [8], [9]. In this case, pedagogical design of the educational process should be based on the integration of effective approaches in offline and online learning, as well as taking into account psychological and pedagogical features of the modern students' generation. Digitalisation provides significant opportunities for building individual educational trajectories based on the creation of micro-porous models of educational disciplines' content, variability of individual characteristics in the learning process, the educational process management and multidimensional assessment of educational outcomes [10]. However, at present, such models have not been developed. As a result, the problem of pedagogical design of personalised adaptive learning of academic discipline for university students in the digitalisation context of education arises.

The development of E-learning and distance learning technologies is accompanied by the development of new approaches to the construction of methodological training systems, including adaptive ones. For example, L.I. Doliner introduces the notion of adaptive methodological system of education, which he suggests "a system containing in its structure an educational technology that has the properties of adaptability to the requirements of teachers, adaptability to the forms of learning, adaptability to the regulatory requirements of the educational organization and open to modification" [12].

A.M. Novikov's research is of particular interest, where he considers methodological systems in the sequence of their historical development:

- Reproductive learning (historically the first type of learning associated with reproduction, reproduction of samples of learning activity);
- Dogmatic learning (learning through listening, reading, rote memorisation, and word-for-word material reproduction);
- Communicative learning (the process of transferring knowledge in a readymade form);
- Developmental learning by L.V. Zankov; D.B. Elkonin and V.V. D.B. Elkonin and Davidov (a methodological system for developing abstract and creative thinking);
- Programme-based learning by B.F. Skinner, N.A. Crowder (learning without a teacher based on training programmes);
- Task-based learning system (step-by-step organisation of learning tasks, methods and their solution selection, diagnostics and assessment of learning outcomes);
- Productive learning system by J. Carroll, B. Bloom (a system focused on achieving the final educational result that corresponds to the established criteria);
- Project-based learning system by G.L. Ilyin (the central part of project-based learning is a project aimed at solving a professionally significant problem);
- System of Contextual Learning by A.A. Verbitsky;
- Simulation learning system (simulation of real-life relations and conditions in the learning process);
- Informational learning system (includes interactive learning systems, hypertext systems and systems based on information and telecommunication networks [13], [14].

The methodological system definition approach is constantly evolving due to the ever-increasing requirements of the modern digital society for the educational system. For example, S.I. Osipova's work presents theoretical foundations for the methodological systems' improvement from the position of personality-centred approach.

We consider it necessary to create the following conditions for our methodological system:

- To ensure conditions for students' personal development based on their learning experience, needs, possibilities and abilities;
- To transfer the learner into a subjective position by activating his/her personal potential, introducing problem-based learning approaches and project activities that develop subject-subject interaction;
- Multifunctional electronic information and education environment allows students to participate in determining their educational path, making decisions, choosing the content and form of educational content, which has a direct impact on personal development [15], [16].

Nowadays, under the conditions of digital education, when the education system is being updated in terms of its transition to a personalized and result-oriented system, which ensures comprehensive personal development of each student, the theoretical foundations for building a methodical education system, along with the above-mentioned ones, include the following provisions:

- Creating conditions for students' personal development through the implementation of their personal goals, needs and abilities;
- Development of a logically coherent sequence of educational process and scientifically substantiated formation of variant content of educational content;
- Reliability of educational content of the discipline in the context of interdisciplinary links and future professional activity;
- Activation of student's personal potential, realization of his subjective position through active inclusion in the educational process and increasing cognitive motivation of the student;
- Development of self-education, self-organisation and self-reflection capacity in the process of solving subject and professional tasks;
- Creation of an individual educational trajectory;
- The inclusion of individual and team project activities;
- Implementation of modern pedagogical and digital technologies.

Z.A. Kargina's work singles out the following educational personalization technologies: didactic, organizational and methodological, and informational, but considering the education personalization at the digitalization stage, we will use a modern concept - digital technologies. The main purpose of didactic technologies is to develop student personality as a subject of educational activity. Among didactic technologies are problem-based learning, active learning (gamification of the learning process), task-heuristic technology, sign-context learning, developmental-acmeological technology. The purpose of organizational and methodological technologies is to put students in the position of a subject of building personal educational space and individual educational trajectory. The potential of using digital technologies opens up opportunities for the student's development as a subject of information activity and information culture in general. This is ensured through the creation and application of automated learning systems, e-learning courses and resources, e-textbooks and simulators, learning systems developed under the conditions of EE implementation.

According to E.G. Skibitsky, the methodological system of adaptive learning in electronic environment should ensure the implementation of technological consistency and systematic and pre-programmed transition from ways and methods of teachers' activity to active learning activity of students and from them to forms of self-education, self-organization and self-reflection in the process of solving various pedagogical and professional tasks [17].

As A.B. Kondratenko points out in his work, when creating a methodological system of personalized learning, it is necessary to proceed from the individual characteristics of a student and apply technologies that provide optimal conditions for realizing the potential of each student [18].

After considering this issue, we can say that the interpretation of the methodological system concept is diverse, but there is a unity of opinion among researchers on the importance of its design as an integral, open, dynamically developing and accessible to prompt modification in the conditions of educational system changes and digital transformation of modern education.

2 METHODOLOGY

The methodological basis of the study was as follows:

- *Systemic approach*, which allowed considering education as a holistic system in the interconnection of its components, allowing to integrate the advantages of competence, personality-oriented, activity, subject-information and environmental approaches (V.G. Afanasiev, I.V. Blauberg, A.M. Novikov, V.N. Sadovsky, E.G. Yudin, etc.);
- *Competency-based approach* in education defining goals and educational outcomes (V.A. Adolf, V.I. Zvonnikov, I.A. Zimnyaya, N.G. Selevko, A.V. Khutorskoy, V.A. Shershneva, L.V. Shkerina, etc.);
- *Personality-oriented approach*, which considers student as a subject of educational activity (A.G. Asmolov, N.V. Gafurova, A.A. Leontiev, S.I. Osipova, I.S. Yakimanskaya, etc.);
- *Activity-based approach*, which prioritizes the inclusion of active and practice-oriented methods in the educational process (B.G. Ananyev, L.S. Vygotsky, P.Y. Galperin, A.N. Leontiev, S.L. Rubinstein, V.D. Shadrikov, etc.);
- *Subject Informational Approach*, which defines organization of learning activities using digital technology at different stages (R.F. Abdeyev, N.I. Pak, A.E. Polichka, I.V. Robert, A.D. Ursul, V.I. Shtanko, etc.);
- *Environmental Approach*, which provides a basis for students' personal development, self-organization, activeness and reflexivity management (N. Luman, Yu. Manuilov, T.V. Meng, N.B. Strekalova, etc.).

Structural and theoretical background for the study was provided by:

- *Studies in the theory of education informatisation* (S.G. Grigoryev, V.V. Grishkun, I.G. Zakharova, M.P. Lapchik, N.I. Pak, E.S. Polat, M.I. Ragulina, I.V. Robert, E.K. Khenner, etc.);
- *Methodological studies, approaches and technologies for e-learning and distance learning* (A.A. Andreev, L.L. Bosova, A.A. Veryayev, B.E. Starichenko, E.G. Skibitsky, O.G. Smolyaninova, S.R. Udalov, G.A. Fedorova, etc.);
- *Research in the field of e-learning personalization* (J. Fischer, R. Lew, J. Payne, A. Uvarov, O. Aiken, etc.);
- *Research in educational content presentation and structuring* (A. I. Azevich, G. A. Atanov, E. N. Davydova, T. Murray, G. M. Tsibulsky, etc.);
- *Theory of programmed and adaptive learning* (G.A. Atanov, V.P. Bespalko, P.L. Brusilovsky, B.F. Skinner, N.A. Crowder, G. Pask, etc.)
- *Research in the field of pedagogical design* (E.S. Zair-Bek, V.M. Monakhov, V.V. Yudin, N.O. Yakovleva, etc.), *microlearning theory* (M.J. Dolasinski, J. Fernandes, M. Lindner, S. Mosel, J. Reynolds, etc.);
- *Problem-based learning theory* (V.A. Krutetsky, I.Y. Lerner, M.I. Makhmutov, M.N. Skatkin, etc.);
- *Game and gamification activity theory* (A. Adler, K. Verbach, S. Detering, B. Stone, D. Hunter, D.B. Elkonin, etc.);
- Motivational theory (T.O. Gordeeva, E. Deasy, A. Maslow, R. Ryan, etc.), *and the theory of learning activity reflexion* (O.S. Anisimov, M.M. Bakhtin, A.K. Karpov, A.V. Petrovsky, G.P. Shchedrovitsky, etc.).

It should be noted that a common problem in the educational reality of HEIs is the initial learning construction of content and then its artificial superimposition on curriculum competences and the educational outcomes formulation [19]. This leads to the fact that the goals of the educational process are the knowledge acquisition rather than the competences' formation. We apply the main idea of reverse pedagogical design model in our study:

1 *Prospective areas for improving the educational process* and justify the feasibility and effectiveness of its construction on the basis of adaptive learning technologies, conduct a conceptual analysis of the conceptual and terminological field of the problem, specify the concept and characteristics of personalized adaptive learning.

2 *Concept of personalized adaptive learning* that integrates the advantages of offline education approaches with online learning opportunities to organize the educational process

3 *Adaptation-based strategies* on the principles of both adaptive and personalized learning, which allow students to independently manage the formation of their educational trajectory.

Regarding the main stages of pedagogical design of personalised adaptive learning under conditions of offline and online component integration with regard to its specificity, we refer to the following.

I. Structuring the field of educational outcomes.
II. Designing a learner's profile.
III. Composition and creation of educational content.
IV. Establishing tools for diagnostics of learning outcomes and feedback.
V. Capacity building for learning management.
VI. Educational reflection.

The research used the following set of methods:

I. *Methods of theoretical research*: comparative and comparative analysis of psycho-pedagogical and scientific-methodological literature, normative-methodological and legislative documents on the research problems, methodological analysis of professional and federal state educational standards of higher education; analysis and generalization of foreign and domestic experience; pedagogical modeling of personalized adaptive educational process and forecasting of its results; comparing, systematization and generalization of data
II. *Methods of empirical research*: pedagogical observation, questioning, interviewing, testing, monitoring, expert evaluation, self-assessment, mutual evaluation, interviewing teachers and students, diagnostics of educational outcomes formation level, pedagogical experiment.
III. *Statistical methods of research data processing:* statistical information, ranking, scaling, rating assessment, methods of mathematical statistics of results processing in pedagogical research.

3 RESULTS

Structure of personalized adaptive training system in the context of digitalization is proposed to be represented by a set of the following sub models:

1. *The varied educational content sub-model* of the personalized adaptive learning system, implemented on the basis of integration of logical methods of concept analysis, logical-psychological methods of correlation of the volume and content of concepts with the methods of graph theory and hypergraphs;
2. *The personal profile sub-model* of the user of personalized adaptive learning system, focused on the personal characteristics;
3. *The educational process management sub-model*, including methods and algorithms for educational content adaptation, individual educational trajectory construction and educational strategy implementation, providing automatic navigation of individual educational process on the basis of integration and development of adaptive management methods;
4. *The competence framework sub-model* in the conditions of digital transformation, designed for structuring, forming and evaluating multidimensional educational outcomes in a discipline using the technique of recording data on students' activity experience, learning, personal qualities in the proposed personalized adaptive learning system, and interfaces of subjects of educational process: teacher and learner.

However, the interface is a set of tools, methods and interaction rules (management, control, etc.) between the elements of a personalised adaptive learning system. Thus, the interface is of great importance for any learning system and acts as an integral part of it, oriented on the participant of the learning process.

Two types of interfaces are proposed in the structure, depending on the subject - participant of the educational process. Educator’s interface provides a mechanism for filling in the educational content, control and measurement materials, provides access to the system settings. In the process of operation, the teacher interface can be used to adjust adaptation parameters, add new ones, modify adaptive

control algorithms, as well as control and management of the learning process. Learner's interface is designed to ensure the learner's interaction with, and includes elements of consultative support. In this approach the user is most comfortable as it allows building a visual representation of the student's personal educational space and includes functionality directly designed to perform the tasks of his/her learning activities. Let us consider in detail each sub-model included in the structures of a personalised adaptive learning system.

3.1 Personalised adaptive learning system

Nowadays, in the context of digitalization of education and construction of personalized adaptive learning, based on the research of A.M. Pyshkalo and developing in the works of T.A. Boronenko, G.I. Sarantsev, and S.I. Osipova. I. Osipova, we present a model of methodological system for personalized adaptive learning in the context of digitalization. The model is determined by the purpose of the research and reflects the process of building an integral learning system in the conditions of online and offline learning integration through functional connections between its components. This model is represented by a set of interrelated and interdependent components:

- Target,
- Content-conceptual,
- Adaptive-technological,
- Result- assessment.

The targeted component of the methodological training system is aimed at providing personalized adaptive learning with the possibility of flexible content adaptation in higher education under the conditions of digitalization of education. This component is classically represented by the requirements of the social order: a set of society and digital economy requirements to students' training, requirements of federal state educational standards of higher education of the Russian Federation, as well as requirements of international projects and standards in the field of education quality improvement, as well as employer's requirements [39, 46, 129, 165]. The target component is a systemic factor of the methodological system and determines its main components: learning content, methods, forms and educational tools, applied technologies and formed learning outcomes. For us, the goal is the implementation of personalized adaptive learning in the electronic information and educational environment of higher education institution under the conditions of digitalization of education, which is implemented through the other components of the methodological learning system based on the formed educational outcomes.

The content-conceptual component of the methodological system is determined by the target component and includes two interrelated components: conceptual and didactic. The conceptual component includes methodological approaches, principles constituting the core of the concept of personalized adaptive learning, criteria for content selection and formation of educational content terms, and the didactic component includes the optimal combination of organizational forms of learning, methods and tools with a focus on specific students, their individual characteristics, initial knowledge, skills and current level of educational outcomes formation.

The basic methodological provisions conceptually ensuring the implementation of personalized adaptive learning in the electronic information and education environment of higher education institution in the conditions of digitalization of education are systemic, competence-based, personality-oriented, activity-based, subject-information-based and environmental approaches, which are interrelated and complement each other. The general scientific systemic approach allows us to consider learning as a holistic system in the interconnection of its components, the systemic component of which is the goal of providing mass personalization and ensuring the effectiveness of the learning process. The competence-based approach is the basis for defining the goals of educational activities and learning outcomes. It allows defining the structure of functional components of a personalised adaptive learning system and considering their interrelation. Personality-oriented approach allows us to consider a student as a subject of educational activity with his/her individuality and involves building an individual educational an individual trajectory. The activity-based approach prioritises active and practice-oriented methods to actively involve students in the process of personalised adaptive learning. The informational approach determines the organisation of learning activities using digital technology at different stages of the information process. The media approach, which provides a basis for personal development, management of self-organization, activity and reflection of students.

Insufficiently developed approaches in the theory and methodology of e-learning for students necessitate a set of pedagogical principles comprising general didactic (scientificity, consistency, interdisciplinarity, fundamentalization, integrity, accessibility); personality-oriented (personalization, individual performance, motivational-intellectual activity, communicativeness) and technology-supportive (micro-pornity, active learning, and active learning) principles.

Educational activity methods represent sequential, interconnected actions of a teacher and learners, ensuring achievement of educational goals and assimilation of educational content. However, the list of existing pedagogical methods is extremely diverse and their choice depends on the educational problem being solved, the specifics of the subjects of the pedagogical process, and the conditions of its implementation. The research identifies the following as the main teaching methods: active learning methods, individual and team learning activities, project method, problem-based learning, and interactive teaching methods. Teaching methods can be selected depending on its specifics. In order to intensify the learning and cognitive activities of students, active learning methods are used, which involve students in learning activities and form cognitive motivation for independent and proactive mastering of the educational material.

Along with the methods of individual work, the methods of teamwork are used in large projects and the distribution of roles arises. Therefore, the development of teamwork skills will contribute to professional development. In e-learning, based on the increased amount of guided independent work of students and, therefore, high motivation, the application of project activities is becoming more and more common practice. Organization of team project activities in accordance with iterative model of real software and hardware systems life cycle allows organizing group projects on application of acquired knowledge and skills in professional activity. Gamification methods in teaching students in an electronic information and education environment contribute to their involvement and retention in the learning process. Problem-based learning methods ensure the acquisition of knowledge in the process of problem-solving in constant communication and cooperation with the learner in the search for the solution of the problem. In this case there are levels of problem-based learning in which the problem is set and students are shown its solution by the teacher; the problem is highlighted and its solution is carried out by students; the problem is indicated and its solution is completed in the students' independent work; the problem is only indicated. The interactive teaching methods included in the model of methodological training system can be divided into discussion and training methods. Discussion methods allow for active communication dialogue between the student and the teacher in the course of conversations, discussions and debates to analyse the training material. Training methods implemented in a personalised adaptive learning system through test simulators allow students to automate their discipline assignments.

The adaptive-technological component of the methodological system includes tools for achieving learning objectives and is interconnected with the content-conceptual component. Determination of functionality and structure of the toolkit, which is a personalized adaptive learning system, is based on the methodological foundations of offline learning implementation and their integration with the principles of adaptive online learning in the concept of personalized adaptive learning, embedded in the content-conceptual component of the methodological system. In its turn, submodels included in the structure of PAS and including technologies for content definition, technologies for its structuring and selection of learning objects, technologies for fixing student parameters, technologies for PAS management, technologies for content adaptation, technologies for ensuring communicative interaction determine the choice of applied organizational forms, methods and means of learning.

The result-assessment component of the methodological system is designed to assess the level of formation of educational outcomes of the student in the discipline and includes assessment criteria and levels of competence formation, as well as methods of control, monitoring and self-monitoring. The components of result-assessment component are determined on the basis of learning outcomes assessment technologies and student's digital footprint fixation, in its turn, the level of educational outcomes formation determines the construction of educational process management submodel and competence framework sub-model.

The results-assessment component allows determining the level of student's educational outcomes formation on the basis of cognitive, praxiological, axiological and reflexive components of competence. When fixing the achieved educational results and assessing the level of competence formation, we consider it possible to determine the following:

- Reproduction level (threshold level) gives a general idea about basic concepts and regularities of professional activity objects functioning, methods and algorithms of practical tasks solution and includes knowledge reproduction and performance of the simplest learning activities;

- Interdisciplinary integration level (basic) allows solving typical tasks of professional activity according to known algorithms, rules and methods and includes the ability to establish relationships and integrate material from different subject areas;
- The level of professional integration (advanced) implies readiness to solve practical tasks of increased complexity, non-typical tasks of professional activity.

Let us elaborate on each level:

- The level of reproduction (threshold) is the application of familiar facts, standard methods in a known situation, recognition of objects and properties, formalization of concepts, facts and construction of simple constructions, application of known algorithms and technical skills, work with standard, familiar expressions and formulas, direct performance of calculations and transformations.
- The level of interdisciplinary integration (basic) - is built on reconstructive activity of analyzing conditions and performing tasks, which, although not typical, are still familiar to students or go beyond the known, only to a very small extent. This level involves integrating subject areas and making connections between them in the practice-oriented context of the proposed task.
- The level of professional integration (advanced) is built as a development of the previous level with a focus on the application of knowledge and methods in various professionally oriented tasks, aimed at developing skills of independence and initiative, includes problem-based approach to presentation of material, encourages students to independently form algorithms of problem solving, integrating knowledge of the whole discipline and explaining, and justifying the obtained results. This level characterizes the choice of applied tools, integration of knowledge from different topics and modules of the discipline, as well as from general engineering and professional field.

To check the formation of the threshold level of competence reproduction the basic learning tasks are offered. The basic level of interdisciplinary integration is tested by solving simple practice-oriented tasks. To check the formation of the advanced level of professional integration, tasks of higher professional level are applied, for example, research projects, in which, first of all, it is necessary to define the problem taking into account professional features, to carry out formalized problem statement, choose algorithms and methods of its solution, implement the solution and conduct its analysis in terms of evaluation of effectiveness of obtained results and to formulate conclusions. We see the evaluation of the results of personalised adaptive learning as possible through control, self-control and monitoring. The control is a measurement of the assessment of learning outcomes and provides feedback in order to establish whether the achieved learning outcomes are in line with the planned ones. The structure of the methodological system also includes feedback that allows adjusting the educational objectives on the basis of the results-evaluation component.

However, the authors of the study have not yet found out that the model of the methodological system of learning provides the implementation of personalized adaptive learning in the electronic information and educational environment of higher education under the conditions of digitalization of education. It should be noted that the proposed model of methodological system provides the effectiveness of the educational process and construction of individual educational trajectory of the learner in the electronic information and educational environment of the subject learning on the basis developed in the study.

4 CONCLUSIONS

The study develops personalised adaptive learning systems for students that implement integration strategies in the educational process.

The most common modern learning management systems are considered and the application of LMS Moodle for mass development and implementation of personalised adaptive learning systems in the educational process of higher education institutions is justified.

The developed systems provide the possibility of continuous monitoring and implementation of feedback mechanisms, accessible and prompt communication between the participants of the educational process (students and teacher), formation and development of independent and teamwork skills, realization of personal potential, student involvement in the learning process, increased motivation, as well as the formation of subject-specific learning outcomes.

Strategies for adapting educational content depending on learning outcomes, individual characteristics and personal goals of learners are presented.

Implementation of project activity support provided the opportunity to implement team projects in accordance with the iterative model of the life cycle of real software and technical systems, continuous monitoring of learners' group activities, application of feedback mechanisms and communication of educational process participants.

Implementation of the developed ones in the educational process ensured formation of individual educational trajectories within a flexible personalised learning schedule with multiple control of the self-education process. Based on the feedback, it was noted that personalized learning in an electronic environment improved the quality of learning and optimized the time of studying educational content, minimized psycho-emotional stress and promoted the development of personal potential of each participant in the pedagogical process.

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