Е. К. ГЕРАСИМОВА, С. Л. ЗОРИН, Г. А. КОБЕЛЕВА, Е. А. МАМАЕВА

Особенности проектирования персонализированной образовательной модели при работе с цифровыми технологиями

Проблема и цель. Трансформация образовательной среды обозначила для дидактической системы следующие приоритеты развития: поддержку непрерывного обучения; личностную ориентацию и учёт индивидуальных особенностей обучающихся; применение цифровых технологий для подготовки востребованных профессионалов будущего. Авторы предлагают реализовывать указанные требования средствами и возможностями современных информационных технологий, максимально учитывающих особенности персонификации.

Методы исследования. Применяется теоретико-методологический анализ и обобщение фундаментальных научных работ по проблеме исследования, обработка результатов тестирования, решения задач, выбора обучающегося (цифровая технология, соответствующее программное средство, функциональные возможности, последовательность выполнения заданий). В педагогическом эксперименте задействован 101 студент (35% девушек и 65% юношей) юридического института Вятского государственного университета, г. Киров. В качестве метода статистической обработки используется критерий Фишера (угловое преобразование).

Результаты. Уточнена сущность понятий «персональная образовательная траектория», «персональный образовательный маршрут» с учётом вызовов к цифровой образовательной среде и с ориентацией на подготовку востребованных профессионалов будущего. Выявлены проблемы персонализации обучения (осознанность выбора, определение характеристических факторов образовательной модели, градация системы задач), содержание которых описано с позиции формальной схемы информационного взаимодействия. Представлен пример проектирования персонализированной образовательной модели на примере изучения технологии обработки электронных таблиц (система учебных проблем, направляющих траекторию познания). На контрольном этапе эксперимента выявлены статистически достоверные различия между экспериментальной и контрольной группами по уровню сформированности цифровых умений и навыков, востребованных в информационном обществе ($\varphi_{\text{крит}} = 1,64 < \varphi_{\text{эмп}} = 2,492$).

Заключение. Работа с цифровыми технологиями позволит учесть ориентацию современного образовательного пространства на персонализацию, непрерывность обучения за счёт реализации в учебно-познавательной деятельности описанной формальной схемы информационного взаимодействия педагога и обучающегося; проектирования дифференцированной системы задач; поддержки осознанного выбора обучающегося; социальной и профессиональной ориентированности действий.

Ключевые слова: программное средство, функциональные возможности, персональная образовательная траектория, персональный образовательный маршрут, персонифицированная среда, цифровая школа

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E. K. GERASIMOVA, S. L. ZORIN, G. A. KOBELEVA, E. A. MAMAEVA

Designing a personalized educational model while working with digital technologies

The problem and the aim of the study. The transformation of the educational environment identified the following development priorities for the didactic system: support for lifelong learning; personal orientation and taking into consideration the individual students' personality structure; use of digital technologies to provide training of the sought-after professionals of the future. The authors propose to implement these requirements with the means and capabilities of modern information technologies that maximally take into account the characteristics of personification.

Research methods. Theoretical and methodological analysis and generalization of fundamental scientific works on the research problem, processing of test results, problem solving, student's choice (digital technology, appropriate software, functionality, sequence of tasks) were applied. The pedagogical experiment was attended by 101 students (35% of girls and 65% of boys) of the Law Institute of Vyatka State University of Kirov, Russia. The Fisher's criterion (angular transformation) was used as a statistical processing method.

Results. The essence of the concepts "personal educational trajectory", "personal educational route" has been clarified. The challenges associated with the digital educational environment and a focus on training of the required professionals of the future were taken into account. The problems of personalization of learning (awareness of choice, determination of characteristic factors of the educational model, gradation of the task system) are identified, the content of which is described from the standpoint of the formal scheme of information interaction. An example of designing a personalized educational model is presented by studying the technology of processing spreadsheets (a system of educational problems that guide the trajectory of cognitive performance). At the control stage of the experiment, statistically significant differences were revealed between the experimental and control groups in terms of the level of formation of digital skills and skills that are in demand in the information society ($\varphi_{\text{crit}} = 1.64 < \varphi_{\text{emp}} = 2.492$).

Conclusion. Work with digital technologies offers the opportunity to take into account the orientation of the modern educational space towards personalization, the continuity of learning due to the implementation of the described formal scheme of information interaction between a teacher and a student in educational and cognitive activities; designing a differentiated system of tasks; supporting the student's informed choice; social and professional orientation of action.

Keywords: software, functionality, personal educational trajectory, personal educational route, personalized environment, digital school

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Introduction

The requirements of the digital economy have determined the need for the educational system to support lifelong learning, the use of innovative technical means to support the processes of automation, globalization and increased competitiveness as integral components of the transformation of society [1]. In addition, the digital educational environment prioritizes such necessary conditions as addressing the needs of the individual, the formation of the habit of learning throughout life. These conditions of personification are largely realized due to the didactic capabilities of new digital technologies. The use of multimedia and electronic educational resources, distance and online courses, gamification services, mobile platforms allows us to take into account individual aspirations and individual needs in the design of the educational process. However, the previously mentioned requirement of life-long learning determines the paradigm shift in the concept of lifelong education [2]. The latter includes the following characteristics: replacement of the general system of continuing education with conceptually structured and practice-oriented research (theoretical disaggregation); personal orientation; innovative research technologies aimed at the formation of a qualitatively different personally and socially significant product; sociocultural orientation, in the process of which a person creates his / her own mutually significant personal and sociocultural experience.

In the works of A. G. Asmolov it is emphasized that the problem of the goals of education is relevant today both in psycho-pedagogical and in socio-cultural terms [3]. At the same time, two main strategies of goal-setting interact: technological (mass) and humanitarian (personal) [4]. For a number of reasons, technologization itself cannot be considered as the only tool for modernizing education. It is necessary to combine technical solutions with psychological and pedagogical innovations. Yu. A. Lyakh's research is also devoted to the theoretical and methodological foundations and methodological issues of determining educational goals in the system of personalized education [5]. In terms of content and technology, a huge number of transformations are taking place, and a new environment appears for a contract between generations. In these conditions, the preparation of a graduate, according to A. G. Asmolov, involves preparing him for the world of uncertainty, where the basic skills are the ability to see the integrity of the information space, the willingness to understand the risks of decision-making and not to avoid choices [4]. Teaching tools will be of a different form, the teacher will be a motivator, navigator, communicator in the world of information. And today every student is able to be an active participant in learning, to find answers to problematic questions and tasks, as he is his own Yandex and Google [6].

E. G. Belyakova, I. G. Zakharova indicate that in the modern personalized educational space, digital technology should complement, expand the range of educational and cognitive influences, enrich cognitive practice, promote the acquisition of the culture of thinking, collaboration skills [7]. However, in reality it turns out that interest in learning increases most often due to the variety of digital means used, the inclusion of game elements. The issues of mastering innovative technologies, developing the content of information resources, the difficulty of choosing and evaluating applications, determining their optimal number to achieve didactic goals determine the professional activities of many modern teachers [1]. In addition, there are many scientific views and approaches to clarify the basic concepts of personalization, which consider various characteristic features of the learning

model [8]. In particular, A. V. Khutorskoy emphasizes that in the modern digital educational environment, any conditions can serve as the basis for choosing a learning technology [9]: individual personality traits, learning styles, the subject being studied, the type of educational institution, training profile, abilities and interests of the student, the range of information interaction, etc. E. V. Soboleva, T. N. Suvorova, E. Y. Bidaibekov, T. O. Balykbayev note that an obligatory criterion for the applied technology to be effective in terms of achieving the set goal in a personalized environment is the student's independent choice [8]. The main problem with personalization is that awareness of the learning path must come from the learner himself. For a tutor, when designing a route, difficulties also arise in collecting correct analytical information about the student's personality, previous cognitive experience and educational achievements. Methodological problems are also possible when choosing effective didactic technologies that maximally support students in their choice. A large number of digital technologies are now being developed to help personalize learning [10]. Let us mention only a few of them: the MOOC platforms; resources created by Stepik platform; Internet service PlayPosit; the navigator for the professions of the future from the Higher School of Economics. These technologies support the construction of a personal educational trajectory of students based on comprehensive assessments of their previous achievements and individual characteristics. E. V. Soboleva, T. N. Suvorova, E. Y. Bidaibekov, T. O. Balykbayev [8] note that personalized learning based on digital technology with appropriate pedagogical support of a mentor or a tutor potentially provides future graduates with a foundation of interdisciplinary knowledge in physics, mathematics, programming, etc., necessary for science and industry.

A. A. Somkin believes that the need to form a personal educational trajectory for personal development, due to the challenges of society, requires the use of new digital technologies when designing a personal route for realizing a student's personal potential in the educational space [11]. A personalized learning environment, supported by software and implemented on the principles of didactics, will allow students to solve strategic tasks (related to the achievement of certain qualitative results and competence-based new formations) with various digital resources and a variable set of actions. It is the personalization of education that will allow the formation and maintenance of nonlinear continuous development of the personality along the trajectory "preschool education - school - university - additional education" in the digital educational space. A software tool should not only be a powerful new educational tool. The use of a wide range of functional capabilities of modern digital technologies (cloud services, word processors, spreadsheets, graphic and video editors, interactive applications, etc.) supports the growing participation of students, an increase in cognitive interest and their direction in professional self-determination. Yu. V. Pushkarev, E. A. Pushkareva [12] note that, despite the interactivity of resources and the inclusion of game elements, mobile applications, students often play a passive role, while modern realities require highly qualified specialists to have creativity, research skills, abilities to work in conditions of uncertainty.

Thus, there is an objective burden of realizing the potential of innovative software and hardware for the formation of a personalized didactic environment. Research hypothesis – the use of modern information technologies will create additional pedagogical conditions that ensure effective personalization of learning (personality orientation, professional self-determination, continuity of education, socio-cultural experience). The purpose of the work is to study the features of designing a personalized learning model when working with various digital technologies for educational purposes.

Materials and methods

The methodological basis of the research is determined by the terms of the system-activity approach (A. G. Asmolov [3]); the concept of personalized learning (A. V. Khutorskoy [9]); analysis of scientific and theoretical sources on the digitalization of education and personality formation in the realities of a digital society (Yu. V. Pushkarev, E. A. Pushkareva [12]). Generalization of the conclusions of Yu. A. Lyakh [5], E. V. Soboleva, T. N. Suvorova, E. Y. Bidaibekova, T. O. Balykbayeva [8] contributed to the formulation of the characteristic features of a personalized educational model.

Research tools: word processors, spreadsheet and graphic editors, multimedia resources, cloud services, interactive applications, programs for creating quizzes and survey forms.

Empirical methods (observation, analysis of solutions to problem situations and tasks of a practice-oriented nature, the implementation of research projects, the intensity of information interaction) were used to obtain relevant information about the quality of assimilation of fundamental theoretical information, the formation of digital skills, the validity of the results, the validity of the use of digital technology and the optimal choice of software, etc.

The experiment was carried out in the framework of teaching the discipline "Informatics" for the educational program of higher education 38.05.02 Legal support of customs procedures (specialist level) on the basis of Vyatka State University (in Kirov). The study involved first-year students, the average age of the respondents was 19 years old. In total, 101 students took part in the experiment (65% of boys and 35% of girls). The use of digital technologies for the selected purpose does not impose special requirements on software and hardware, it can be combined with other information resources and traditional materials. The Fisher's angular transformation (Fisher's criterion) was used as a method of statistical processing [13].

Literature review

Analysis of the scientific and methodological literature on the formulated problem made it possible to identify the following areas in domestic and foreign research:

1. Description of the requirements, challenges of the digital economy to the content, methods and means of the modern educational space.
2. Study of the features and distinctive characteristics of differentiation, individualization, personalization of learning.
3. Studying the possibilities, problems of using innovative digital technologies for personalization of learning.
4. The need to improve the learning model, taking into account the capabilities of digital technologies to respond to the challenges of the future, to support the student's professional self-realization.

For example, M. Binkley, O. Erstad, J. Herman, S. Raizen, M. Ripley, M. Miller-Ricci, M. Rumble indicate that advanced economies are undergoing a significant shift from manufacturing to information and knowledge [14]. Knowledge itself is becoming more and more specialized, and digital technologies are changing the nature of teaching and educational work and social relationships. Readiness for decentralized decision-making,

openness to constant exchange of information, teamwork, project management and innovative research activities are becoming key requirements in modern enterprises and the labor market [15]. Trainees can no longer rely on professional self-fulfillment in an industry where manual labor is predominant or routine skills are used. Such professions are losing their relevance, and the corresponding work can be done efficiently with the help of machines. A professional career in the future depends on the ability to communicate, share and use information to solve complex problems, on the ability to adapt and innovate in response to new demands and changing circumstances, on the ability to mobilize and realize the power of technology to create new knowledge, and on the expansion of human potential and productivity [8].

When identifying the features and distinctive characteristics of personalization of learning, the results of research by Yu. A. Lyakh were taken into account [5]. She formulated the author's understanding of the phenomenon of "personalized learning", investigated its distinctive features (motivation, co-creation, social construction, self-knowledge). Each feature is revealed in specific educational situations with the emphasis on the role of a teacher, a student. Such analytical work allowed Yu. A. Lyakh to identify the differences between individualization, differentiation and personalization of teaching. The author emphasizes that it is the personalized model that immerses students as much as possible in the design and development of solutions to the problem of cognition. Moreover, within the framework of a personalized educational environment, a person receives the maximum conditions for the development of the skill "to be able to learn", the formation of a habit of mind. Habits of the mind refer to the qualities and skills of learners that guide their strategic abilities, expand ingenuity. That is, the habits of the mind determine the formation of the so-called "soft skills" that underlie the demanded supra-professional competencies.

A. A. Somkin substantiates that the formation of a digital society is accompanied, on the one hand, by high themes of scientific and technological progress, and on the other, by the activation of socio-cultural communications, which are focused mainly on the ideas of cooperation and assistance, tolerance and mutual understanding, respect for the individual and his rights [11]. In the new realities, such an important institution of socialization as education, in its traditional form, ceases to meet the challenges of the time. Global digital transformations require a revision of the organization of training. The author proves that a gradual transition of the education system to a personality-oriented learning model is necessary.

Raising a creative and responsible person who owns a communicative culture, according to A. Nuri, Mr. Sajidan, D. Oetomo, N. Prasetyanti, P. Parmin [16], should be reoriented from mechanical memorization of incomprehensible scientific facts and their formal reproduction to the development of creative innovative thinking. The rethinking of learning objectives should be accompanied by the formation of communicative dialogical skills, an independent critical attitude to professional problems, the ability to self-reflection and constant self-education. A. Khan, S. Breslav, K. Hornbæk prove that taking into account the principles of interactivity, visualization, personalization, multimedia, self-explanation, spatial representation in the organization of teaching and learning helps students to solve problems more efficiently [17].

The performed analysis of scientific and pedagogical literature allows us to reasonably assert that there are various terms due to the peculiarities of pedagogical support in the design of a personalized learning model: personal educational route, personal educational trajectory, personal curriculum, personal educational program, etc.

When identifying the potential, problems of using innovative digital technologies for personalizing learning, we note that a large number of educational solutions are proposed to improve the teaching methodology now. Digital technology offers mobile, customizable, user-friendly environments to support learning and stimulate individual potential. Nevertheless, as concluded by M. C. Buzzi, M. Buzzi, E. Perrone, C. Senette, technological learning tools are usually developed without regard to accessibility, which undermines the inclusion of people with special needs [18]. To bridge this gap, the authors are developing a web platform to provide affordable digital tools to people who can benefit from cognitive learning. The results of this study highlight the importance of content motivation and flexibility, levels of difficulty and pace for personalization. O. N. Berduygina notes that educational media resources are becoming more and more popular, which actualizes the issues of identifying their role and significance in the educational process, typology and classification [10]. The author describes digital means designed to enrich the intellectual potential of the participants in the didactic process. A significant result of the work for this research is that it defines the functions of the modern digital educational environment, which include compatibility and integration, personalization, analysis tools, collaboration, accessibility and an intuitive interface.

E. G. Belyakova, I. G. Zakharova investigate the problem of students' readiness to design the trajectory of their development and cognition by selecting and using the resources of the digital educational environment. Scientists substantiate the importance of this problem in the context of the integration of formal and non-formal education, its personalization in an open information environment and the individualization of education through the practice of individual educational trajectories [7].

J. Y. Yau, Z. Hristova propose to use mobile learning resources (m-learning) for personalizing education, that is, learning based on mobile technologies, mobile applications [19]. M. A. Virtanen, E. Haavisto, E. Liikanen, M. Kääriäinen explore a learning environment, laboratory, with digital learning resources, embedded functional objects, mobile devices and sensor technologies [20]. The authors substantiate that a convenient user interface using the technique of a spherical panoramic image makes it possible to realize personalization due to flexibility, richness of context, interactivity, and structuring of information. E. V. Soboleva, T. N. Suvorova, E. Y. Bidaibekov, T. O. Balykbayev [8] propose a model of personalized learning based on working with three-dimensional images.

I. N. Golitsyna considers the features of the concept of "flexible learning": it provides the teacher with additional opportunities for organizing students' independent work, individual control of assignments, allows to introduce elements of personalization of learning into the traditional educational process [21]. Flexible learning contributes to the improvement of self-education and lifelong learning techniques, the development of professional competencies and the formation of a personal-oriented digital educational environment, including the use of mobile devices.

Thus, a personalized learning environment is a model in which digital learning is combined with social interaction and collaboration. A personalized learning model allows to prepare a personality that best meets the challenges of the digital economy and the needs of the society of the future [22]. However, in all analyzed works, the teacher initially offers the student a digital technology for performing educational and cognitive activities: a mobile service, a 3D modeling tool, a programming language, an interactive application, etc. At the same time, the process of choosing a digital technology itself, the optimality of its functionality for solving a specific problem, argumentation of application - can and should

also set the trajectory for personalized learning. The teacher is required to organize targeted pedagogical support, which involves taking into account the individual achievements of a particular student and analyzing the results obtained earlier.

Research program

The main goal of the experiment was to test the effectiveness of the use of digital technologies to form a personalized educational space. At the preparatory stage of the experiment, a general assessment of the existing level of theoretical knowledge and information skills, problem solving skills, professional practice and work with software was carried out. As part of the control event, students were asked to perform testing on specific digital technologies studied within the discipline "Informatics". The test questions were developed by the authors in accordance with the educational and methodological complex and the work program. For each digital technology - 10 tasks, a total of 100 were selected for testing. Here are examples of the questions.

1. In the proposed, partially filled table (columns: historical fact, invention, personality) fill in the empty cells. For example, for the specified informational event, determine its participants, scientists and time period.

2. From the proposed software, select those that support the implementation of this digital technology. For example, software tools, MS Word, WordPad, Notepad, Paint, Prezi, etc. And digital technology is word processing technology.

3. The first column contains a set of characteristics of a digital technology: "automatic recalculation of the result when the initial data changes", "data sorting", "typing", etc. The second column presents the same number of digital technologies that students need to correlate with the values of the first column. A variant of complicating the task may be a situation when the students will be presented with an excessive number of digital technologies or functional capabilities.

4. A specific practical task has been formulated. For example, make a list of employees in your organization, sorting them by age. Calculate the length of service of each, the average for the department, the organization itself as a whole. The choice of a specific digital technology should be reasoned.

5. Solve the problem using the digital technology specified in the assignment. For example, arrange the Pythagorean table. The implementation can be done both in a text editor and in spreadsheets, presentation, interactive application.

When completing the test, a student received a "passed" mark if he scored more than 70 points. In other cases, the student was considered to have failed the test. Thus, it was possible to collect data on 101 students, of which the experimental (50 students) and control (51 students) groups were formed. The sample was not random. The experimental group includes 65% of boys and 35% of girls, which is due to the specifics of training. Further, as part of the formative stage, the teacher carried out methodological work in the experimental group to design a personalized learning model using digital technologies. The students of the control group studied information technologies according to the work program of the discipline in the traditional way through a series of lectures and seminars, with the support of multimedia presentations and electronic resources on the Internet. At the control stage of the experiment, one more testing was carried out. The test questions were designed according to the principles described earlier.

Research results

By personalization in the context of the research being conducted, we mean the creation of an educational environment focused on individual needs and the disclosure of individual capabilities, and providing the most effective learning. The analysis of scientific literature made it possible to conclude that the concept of "personalization" is often replaced by the concepts of "adaptability of educational content", "differentiation", "individualization". With such a replacement, the student loses the ability to manage the educational process and choose the subject of study. To minimize the risks of such a substitution in the research being conducted, we will define the characteristic features of a personalized learning process: it starts with the student; focuses on the interests, preferences and aspirations of the individual; students are actively involved in the design of the didactic process; students have the right to take part in the discussion and choice of the subject of study; select mentors/experts/tutors to support the learning path; assessment is seen as a continuation of learning [23].

Let's clarify the key interpretations of the basic concepts of personalized learning. By a personal educational route we mean a purposefully designed educational program that allows to put the student in the position of a subject of activity (selection, development, implementation of your own educational program), as well as a specific sequence of mastering the components of the content of education, chosen for a specific person. An important point in understanding this definition is the emphasis on personal development, motivation for cognitive activities, the individual pace of passing the personal path of realizing personal potential. A detailed analysis of the interpretations of the concepts of "personal educational route", "personal educational trajectory", "personal educational plan", "personal educational program" allows us to conclude that each concept testifies to the consideration of individual cognitive needs and interests of the individual, about building an individual, own educational ways for each student in modern conditions of variability of education (creation of optimal conditions, choice of individual forms, means, teaching methods). We also conclude that there is a difference between the very terms "route" and "trajectory". Route - the intended route of the object, taking into account the direction of movement with the indication of the start, end and intermediate points. Trajectory is a line that an object describes as it moves. Thus, we believe that a personal educational route is a planned way of achieving educational results, and a personal educational trajectory is the actual implementation of an educational route according to an individual educational program.

A necessary criterion for learning based on information technology to be effective in achieving the goals of a digital school, training demanded specialists of the future and to support a personalized environment is the student's independent choice [24]. The main problem with personalization is that awareness of the trajectory of cognition must come from the learner himself. When designing a route, a tutor also encounters difficulties in collecting correct analytical information about the student's personality, previous behavioral and cognitive experience. There may also be problems when choosing effective didactic technologies that maximally support students in their choice. We believe that in the modern digital educational environment, any conditions can serve as the basis for choosing a learning technology: individual personality traits, styles of cognition, the subject being studied, the

type of educational institution, the profile of training, the student's abilities and interests, the range of information interaction, etc.

Consider a fragment of the model devoted to the study of spreadsheet processing technology and its main capabilities. The teacher in a monologue form informs the students about the functional capabilities: filling in with initial data; obtaining results using formulas that connect the source data and the results, and as variables in the formulas, references to the cells that contain the source data are included; recalculation of results when the initial data changes.

In front of the students on a projector, a table prepared in advance by the teacher. For example, three rows and columns (A – product name, B – received, C – sold, D – remainder).

Question 1: How to calculate the remaining milk? Write dependency by formula. As a result of discussions, the formula $D2 = B2 - C2$ is written in cell D2.

Question 2: Suppose more milk was sold, for example, 154. What is the value in cell D2? The brainstorming results are verified by changing the value of cell C2 in the spreadsheet. Similarly, discuss the effect of changing the values in cell B2 on the result.

The following questions can be addressed to learners who understand the material.

Question 3: Check the validity of the formula for calculating bread sales. In this case, the formula (with an error) is already entered in advance by the teacher into the cell. As an error, there can be a reference to another cell, the use of real values (for example, $D3 = 584 - 484$), etc.

Question 4: Match the values of cell B2 to get the given value of cell D2.

To diagnose the understanding and level of assimilation of the material, in addition to working with the main table, you can provide for an appeal to a non-standard situation. To do this, we present an impersonal fragment of the table that is not related to the main task. We indicate that column C contains the results and its values are calculated by the formula, and ask what happens if the number "3" is changed to "2" in cell B2.

At the first level of acquaintance with the material and its awareness, it is assumed that students mentally restore the formula $C2 = A2 * B2$, perform calculations for new data $B2 = 2$ and get $C2 = 24$.

At the second level, the teacher tells about a case that happened in another group of students, when "3" was changed to "2" and NOTHING happened. "Why? Your assumptions." (The situation is very common, from the educational practice of the authors). Suggestions are made, and maybe someone from the group will guess. If not, the teacher will tell the answer - the formula for cell C2 is written as follows: $C2 = 12 * 3$, i.e. the formula used values, not cell references. Discussing the situation has the following advantages: a possible error is prevented; a deeper understanding of the value of the idea of using the addresses of cells containing the initial data in formulas to find the results; a connection is established between theoretical material and its practical application.

Much more often than a monological message of information, an interactive form of explanation, a problematic presentation of material, is used. Questions to learners do not imply receiving new information in response, but, rather, prompt thought, mark the main points, and form a plan for future research. This is especially important at the stage of motivation, communication of initial knowledge. It should be noted that in this situation the question itself performs an informational function, the question informs the learning subject in which direction the correct solution should be sought, and, possibly, suggests which questions still need to be answered. This is how the core line and reference points of the material under study are outlined. The answers can be heard in several versions:

1. After the question, the teacher pauses, during which the students pronounce their intended answer mentally or aloud, and then voice the correct answer - this option is good for a sufficiently long explanation that you would not want to interrupt, or in the case when the group is inactive or poorly prepared.

2. The teacher expects the response options and highlights the one that seems to him the most acceptable, with the obligatory justification of the choice made.

3. The proposed options are discussed by everyone, the choice belongs to the students, if they were able to sufficiently argue for it. In this case, the teacher acts as an arbiter, moderator of the discussion. Such a situation develops in the classroom infrequently and only when the students are already accustomed to feeling themselves subjects of knowledge, are confident in the importance of their opinion, and are not afraid to submit it to the general court. Further, the teacher defines a chain of problem situations that are consistently resolved by students in the course of experiments. The order of work is thought out, while providing for a certain degree of freedom, which allows you to flexibly respond to the situation of a specific lesson (variability of the trajectory of cognition). At the same time, the teacher needs, firstly, to make sure that this plan is supported in a preliminary conversation with the students, and, ideally, would be perceived by them as their own, developed during the discussion. Secondly, it is necessary to take into account the answers to the questions given during the discussion, as well as the ideas expressed for solving the problems posed.

In particular, the following situations are possible [25]:

- when, in order to solve the problem, the students offered two or even three options that can be considered acceptable, but an assessment of their advantages and disadvantages is required;
- when an answer lying on the surface, which seems correct at first glance, has limitations or contains a hidden flaw, leading in a certain case to an error;
- when the error of the proposed answer is not obvious and, moreover, the error contains some kind of contradiction, which can serve as a source of new knowledge, a deeper understanding of the method being mastered.

In all these cases, experimental verification of the proposed ideas has a perspective and cognitive value. We also note that in the corresponding personalized environment, each student is given the opportunity to independently choose a software tool, the sequence of resolving a chain of problem situations, and the pace of work. Thus, in the experimental work, thanks to modern digital technologies, the opportunity to train practical skills was realized; additional conditions for self-education of students have been created; a comprehensive presentation of educational material was organized. In other words, systematic pedagogical work has been carried out to train specialists in demand for a digital society.

At the verification stage of the experiment, a repeated measurement was carried out, also containing 100 questions. Information about the test results before and after the experiment is presented in Table 1.

Table 1

Test results before and after the experiment

	Before the experiment		After the experiment	
	Control group	Experimental group	Control group	Experimental group
Proportion of students who failed the test	51% (26)	52% (26)	45% (28)	22% (11)
Proportion of students who passed the test	49% (25)	48% (24)	55% (23)	78% (39)

The reliability of the results obtained was checked using the Fisher angular transformation (Fisher's criterion) using an online calculator (<https://www.psychol-ok.ru/statistics/fisher/>). The critical value of the Fisher criterion for a significance level of 0.05 (ϕ_{crit}) is 1.64.

The following hypotheses were accepted: H0: the level of formation of the demanded skills and digital skills of students after solving problems in a personalized environment by means of modern information technologies in the experimental group is statistically equal to the level of the control group; hypothesis H1: the level of formation of the required skills and digital skills of students after solving problems in a personalized environment in the experimental group is higher than the level of the control group.

The empirical value of the Fisher criterion before the start of the experiment is 0.01 ($\phi_{emp} = 0.01 < \phi_{crit} = 1.64$). Therefore, before the start of the experiment, the hypothesis H0 is accepted. The value of the Fisher criterion after the experiment is 2.492 ($\phi_{crit} = 1.64 < \phi_{emp} = 2.492$), therefore the hypothesis H0 is rejected and H1 is accepted. So, the differences in the levels of formation of skills and abilities after solving problems in a personalized environment by means of modern digital technologies between the students of the control and experimental groups are not due to random factors, but are logical.

Discussion

Analytical work with scientific and methodological literature revealed that in practice, the didactic process is mainly focused on the average level of the student's personality development, and is based on statistical data on the correspondence of the majority of students of this age to certain "age norms". But it must be remembered that not every student can fit into the concept of "average", and, accordingly, not everyone can fully realize their potential. The reasons can be both features and deviations in psychophysical development, and social problems. In general, the model of personalized learning when working with digital technology is as follows:

1. The "Student" system is in the $C_{ij} \in M$ state.
2. The mentor assumes to transfer her to the state $C_{ij+1} \in M$, for which he selects and implements the influence (set of influences) D_j . The state C_{ij+1} is predicted as the result of a compromise between its highest probability, determined by the initial state C_{ij} , and desirability both from the standpoint of educational achievements and from the standpoint of intellectual development (getting C_{ij+1} into the zone of proximal development), as well as taking into account the previous value Δ – the difference between the real and predicted states of the system in the previous step.
3. The student goes into the state C_{ij+1}' , which differs from the state C_{ij+1} , that is, does not coincide with the teacher's forecast. This state is diagnosed and determined by $D = C_{ij+1}' - C_{ij+1}$.
4. State C_{ij+1}' is taken as a new state C_{ij} , and the process is repeated again.

In accordance with the given model, the following features of a personalized educational environment can be distinguished:

1. Diagnostics of the state of the "Student" system: initial state C_{i0} ; the current state C_{ij} which the system receives as a result of the action (at the previous step it was defined as C_{ij+1}'); the difference between the predicted and real states $D = C_{ij+1}' - C_{ij+1}$, as well as a study of the reasons for the deviation.
2. Search for a set of influences taking into account: the state C_{ij} , which was determined at the previous step as C_{ij+1}' ; requirements for the new state of the "Student"

system C_{ij+1} ; models of transition from state C_{ij} to state C_{ij+1} ; analysis of the reasons for the deviation $D = C_{ij+1} - C_{ij+1}$.

It should be noted that the indicator of the effectiveness of the teacher's work is a consistent decrease in Δ . On the one hand, he more accurately predicts a new state, on the other hand, he selects more effective impacts. Observation of problem solving and information interaction through digital technology allow the mentor to accurately diagnose the condition of the student. At the same time, one should pay attention to the following points: what kind of mistakes the student makes; is he able to find an error and exactly how he searches – whether he analyzes the result or acts in a random way; how the result is styled – the styling shows whether the learner sees the structure; to what extent he is capable of building an activity plan both for himself and for another (software), how much he can put himself in the place of a formal executor; how he can express his thoughts both in natural language and (especially) in the language of technology.

Conclusion

Personalization of learning in a digital educational environment determines the need to resolve a range of theoretical and practical problems. In theoretical terms, it is difficult to concretize the phenomenon of "personalized learning model", to clarify the fundamental scientific concepts. In this work, to differentiate the terms "personalization", "differentiation", "individualization", the characteristic features of a personalized educational model are highlighted: learning begins with a person; focuses on the interests, preferences and aspirations of the individual; students actively participate in the design of the didactic process and in the discussion of the choice of the subject of study; learners select mentors / experts / tutors to support the learning path; assessment is seen as a continuation of learning. It also clarifies the essence of the concepts of "personal educational trajectory", "personal educational route", taking into account the challenges to the digital educational environment and with a focus on training the sought-after specialists of the future. When designing a personal learning model, aspects of personal development, motivation for cognitive activities, the individual pace of passing the personal path of realizing personal potential are taken into account. The spectrum of practical problems describes in detail the features of supporting the conscious choice of tools and methods of activity, self-determination of the trajectory of cognition, the gradation of the system of tasks and questions for thought.

The materials of the research work made it possible to formulate and describe the following features of the design of a personalized educational model of learning when working with digital technologies:

- a) the priorities of the digital society in relation to the training of in-demand specialists have an impact on the selection of a set of formed skills, abilities and competencies of the student, which are determined at the input of the personalized educational model;
- b) the selection of content and the logic of the course takes into account cognitive styles, comparison of the current and immediate levels of development, respect for the interests of the individual due to the fact that the student independently chooses a software tool, a level of task and a sequence of tasks for independent execution;
- c) the application of the described formal scheme allows avoiding a direct evaluative approach, since work with information objects presupposes an independent, creative research;

d) the diagnostic and control components of the model assume that the student will complete one of the multilevel tasks on the application of the functionality of digital technology, corresponding to the selected individual trajectory

e) educational results at the output of the personalized educational model when working with information technology (fundamental theoretical knowledge, digital skills, in-demand skills, experience in solving practical problems) correlate with the initial level of skills.

Analysis of the results of educational and cognitive activities of students allows us to reasonably assert that the use of modern information technologies supports the personalization of learning in a digital school. The effectiveness of the proposed approach is confirmed by the pedagogical experiment. The results obtained can be used for a practical response of the didactic system in the context of the digitalization of education to the requirements of modern society in terms of training the sought-after professionals of the future.

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Информация об авторах

Герасимова Елена Константиновна

(Россия, Ставрополь)

Кандидат педагогических наук, доцент
кафедры информатики института математики и
информационных технологий имени профессора
Н.И. Червякова

ФГАОУ ВО "Северо-Кавказский федеральный
университет"

E-mail: elkongerasimova@gmail.com

ORCID ID: 0000-0003-3758-8533

Зорин Сергей Леонидович

(Россия, Киров)

Кандидат юридических наук, доцент кафедры
судебных экспертиз

Вятский государственный университет

E-mail: usr11078@vyatsu.ru

ORCID ID: 0000-0001-6606-1883

Кобелева Галина Александровна

(Россия, Киров)

Заведующий кафедрой управления в образовании
Кировского областного государственного
образовательного автономного учреждения
дополнительного профессионального образования
«Институт развития образования Кировской области»

E-mail: ga.kobeleva@kirovipk.ru

ORCID ID: 0000-0001-8099-7792

Мамаева Екатерина Александровна

(Россия, Киров)

Старший преподаватель кафедры цифровых
технологий в образовании

Вятский государственный университет

Электронная почта: mamaevakathy@gmail.com

ORCID ID: 0000-0002-7721-8820

Information about the authors

Elena K. Gerasimova

(Russia, Stavropol)

PhD in Pedagogical Sciences,
Associate Professor

Department of Informatics, Institute of Mathematics
and Information Technologies (named after Prof. Nikolay
Chervyakov)

North Caucasus Federal University

E-mail: elkongerasimova@gmail.com

ORCID ID: 0000-0003-3758-8533

Sergey L. Zorin

(Russia, Kirov)

PhD in Legal Sciences, Associate Professor of the
Department of forensic examinations

Vyatka State University

E-mail: usr11078@vyatsu.ru

ORCID ID: 0000-0001-6606-1883

Galina A. Kobeleva

(Russia, Kirov)

Head of the Department of Education Management, of
Kirov Regional State Educational Autonomous Institution
of Continuing Professional Education

Institute for Educational Development of the Kirov
Region

E-mail: ga.kobeleva@kirovipk.ru

ORCID ID: 0000-0001-8099-7792

Ekaterina A. Mamaeva

(Russia, Kirov)

Senior Lecturer,

Department of Digital Technologies in Education
Vyatka State University

E-mail: mamaevakathy@gmail.com

ORCID ID: 0000-0002-7721-8820