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ВЛИЯНИЕ ТЕХНОЛОГИЙ НА РАЗВИТИЕ ОБРАЗОВАНИЯ

EVOLUTION OF TEACHING AND LEARNING THROUGH TECHNOLOGY

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The features of game mechanics use in teaching computer science for the development of creative thinking of students

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Abstract. *Problem statement*. One of the priority tasks of modern society is the creation of conditions conducive to the upbringing and development of a creative personality. The computer science course has a didactic potential in terms of the formation of initiative, independence, imagination, the ability to set and solve problems. The presented study aimed at substantiating the effectiveness of game mechanics use in teaching computer science to solve the problem associated with the need to develop the creative thinking of students. *Methodology*. The mechanics "Achievement," "Reckoning on trust," "Fun once – always fun," "User progress" are implemented with game elements and methods in the study of theoretical computer science. Resources of digital services (interactive whiteboards, random selection generators) are used for gamification. The base of the experiment is a secondary school with in-depth study of individual subjects in the Stulovo village (Slobodskoy district, Kirov region). The study covered 74 students of the seventh grade (64% – girls and 36% – boys). The average age of the respondents is 13 years. Statistical processing of the results was performed using Pearson's chi-squared test. *Results.* During the game, students study theoretical material, solve a system of creative and non-standard tasks on the topic "Measurement of information." For each game mechanic, a goal, tasks, sets of rules and restrictions are defined. Statistically significant differences in the qualitative changes that have taken place in the system according to the levels of development of creative thinking are identified. *Conclusion*. The features of the presented version of the application of game mechanics in teaching computer science in

terms of the development of creative thinking are described: taking into account the age characteristics of students when formulating message texts, inclusion of digital services, combination of oral and written speech with interaction on a computer network.

Keywords: digital school, gamification, information interaction, game mechanics, information measurement, creative thinking

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Особенности применения игровых механик в обучении информатике для развития креативного мышления школьников

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Аннотация. *Постановка проблемы.* Одна из приоритетных задач современного общества – создание условий, способствующих воспитанию и развитию креативной личности. Курс информатики обладает дидактическим потенциалом в плане формирования инициативности, самостоятельности, фантазии, умений ставить и решать задачи. Представленное исследование направленно на обоснование эффективности использования игровых механик при обучении информатике для решения проблемы, связанной с необходимостью развития креативного мышления школьников. *Методология.* Механики «Достижение», «Расчет на доверие», «Весело один раз – весело всегда», «Прогресс пользователя» реализованы при включении игровых элементов и методов в изучение теоретической информатики. Для геймификации применяются ресурсы цифровых сервисов (интерактивные доски, генераторы случайного выбора). База эксперимента – средняя общеобразовательная школа с углубленным изучением отдельных предметов д. Стулово (Слободской район Кировской области). Исследованием охвачено 74 обучающихся седьмых классов (64 % – девушки и 36 % – молодые люди). Средний возраст респондентов – 13 лет. Статистическая обработка результатов выполнена с помощью критерия хи-квадрат Пирсона. *Результаты.* В процессе игры обучающиеся изучают теоретический материал, решают систему творческих и нестандартных заданий по теме «Измерение информации». Для каждой игровой механики определены цель, задачи, наборы правил и ограничений. Выявлены статистически достоверные различия в качественных изменениях, произошедших в системе по уровням развития креативного мышления. *Заключение.* Описаны особенности представленного варианта применения игровых механик при обучении информатике в плане развития креативного мышления: учет возрастных особенностей школьников при формулировании текстов сообщений, включение цифровых сервисов, комбинирование устной и письменной речи и взаимодействия по компьютерной сети.

Ключевые слова: цифровая школа, геймификация, информационное взаимодействие, игровая механика, измерение информации, креативное мышление

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Problem statement. UNESCO recommendations, international rules in the field of education, determine that innovative pedagogical technologies (e-learning, distance learning, m-learning, artificial intelligence, gamification, etc.) and digital services provide additional didactic potential to enrich traditional educational organizational forms.[1] According to D. Halpern, forward looking education should be based on two principles: the ability to quickly navigate in a rapidly growing flow of information and find what we need, and the ability to comprehend and apply the received information [1]. These conclusions are also consistent with the positions of the current federal state educational standard of general education, according to which the task of a modern school is to develop the student's personality.[2]

According to G.I. Fazylzyanova, T.Yu. Sokolova, V.V. Balalov, a digital school mentor is recommended to use innovative pedagogical technologies to enhance the cognitive activity of students dynamically [2]. N.I. Isupova, T.N. Suvorova study the potential of the "flipped classroom" technology for changing traditional methodological systems of teaching, developing memory, attention and thinking [3]. The authors convincingly prove that the use of gamification within the "flipped classroom" technology helps to increase the motivation and involvement of students, the activation of cognitive interest, the formation of self-education and self-learning skills.

E.V. Soboleva, T.N. Suvorova, M.I. Bocharov, T.I. Bocharova point that the future graduate of the digital school should be ready and able to apply technological innovations and Internet resources to test hypotheses, search for facts and solve non-standard problems [4].

Creative students who can learn and think outside the box, according to the conclusions of M.K. Suyundikova, E.O. Zhumataeva, M.M. Suyundikov, have a number of skills and abilities that are in demand by modern society, such as finding various problem resolution options, expressing own point of view on a problem without fear, developed imagination and creative thinking, etc. On this basis the teachers of the digital school are faced with the task of creating conditions for the formation of the creative personality of student [5]. The authors consider that creative thinking is demonstrated not just in a random outburst of new ideas, it can also bring real significant returns. The habit of thinking creatively helps people achieve better results in transforming the surrounding reality, efficiently and competently respond to emerging challenges [6].

[1] 17 Goals to Transform Our World. Sustainable Development Goals. Available from https://www.un.org/sustainabledevelopment/ (accessed: 25.04.2022).

[2] Federal State Educational Standards for Basic General Education. Available from https://fgos.ru/fgos/fgos-ooo (accessed: 25.08.2022).

So, creative thinking is based on knowledge and experience and, therefore, can be the subject of purposeful formation.

According to C. Dichev and D. Dicheva, a new direction in the development of creativity in the educational and professional sphere is gamification based on the use of entertaining games in order to increase the motivational component of the creative process [7]. A promising direction, according to S. Dyson, Y. Chang, H. Ch. Chen, H. Yu. Hsiung, Ch. Ch. Tseng and J. H. Change, is the development of methods for training creativity in the professional and educational spheres based on board role-playing games, which allow including emotional and cognitive creative competence [8].

Taking into account modern requirements for the availability of distance education and communication in the business sphere, special attention is paid to the creation of educational games and platforms on a digital basis [9]. According to the conclusions of U. Cakiroglu, B. Basibuyuk, M. Guler, M. Atabay, B.Y. Memis, game technology is cross-subject and can be applied with equal efficiency in the study of various disciplines and courses [10]. This study examines the possibility of its implementation in the course of studying computer science at school. At the same time, as O.V. Sergeeva shows, effective memorization mechanisms are connected, which have a greater didactic effect than theoretical facts and abstract reasoning [11]. Game mechanics, as noted by N.N. Vekua, A.A. Lubsky, M.S. Perevozchikova, Ju.N. Folgerova, are cognitive research resources along with theoretical concepts and empirical procedures, thanks to which participants in the didactic process get new knowledge [12].

In general, game mechanics, according to O. Mauroner, should be understood as a set of rules and methods to support the interaction of the participants of the game environment and the game space itself (characters, design, plot) [13].

G.L. Parfenova, O.G. Kholodkova, Yu.A. Melnikova determine that the inclusion of games in work with teenagers of Z generation, firstly, is one of the labor functions of a mentor in the conditions of society informatization, and, secondly, an important aspect of improving the education quality [14].

The gamification of teaching computer science, which is substantiated by K.V. Safonov, E.A. Ischukova, V.V. Zolotarev, necessitates the teacher to solve a whole range of problems: technical, methodological, organizational [15]. N.N. Vekua, A.A. Lubsky, M.S. Perevozchikova, Ju.N. Folgerova, summarizing practical experience, concludes that educational gaming resources are practically not developed for teaching computer science [12]. The choice of interactive technology and digital service remains with the teacher. According to their conclusions, the modern information environment for teaching computer science should be guided by the new realities of didactics; provide opportunities for adaptation to the specific features of the subject.

The analysis of the scientific works listed above allows to identify *the problem* associated with the need for additional study of the formation of students' creative thinking in various game situations of didactic interaction. The article presents a study aimed at substantiating the effectiveness of game mechanics use in teaching computer science for the development of creative thinking in students.

Methodology. The following methods were used in the work: theoretical analysis and generalization of literature in describing the essence and potential of

the phenomenon of "gamification of education" in the context of UNESCO recommendations and the development of a digital school, clarifying the principles of game mechanics and their limitations for teaching computer science.

Evaluation criteria for the formation of creative thinking in the process of applying the studied concepts, implementing approaches for measuring information: generating new ideas (fluency of thinking); various application of methods and means (flexibility of thinking); non-standard use of data in educational and cognitive activity (originality of thinking); substantiation of expediency and applicability for obtaining the planned result (development of thinking).

Fundamental factors for including game elements in non-game contexts in computer science lessons: game mechanics (rules) and players. When designing gaming educational spaces, the teacher must monitor/record feedback in electronic form (player – system, player – player, player – leader).

To obtain up-to-date information about the effectiveness of the use of game mechanics for the development of creative thinking of students in computer science lessons, empirical methods are used: monitoring the communication of all participants in information interaction (for example, the content and volume of the "Memo for a friend" for recognizing false (fake) information); analysis of the speed and quality of solving problems of information search on the Internet; discussion of the work results on the transfer of information from one unit to another, etc.

The base of the experiment is a secondary school with in-depth study of individual subjects in the village of Stulovo. The study covered 74 students of the 7th grade: 64% are girls and 36% are boys. The average age of the respondents is 13 years. The use of game mechanics is implemented in the study of the topic "Measurement of information."[3]

The author's control work used to assess the input conditions includes the following blocks "Information and knowledge," "Perception and presentation of information," "Information processes." There are 12 tasks.

The level of formation of creative thinking ("high," "medium," "low") is evaluated by the sum of all 3 blocks. Low level is from 0 to 11 points inclusive, medium level is from 12 to 20 points inclusive, high level is more than 21 points.

Statistical processing of the results was performed using the $\chi 2$ (chi-squared) test of Pearson.

Results and discussion. According to D. Halpern, the creativity of thinking "is manifested in visual images and ideas, in the ability of a person to formulate own concepts and generalize previous experience; to analyze facts, correlate own understanding of the study subject and apply creative foresight" [1]. The last definition allows to single out such criteria for evaluating creative thinking as originality, flexibility, fluency. These conclusions correspond to the results of studies by J. Guildford who also includes elaboration in the presented list [16]. So, within the framework of the preparatory stage of the experiment, according to the results of analytical work with the literature, these four criteria were chosen as efficiency indicators of the technology used.

[3] Semakin IG, Zalogova LA, Rusakov SV, Shestakova LV. Informatics and ICT: textbook for grade 7. Available from https://uchebnik-tetrad.com/informatika-uchebniki-rabochie-tetradi/uchebnik-po-informatike-7-klass-semakin-chitat-onlajn (accessed: 20.08.2022).

For the initial diagnosis, students were asked to complete 12 tasks of the test, including the following blocks "Information and knowledge," "Perception and presentation of information," "Information processes." Each block contains 4 questions to assess the criteria of originality, flexibility, fluency, elaboration. For the correct performance of the task, the student received 2 points.

Sample questions for each criterion are presented below.

Task 1 (originality and fluency). Students are asked to open a dictionary and choose the first word that comes across, then come up with as many associations as possible. For example, the word "motivation" and associations to it: "stimulus," "money," "stick," "carrot," "encouragement," "feeling."

Task 2 (flexibility). "Changeling game." Students write down the words (on a specific topic from the above) from right to left. Task modification is that students decipher the word.

Task 3 (elaboration and fluency). Divide the situations listed below into three groups, in which the information carrier is: 1) a material object; 2) waves; 3) the state of matter. Examples: bell for break, buzzing bees, broadcast on TV, etc.

Task 4 (elaboration). Give examples:

– reliable, but not objective information;

– complete, reliable, but useless information;

– relevant, but inaccessible information.

So, for the control event, the student could get from 0 to 24 points. Thus, it was possible to collect data on 74 students divided into the control and experimental groups. Each has 37 people.

The results of the measurement carried out before the start of the experiment are presented in Table.

The results of measurements on the level of development of creative thinking

Level	Groups			
	Experimental (37 pupils)		Control (37 pupils)	
	Before the experiment	After the experiment	Before the experiment	After the experiment
High	2	11	3	5
Medium	16	22	16	15
Low	19	4	18	17

The second stage of the experiment was devoted to the analysis of the experience of gamification in teaching computer science, gaming technologies (services and platforms).

At the preparatory stage of the experiment for the practical implementation of game mechanics, "Achievement," "Reckoning on trust," "Fun once – always fun," "User progress" mechanics were chosen.

At the heart of the "Achievement" mechanics is a material/virtual expression of the player's action result. Achievements are considered by the game teacher on their own or as rewards. For example: a hint on a test, an assessment, additional time to prepare an answer, etc.

In the "Reckoning on trust" mechanics the social component of network communication between the participants of information interaction is implemented.

The “Fun once – always fun” mechanics is focused on achieving the following effect: the repetition of simple actions that deliver predominantly positive emotions to the game participant.

In the “User Progress” mechanics the achievements of the participant in the game educational space are tracked when solving a series of tasks.

The third stage of the study was devoted to the implementation of game mechanics in the study of the topic “Measurement of information.”

Let's consider the implementation of the “Reckoning on trust” mechanics. Each student in the experimental group is offered a situation for thinking. Its resolution determines one game beat. The game continues until the participants can independently or with additional help (other players, information sources, etc.) solve their “riddle.” In each game situation there is a message received over a computer network. The text of the message for creative, research (possibly collaborative) activities is presented on an interactive whiteboard.

An example of a game situation. Vasya's older brother is in the camp. They have various competitions, the guys are studying coding. In a conversation with Vasily, his brother said that he really liked the game “Spy Kids.” In addition, he noted that there are problems with the phone: it does not turn on, then it turns itself off. The next day, Vasya receives three SMS messages from an unknown number that look like jabberwocky. At the end of the last message was a “smile.” Vasily would have deleted these messages without getting to the point. But he remembered the conversation with his brother and… began to puzzle out.

The goal of the game is to decipher the message and determine the amount of information (information volume).

Game tasks:

– to learn to generate and improve diverse and creative ideas;

– to evaluate ideas and select those that can be further developed and refined.

The point is that during the game, students learn to critically evaluate the messages they receive, apply elements of cryptography, and become imbued with trust/distrust in a virtual companion.

Game questions: what information did Vasily’s brother transfer in messages? Determine the information volume of the received message.

Task modification: to send an encrypted message to the brother in response.

Game restrictions:

1. Be sure to bring discussions in the group to the formulation of the network etiquette rules (safe communication on the network).

2. The player can turn to external help only at the stage of “decoding” the message.

3. If the “game beat” turned out to be unsuccessful, then the player should not be unduly severely punished.

Let’s explain the essence of the “Fun once – always fun” mechanics for its study.

The entire experimental group was divided into 2 parts.

Each student of the first subgroup is given a plate with the name of the region/subject of Russia (two-digit number, months, etc.) on his back. There are two plates with this name at different players. It is not difficult to read what is written on the back of a classmate. Game problem: identify the inscription on the plate

on your back. Modification of the game (for adding additional points) is to form a pair with a second person carrying a similar plate.

Game restrictions:

1. Participants are only allowed to ask questions to surrounding people that they can answer "yes" or "no." For example: "Is this the easternmost subject of Russia? Is this the smallest region in Russia?", etc.

2. For each player from the second subgroup, there is a curator who monitors the correctness of questions and answers.

During the information interaction, both the student and his curator write down the questions and answers that the player receives.

The goal of the game is to identify the inscription on the plate.

Game tasks:

– to learn to ask questions that require the answer "yes" or "no," i.e. transferring ideas and information to the recipient in an understandable form;

– to form skills and abilities of oral information exchange;

– to establish trusting relationships;

– to develop logic and flexibility of the mind;

– to achieve a positive result in collaboration.

Game achievements: points, grades, access to new materials (pictures, links), additional minutes for solving test tasks, etc.

Students of the control and experimental groups were trained on the materials of I.G. Semakin, L.A. Zalogova, S.V. Rusakov, L.V. Shestakova. The textbooks involves working with information of various types, learning to organize their own informational activity and planning its results. A large number and variety of tasks makes it possible to adapt the practical part of the training course content to the profile of the class, the level of students training, the amount of study time, the level of hardware and software.

Students in the control group also studied about information, information properties, information representation in a computer and approaches to measuring information. On lessons the teacher analyzed examples of tasks solving, methods for assessing the amount of information, selected tasks for self-study. Computer network resources and digital technologies were actively used (to search for information, design solutions, presentations). Students in the control group learned to measure the information volume of text in bytes; recalculate the amount of information in various units (bits, bytes, Kb, Mb, Gb). However, students from the control group were not specifically involved in the game activity for measuring information.

At the fixing stage of the experiment, the test was again carried out from 3 blocks, 4 tasks in each. Post-experiment data are also presented in Table.

In this case, the hypotheses are formulated as follows.

H0: the level of creative thinking in the experimental group is statistically equal to the level in the control group; H1: The level in the experimental group is higher than the level in the control group.

Further, the values of the criterion were calculated in the online resource before ($\chi 2$ observable 1) and after ($\chi 2$ observable 2) the experiment. For $\alpha = 0.05$, according to the distribution tables, $\chi 2_{crit}$ is equal to 5.99. Thus, $\chi 2_{obs1} < \chi 2_{crit}$ ($0.23 < 5.99$), and $\chi 2_{obs2} > \chi 2_{crit}$ ($11.62 > 5.99$). Therefore, the shift towards in-

creasing the level of creative thinking of the students in the experimental group can be considered non-random.

Performing a quantitative analysis of the data obtained, we can conclude that after the completion of the experiment, 30% of students in the experimental group had a "high" level of creative thinking formation (11 students out of 37). While initially this percentage was equal to 5% (2 respondents out of 37). The number of students with a "low" level has significantly decreased from 51 to 11%. For the control group, the following was recorded: the indicator for the "high" level qualitatively changed from 8 to 14%, and for the "low" level changed from 49 to 46%.

So, the described system of actions for game mechanics use in teaching computer science allows:

– to create additional conditions for the development of originality, fluency, flexibility and elaboration of thinking;

– to get experience in research and educational and entertaining activities in the study of theoretical computer science;

– to apply concepts, scientific information, information theory formulas to solve game situations;

– to connect virtual network resources to organize direct communication between participants in the didactic process;

– to form collaboration skills (group creative thinking);

– to develop socially significant personality traits (family values, purposefulness, the value of friendship, etc.).

The research materials correspond to the priority directions of UNESCO activity and the system of Russian education in terms of gamification of education [13]. The results obtained supplement the conclusions of N.I. Isupova, T.N. Suvorova about the potential of didactic games for teaching computer science [3] and develop the ideas of S. Dyson, Y. Chang, H.Ch. Chen, H.Yu. Hsiung, Ch.Ch. Tseng and J.H. Change regarding the influence of game strategy, mechanics, dynamics on the formation of creative thinking [8].

Conclusion. The most important principle of modern education is the optimization of upbringing, socialization and adaptation of the individual through the use of innovative psychological and pedagogical technologies. One of them is gamification. It allows game mechanics use to support the assimilation of large amounts of theoretical material by students and prevent information overload. The study made it possible to formulate the following features of game mechanics use in teaching computer science in terms of the development of creative thinking:

– the need to take into account the age characteristics of students when formulating message texts. Non-standard tasks, game problems, as a rule, have a high level of difficulty (concepts, terms, facts). At the same time, the teacher should remember that the game must both bring pleasure to the participant and contribute to the activation of cognitive activity;

– the usefulness of including digital services in the game. For example, random number generators (https://randstuff.ru/number/) or fortune wheels (https://ru.piliapp.com/random/wheel/) for choosing a player, dividing into teams;

– the importance of the content of the plot, the system of characters for the game situation. They should allow to generate and discuss ideas;

– the expediency of combining oral, written speech, interaction over a computer network. This provides additional conditions for the development of creativity of speech – an important factor in the formation of creative thinking.

Thus, inclusion game mechanics into computer science education is an effective technology for the development of creative thinking. The proposed methodology can be explored in a variant way to organize the process of studying and perception of information in the online space and in other school subjects, as it involves universal forms and characteristics of the human psyche.

References / Список литературы

[1] Halpern DF. Teaching for critical thinking: helping college students develop the skills and dispositions of a critical thinker. *New Directions for Teaching and Learning*. 1999;(80):69–74. http://doi.org/10.1002/TL.8005

[2] Fazylzianova GI, Sokolova TYu, Balalov VV. Gamification trends in educational communications in a digital society. *Economic and Social Research*. 2021;(1):105–110. http://doi.org/10.24151/2409-1073-2021-1-105-110
Фазылзянова Г.И., Соколова Т.Ю., Балалов В.В. Тенденции геймификации в образовательных коммуникациях цифрового общества // Экономические и социально-гуманитарные исследования. 2021. № 1. С. 105–110. http://doi.org/10.24151/2409-1073-2021-1-105-110

[3] Isupova NI, Suvorova TN. Gamification of the educational process using the "flipped classroom" technology. *Perspectives of Science and Education*. 2019;(5):412–427. http://doi.org/10.32744/pse.2019.5.29
Исупова Н.И., Суворова Т.Н. Геймификация учебного процесса с использованием технологии «перевернутый класс» // Перспективы науки и образования. 2019. № 5 (41). С. 412–427. http://doi.org/10.32744/pse.2019.5.29

[4] Soboleva EV, Suvorova TN, Bocharov MI, Bocharova TI. Development of the personalized model of teaching mathematics by means of interactive short stories to improve the quality of educational results of schoolchildren. *European Journal of Contemporary Education*. 2022;11(1):241–257. http://doi.org/10.13187/ejced.2022.1.241

[5] Suyundikova MK, Zhumataeva EO, Suyundikov MM, Snopkova EI. Prerequisites defining the trajectory of creative thinking. *Education and Science Journal*. 2021;23(3):75–100. http://doi.org/10.17853/1994-5639-2021-3-75-100

[6] Muhammadiyeva H, Mahkamova DK, Valiyeva S, Tojiboyev IU. The role of critical thinking in developing speaking skills. *International Journal on Integrated Education*. 2020;3(1):62–64. http://doi.org/10.31149/ijie.v3i1.273

[7] Dichev Ch, Dicheva D. Gamifying education: what is known, what is believed and what remains uncertain: a critical review. *International Journal of Educational Technology in Higher Education*. 2017;14:9. http://doi.org/10.1186/s41239-017-0042-5

[8] Dyson S, Chang Y, Chen H-Ch, Hsiung H-Yu, Tseng Ch-Ch, Chang J-H. The effect of tabletop role-playing games on the creative potential and emotional creativity of Taiwanese college students. *Thinking Skills and Creativity*. 2016;(19):88–96. http://doi.org/10.1016/j.tsc.2015.10.004

[9] Hamada M, Hassan M. An interactive learning environment for information and communication theory. *Eurasia Journal of Mathematics Science and Technology Education.* 2017;13(1):35–59. http://doi.org/10.12973/eurasia.2017.00603

[10] Cakiroglu U, Basibuyuk B, Guler M, Atabay M, Memis BY. Gamifying an ICT course: influences on engagement and academic performance. *Computers in Human Behavior*. 2017;69:98–107. http://doi.org/10.1016/j.chb.2016.12.018

[11] Sergeeva OV. Development of research computer game: how new ontology helps to cope with the methodological challenges in sociology. *Sociology of Science and Technology*. 2021;12(3):171–184. http://doi.org/10.24412/2079-0910-2021-3-171-184

Сергеева О.В. Разработка исследовательской компьютерной игры: как новая онтология помогает решать методологические проблемы социолога // Социология науки и технологий. 2021. Т. 12. № 3. С. 171–184. http://doi.org/10.24412/2079-0910-2021-3-171-184

[12] Vekua NN, Lubsky AA, Perevozchikova MS, Folgerova JuN. Peculiarities of forming high-demanded soft skills in the educational space of the escape room. *Perspectives of Science and Education*. 2020;(6):397–412. http://doi.org/10.32744/pse.2020.6.31

[13] Mauroner O. Gamification in management and other non-game contexts – understanding game elements, motivation, reward systems, and user types. *Open Journal of Business and Management*. 2019;7:1815–1830. http://doi.org/10.4236/ojbm.2019.74125

[14] Parfenova GL, Kholodkova OG, Melnikova JuA. Complex psychological and educational support for gifted children in social and educational space: description of the model. *Science for Education Today*. 2019;9(6):88–105. http://doi.org/10.15293/2658-6762.1906.06
Парфенова Г.Л. Холодкова О.Г., Мельникова Ю.А. Комплексное научное психолого-педагогическое сопровождение одаренных детей в социально-образовательном пространстве: обоснование модели // Science for Education Today. 2019. Т. 9. № 6. С. 88–105. http://doi.org/10.15293/2658-6762.1906.06

[15] Safonov KV, Ischukova EA, Zolotarev VV. Application of gamification elements in the training of students – future specialists in the field of information security. *Perspectives of Science and Education*. 2021;(1):450–463. http://doi.org/10.32744/pse.2021.1.31
Сафонов К.В., Ищукова Е.А., Золотарев В.В. Применение элементов геймификации в подготовке студентов – будущих специалистов в области защиты информации // Перспективы науки и образования. 2021. № 1 (49). С. 450–463. http://doi.org/10.32744/pse.2021.1.31

[16] Guilford JP. Creativity. *American Psychologist*. 1950;5:444–454. http://doi.org/10.1037/h0063487

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