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EMPIRICAL EVALUATION OF GAMING SOFTWARE OF THE GAMIFICATION ENVIRONMENT FOR THE PREPARATION OF FUTURE BACHELORS OF INFORMATICS

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The article presents a model of introducing a gamification environment into the educational process for the preparation of future bachelors of informatics. We have analyzed the domestic and foreign experience in selecting criteria for software and hardware, determined the criteria for selecting the components of the gamification environment and the indicators of each criterion, selected the components of the gamification environment, conducted an experimental evaluation of some software samples according to the defined criteria. The purpose of the article is to design a model of a gamification environment for training future bachelors of computer science in higher education institutions. Design, cloud-oriented, content and information and communication criteria were selected for the selected platforms and their components were outlined. A table of evaluation by experts was developed and the results were analyzed. A ranking of the received data was also made and conclusions were drawn based on the evaluation results. According to experts' assessments, the environment most suitable and least suitable for the selected criteria was determined, as it scored the highest and lowest number of points. An expert assessment of gamification platforms was conducted, criteria for selecting such platforms were developed, and indicators of each environment were outlined. We see the design of other components of the gamification environment, the creation of tasks using gamification technologies, the analysis of feedback, the development of technological infrastructure and the creation of methodological recommendations for the implementation and use of the environment as further perspectives of the research.

Keywords: Digitization, digital educational environment, gamification, gamification environment, bachelor of computer science

Introduction. The Problem Statement Along with the expansion of information and communication technologies from the beginning of the 21st century, a significant transformation in the field of education is coming. Teachers in higher education institutions are moving towards improving teaching methods and spreading their diversity through the use of digital technologies. The introduction of advanced technologies made the presentation of material by teachers more convenient, and the perception and processing of information by students – more effective. In modern conditions, when informatization of the educational process has become a permanent factor, the use of information and communication technologies is a necessary component of higher education. These methods play an important role in the educational process of higher educational institutions, not limited to tools for solving pedagogical tasks, but provide new opportunities for learning, contribute to the development of methods and didactics, and also contribute to the creation of new forms of learning. One of the promising areas of development of modern information technologies is the use of gamification technologies.

The **purpose** of the article is to determine the selection criteria for the components of the gamification environment and conduct an experimental analysis of the selected samples.



The task of the research is:

1. Analysis of the experience of introducing games into the educational process.
2. Determination of selection criteria for the components of the gamification environment.
3. Selection of components of the gamification environment.
4. Classification of the components of the gamification environment.
5. Experimental evaluation of selected software samples according to defined criteria.

Analysis of recent research and publications.

The issue of using gamification technologies in the field of education of higher educational institutions is dealt with by:

1. Researchers in the field of education, who specialize in research on the use of gamification in the educational context, conduct scientific research, analyze the impact of gamification on learning and development of students in higher education institutions;
2. Teachers at universities study and implement game techniques in their classes and courses. They explore how gamification can improve learner engagement and motivation to learn;
3. Technology companies and startups that specialize in the development of platforms and tools that use gamification for educational purposes. They create educational games, applications and platforms that help students learn through gaming technologies;
4. Educational institutions and organizations that include gamification in their training programs. They conduct research and experiments on the use of gamification in classrooms and outside them [12].

The works of V. Bykov, S. Lytvynova, M. Shishkina, A. Milich, K. Simych, M. Mulintovych and others are devoted to the issue of designing the educational and scientific environment of a higher education institution. Among scientists, V. Bykov, K. Werbach, K. Larson, Lee Sheldon, E. Corcoran, O. Chyzhikova, O. Shimanska, I. Sergienko, N. Morse, K. Caperson, J. McGonigal, S. De Bevo, L. Gallagher and others [3, 4, 5]. Nevertheless, as of today, the problem of creating a gamification environment for the training of future informatics bachelors is still relevant.

Research methods. To solve the research tasks, the analysis of scientific publications of domestic and foreign researchers was carried out. The following methods and approaches were used to conduct the research: analysis of theoretical sources related to the design of the gamification environment, generalization and systematization of the information obtained from the analysis of theoretical sources and the use of system analysis methods to understand and analyze the characteristics and relationships of the gamification environment.

The Presentation of Main Material. The design components of the gamification environment are the basis for creating the gamification environment and reflect its functionality and structure. Higher educational institutions need to increase the efficiency of the educational process and involve students in performing complex tasks. The application of gamification principles can improve student engagement in active learning and promote new forms of group collaboration. This allows you to create a stimulating environment where students are involved in the educational process and have the opportunity to develop cooperation skills and solve tasks with the help of gamification elements. To design a gamification environment model, it is necessary to take into account several key elements, including: the goal, the definition of the target audience, the selection of game services and platforms, creating tasks with gamification elements, progression, feedback, technological infrastructure and methodological recommendations for the implementation and use of the environment. The following are defined as elements of the gamification environment:

1. Didactic materials.
2. Methodological recommendations.
3. Training courses.
4. Participants of the educational process.
5. Teaching aids.

First of all, it is worth paying attention to the training tools, since gamification tools are used here. The use of gamification technologies requires special software and hardware. In the following works, we will talk about the hardware, but the interaction between the student and the teacher is carried out precisely through the software. O. Spirin, T. Vakalyuk, L. Luparenko, O. Golovnia, S. Litvynova, R. Blanco, M. Trinidad, M. Jose Suarez-Cabal, A. Calderon, M. Ruiz, Javier Tuya, M. Jean Cadet and others. [3, 4, 5, 6, 7, 8, 10].

There are many software tools that can be used to create a gamification environment in educational institutions. Ready-made gamification platforms are software solutions that include tools and functionality for creating a gamified environment. Among the most famous are: Classcraft, Kahoot, Breakout EDU, Quizizz and Moodle. There are specialized applications and web services that allow you to create game tasks, distribute points, reward achievements and track student progress. Examples include Classcraft, Epic Win, ClassDojo, and Socrative. The use of virtual environments and games can create an immersive learning environment that combines gamification and learning. For example, Minecraft Edu, Second Life or games designed specifically for educational purposes. Also, some learning management systems, such as Moodle, Canvas or Blackboard, have built-in gamification tools or plugins that allow you to add game elements to the learning process. The next category of software is custom solutions that are designed for unique needs and allow you to develop your own software. In addition to software tools, it is also important to consider other components of a gamified environment, such as tasks, game rules, rewards, communities, and feedback, and choose the software tool that is best suited to integrate these elements [6].

Here are some specific examples of software that can be used to design a gamified learning environment:

1. Kahoot: This is an interactive platform for creating quizzes and game tasks. Teachers can create questions for students to answer using mobile devices, compete against each other and earn points.
2. Minecraft Edu: This is a special version of the Minecraft game designed for educational purposes. It allows teachers to create virtual learning environments where students can interact, collaborate and solve problems.
3. Breakout EDU: This is a platform that offers a set of ready-made game scenarios with riddles and puzzles. Teachers can use these scenarios to create a variety of gamified activities.
4. 3DGameLab: This is an online platform that allows teachers to create gamified courses. It offers tools for creating quests, rewards and feedback.
5. Quizizz: This is an interactive platform for conducting quizzes and contest games. It offers a large number of ready-made quizzes, as well as the possibility of creating your own. Students compete among themselves, receiving points for correct answers [1].

When determining the criteria for selecting software for gamification tools, we focused on improving the efficiency of students' perception of new information and its systematization. We analyzed the experience of introducing digital environments into the educational process in Ukrainian higher education institutions, as well as studied the foreign experience of using gamification tools. As a result, the following criteria for the selection of software for gamification tools were formulated: design, cloud-oriented, content, and information and communication [9, 13].

Let's consider in more detail each of the criteria and their evaluation of their indicators by experts.

The design criterion involves designing the environment and adapting it to the needs of a specific group and teacher.

The indicator "augmented/virtual reality tasks" involves the ability to create and complete tasks using augmented and/or virtual reality.

"Availability of a free license" implies the availability of full or partial free access to the functionality of the platform.

The "authorization" indicator provides for the possibility of authorizing students using a link or registering independently without an invitation.

The "rights setting" indicator provides access to the class with certain rights set by the teacher.

The indicator "creating a class" provides the ability to create groups to create specific tasks for a group of students.

The cloud-oriented criterion implies access from any place and gadget, regardless of place and time, as well as the presence of not only a desktop version of the platform, but also a web version and a mobile application.

The indicator "availability of a web version" implies the presence of not only a desktop version and a mobile application, but also a cloud platform for performing tasks.

"Mobile application" implies the availability of a mobile application for performing tasks from gadgets on the IOS or Android platform.

The meaningful criterion outlines the extent to which each platform corresponds to the syllabus of the selected training courses. It reveals to what extent professional competences are cultivated during the use of this or that platform.

"Formation of professional competences" presupposes the presence of a sufficient level of education of key competences during the use of this or that platform.

"Formation of general competences" presupposes the presence of a sufficient level of education of general competences provided for by the educational program during the use of one or another platform.

"Compliance with the curriculum" implies the completion of all tasks provided for in the curriculum.

The information and communication criterion assumes the presence of the functionality of using the platform to introduce gamification into the educational process and the presence of communication in the web version, desktop or mobile application, communication between the teacher and students, as well as between the group. Let's consider each indicator in detail.

The indicator "multimedia design" assumes the presence of adding audio and video materials to the task, with the possibility of editing them in the platform itself by the teacher [8].

"Reports" allows you to view reports on completed tasks and shows the number of attempts to successfully complete the task.

The "help" indicator characterizes the help section of the platform for performing a certain task. Intended for teacher filling in methodical instructions [11].

The use of the expert evaluation method for gamification tools of the educational process consists in the fact that a specific characteristic of the tool is numbered in ascending or descending order, depending on the presence of an indicator of this characteristic. In total, 5 gamification tools in the educational process were proposed for evaluation. We have proposed a scoring system for evaluating the criterion indicator, according to which the highest score is 10 for the highest manifestation of the criterion indicator, and 1 for the lowest manifestation.

To reduce the probability of coincidences between experts, the proposed platforms are placed in a random sequence.

The results of the expert survey are presented in Table 1.

Table 1

| Expert | Kahoot | Minecraft edu | BreackoutEdu | 3DGameLab | Quizizz |
|--------|--------|---------------|--------------|-----------|---------|
| 1 | 5 | 3 | 1 | 2 | 4 |
| 2 | 4 | 3 | 1 | 2 | 5 |
| 3 | 5 | 2 | 4 | 1 | 3 |
| 4 | 5 | 4 | 1 | 2 | 3 |
| 5 | 3 | 1 | 4 | 2 | 5 |
| 6 | 5 | 1 | 2 | 3 | 4 |
| 7 | 5 | 1 | 3 | 4 | 2 |

| | | | | | |
|----|---|---|---|---|---|
| 8 | 4 | 1 | 3 | 2 | 5 |
| 9 | 3 | 5 | 1 | 2 | 4 |
| 10 | 4 | 2 | 1 | 5 | 3 |
| 11 | 5 | 3 | 1 | 4 | 2 |
| 12 | 4 | 3 | 2 | 1 | 5 |
| 13 | 4 | 3 | 2 | 5 | 1 |
| 14 | 5 | 2 | 1 | 3 | 4 |
| 15 | 4 | 1 | 2 | 3 | 5 |
| 16 | 4 | 3 | 2 | 1 | 5 |
| 17 | 5 | 3 | 2 | 4 | 1 |
| 18 | 4 | 5 | 3 | 1 | 2 |
| 19 | 5 | 4 | 2 | 1 | 3 |
| 20 | 5 | 3 | 2 | 4 | 1 |

The total rating of each platform equals: Kahoot! – 88, MinecraftEdu – 53, BeackoutEdu – 40, 3DGameLab – 52, Quizizz! - 67 points.

According to the formula for determining concordance ($W = \frac{S(d^2)}{S_{\max}(d^2)} = \frac{12 \cdot S(d^2)}{m^2(n^3 - n)}$), where $S(d^2)$ – sum of squares of values, $S_{\max}(d^2)$ – the maximum value of the sum of the squares of the values, m – the number of experts, n – the number of evaluated platforms, it is possible to calculate that $W = 0.3365$. This value is between 0 and 1. If W is approximately equal to 0, then the relationship between the ranking of experts is very small, while if W approaches 1, then the ranking of experts practically coincides [2].

Discussion. Since the result we obtained is closer to 0, we can say that expert opinion is quite subjective. The obtained results indicate the statistical significance of the concordance coefficient w . The obtained result can be substantiated by different approaches to the implementation of such platforms in institutions of higher education. We can conclude that Kahoot platforms are the most suitable! and Quizizz!, as they scored 88 and 67 points, respectively, according to experts. Based on this, we can say that the BreakoutEDU and 3DGameLab platforms are the least suitable for the criteria of design, functionality, information and communication, and content. This is due to the fact that these platforms have poorly developed user rights settings, very limited functionality of the free license, and only a desktop or web version is available.

Conclusion. Thanks to the design of a digital environment of gamification in the educational process of training future bachelors of informatics, the applicant has the opportunity to use the game environment during training and make the training process itself more effective. We conducted an expert evaluation of gamification platforms, developed criteria for selecting such platforms, and outlined the indicators of each environment. In our opinion, thanks to the use of such teaching methods, students will be able to increase their success rate, improve their skills in acquiring new information, and better systematize the received information. In the future, it is planned to develop a model for designing a gamified educational environment for training bachelors of computer science and create a methodical system for its use in training students. During the design of the model, the goal, task, and needs of introducing the gamification environment into the educational process were formed.

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**ЕМПІРИЧНА ОЦІНКА ІГРОВОГО ПРОГРАМНОГО ЗАБЕЗПЕЧЕННЯ
ГЕЙМІФІКАЦІЙНОГО СЕРЕДОВИЩА ДЛЯ ПІДГОТОВКИ МАЙБУТНІХ
БАКАЛАВРІВ ІНФОРМАТИКИ**

У статті представлено модель упровадження середовища гейміфікації в освітній процес для підготовки майбутніх бакалаврів інформатики. Проаналізовано вітчизняний та зарубіжний досвід вибору критеріїв програмно-технічного забезпечення, визначено критерії відбору компонентів середовища гейміфікації та показники кожного критерію, відібрано компоненти середовища гейміфікації, проведено експериментальну оцінку окремих зразків програмного забезпечення відповідно до визначених критеріїв. Метою статті є розробка моделі середовища гейміфікації для підготовки майбутніх бакалаврів інформатики у закладах вищої освіти. Для обраних платформ було обрано дизайн, хмароорієнтованість, контент та

інформаційно-комунікаційні критерії й окреслено їх компоненти. Розроблено таблицю оцінювання експертами та проаналізовано результати. Також проведено ранжування отриманих даних та зроблено висновки за результатами оцінювання. За оцінками експертів було визначено середовище, яке найбільш та найменш відповідне обраним критеріям, оскільки воно набрало найбільшу та найменшу кількість балів. Проведено експертну оцінку гейміфікаційних платформ, розроблено критерії відбору таких платформ, окреслено показники кожного середовища. Подальшими перспективами дослідження ми вбачаємо проектування інших компонентів середовища гейміфікації, створення завдань із використанням технологій гейміфікації, аналіз зворотного зв'язку, розвиток технологічної інфраструктури та створення методичних рекомендацій щодо впровадження та використання середовища.

Ключові слова: цифровізація, цифрове освітнє середовище, гейміфікація, середовище гейміфікації, бакалавр інформатики

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