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GAMIFICATION TECHNOLOGIES IN THE EDUCATIONAL PROCESS OF SMART-TNPU IN THE COMPUTER SCIENCE TEACHING

The article describes the features of the gamification technologies used in the educational process of SMART-TNPU, based on the work experience of researchers of Ternopil Volodymyr Hnatiuk National Pedagogical University (TNPU). An analysis of the game technologies implementation in the process of learning computer science at the university and general secondary education institutions was conducted. In the conditions of martial law, the situation with gamification of education is considered, the role of gamification in the educational process is determined. Significant achievements of the teachers of the Department of Computer Science in the study of problems related to the game technologies used in classes with different age groups of pupils and students are described. The conducted research helped to identify the main playgrounds and platforms that contribute to the development of digital competences of the participants of the educational process, help them create their own game projects. Approaches to the stages of implementing gamification in the SMART-TNPU system have been analyzed. The specifics of each stage of gamification are defined, the analysis of game project creation services and their use is presented. The main types of gamification in the educational process are outlined. The examples of student game projects and tasks are provided. The spheres of positive influence of gamification technologies using a Likert scale are substantiated, and caveats regarding their mass use are indicated. Gamification is an example of the use of innovative technologies, which contributes to increasing the efficiency of the organization of the educational process and achieving high results in the training of a modern computer science teacher.

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ТЕХНОЛОГІЇ ГЕЙМІФІКАЦІЇ В ОСВІТНЬОМУ ПРОЦЕСІ SMART-ТНПУ ПРИ НАВЧАННІ ІНФОРМАТИКИ

Описано особливості використання технологій геміфікації в освітньому процесі SMART-ТНПУ при навчанні інформатики з досвіду роботи науковців Тернопільського національного педагогічного університету імені Володимира Гнатюка (ТНПУ). В умовах війни рашистської росії проти України технології, адаптовані до умов дистанційного чи змішаного формату навчання, стають більш потрібними, оскільки дають можливість не тільки підвищувати самомотивацію учасників освітнього процесу, а й сприяють зростанню якості навчання та показників успішності. Однією таких технологій, апробованих на базі STEM-центру кафедри інформатики та методики її навчання ТНПУ, є ігрофікація. Мета полягає в тому, щоб продемонструвати можливості використання технологій геміфікації в організації освітнього процесу в ТНПУ під час воєнного стану та проаналізувати їх специфіку під час вивчення курсів інформатичної галузі. Оскільки на сьогодні не існує уніфікованих підходів, обґрунтованих принципів та методів щодо впровадження технологій ігрофікації в освітній процес, то проблема залишається відкритою та актуальною для дослідження. Проведено аналіз впровадження геміфікації у процес навчання інформатики в університеті та закладах загальної середньої освіти. Розглянуто ситуацію з гейміфікацією навчання в умовах воєнного стану, визначено роль ігрофікації в освітньому процесі. Описано вагомі здобутки викладачів кафедри інформатики та методики її навчання ТНПУ у вивченні проблем, пов'язаних з використанням ігрових технологій на заняттях з різними віковими групами учнів та студентів. Проведені дослідження дають можливість визначити основні ігрові майданчики та платформи, що сприяють розвитку цифрових компетентностей учасників освітнього процесу, допомагають їм створювати власні ігрові проєкти. Проаналізовано підходи до етапів реалізації гейміфікації у системі SMART-ТНПУ. Визначено особливості кожного етапу гейміфікації, представлено аналіз сервісів створення ігрових проєктів та їх використання. Окреслено основні види гейміфікації освітнього процесу. Подано приклади студентських ігрових проєктів і завдань. Обґрунтовано сфери позитивного впливу технологій гейміфікації за шкалою Лайкерта та вказано застереження щодо масового їх використання. Гейміфікацію подано як приклад використання інноваційних технологій, що сприяє підвищенню ефективності організації освітнього процесу та досягненню високих результатів у підготовці сучасного вчителя інформатики.

Ключові слова*: технології ігрофікації, ігровий проєкт, гейміфікація, SMART-система, ігрові технології.*

The world emphasizes four advanced technologies that can radically change the traditional learning process: distance education, personalization, interactive learning and learning through video games. All the listed technologies belong to gamification [11].

In Ukraine, in connection with the active implementation of the distance education format due to the spread of the coronavirus disease and the introduction of martial law, more and more teachers began to use game technologies. Especially in their teaching activities, which are gradually becoming an important element of the educational space.

The main task in reforming the modern system of training the computer science teachers is the use of innovative methods in education, including the introduction of gamification when studying various informatics courses. This approach will contribute to the formation of a competent specialist, capable of finding the right solutions in specific educational and professional situations [5].

In the conditions of martial law in Ukraine, technologies adapted to the circumstances of distance or mixed format education are becoming more important as they provide an opportunity not only to increase the self-motivation of participants in the educational process, but also contribute to the growth of the quality of education and success rates. One of such technologies, tested on the basis of the STEM-center Computer Science Department at TNPU, is gamification. Since today there are no unified approaches, well-founded

principles and methods for the implementation of gamification technologies in the educational process, this confirms the relevance of the study.

Studying certain sections of computer science is considered a difficult and often ineffective process. For this reason, the various approaches that have been proposed and tested have not been convincingly successful. These included the use of games as an attempt to increase student engagement, either at the initial or final stage. However, gamification offers a whole new set of opportunities to engage students more actively, such as clear goals with different ways to get achievements, a system of tasks and limitations.

Many Ukrainian scientists are engaged in researching the process of gamification. O. Diadikova [1], S. Marienko, I. Borysiuk analyze the game as a learning technology. O. Karabin [2, p. 44–47], O. Makarevych [3, p. 279–282] define gamification in the educational process as a means of student development. A. Yurchenko, O. Semenikhini?, Y. Khvorostina [5] studied learning programming with the help of gamification through the prism of current curricula.

Gamification has gained wide attention among foreign scientists as well. S. Deterding was engaged in the definition of this concept [6, p. 9–14]. The history of gamification and its role in education became the subject of the research by F. Nazokat. The basis of the works of R. Landers, K. Bauer [12, p. 688], R. Callan, M. Armstrong are the study of the relationship between psychological theory and gamification of learning. The influence of the game on learning outcomes was studied by M. Sanchez [10], R. Owens and I. Karatas [10, p. 336]. S. Combefis S. [8], V. le Clement de Saint-Marcq [9, p. 118–136] paid considerable attention to learning programming and developing algorithms using various web platforms.

The purpose of the article is to demonstrate the possibilities of using gamification technologies in the organization of the educational process during the martial law in Ukraine at TNPU and their specificity when studying IT courses.

This paper defines the key design goals and proposes a model of the platform for gamification of education intended for the study of computer science. It includes the structure of the platform, the stages of passing the course based on gamification, the main types of gamification, and the implementation technology.

The created SMART-TNPU system is constantly developing, based on the progress of science and advanced technologies, which leads to the introduction and use of new approaches to the organization of education. Teachers of the Computer Science Department, responding to the challenges of the digital society in the conditions of war, first adapt game environments and platforms for the transformation of education. They create opportunities to combine acquired practical skills for the development of digital competences of all participants in the educational process.

In order to identify the level of interest of students in gamification both in distance lessons and in blended learning, the teachers of the Department of Informatics conducted a survey among the participants attached to the experimental game platform (Fig. 1).
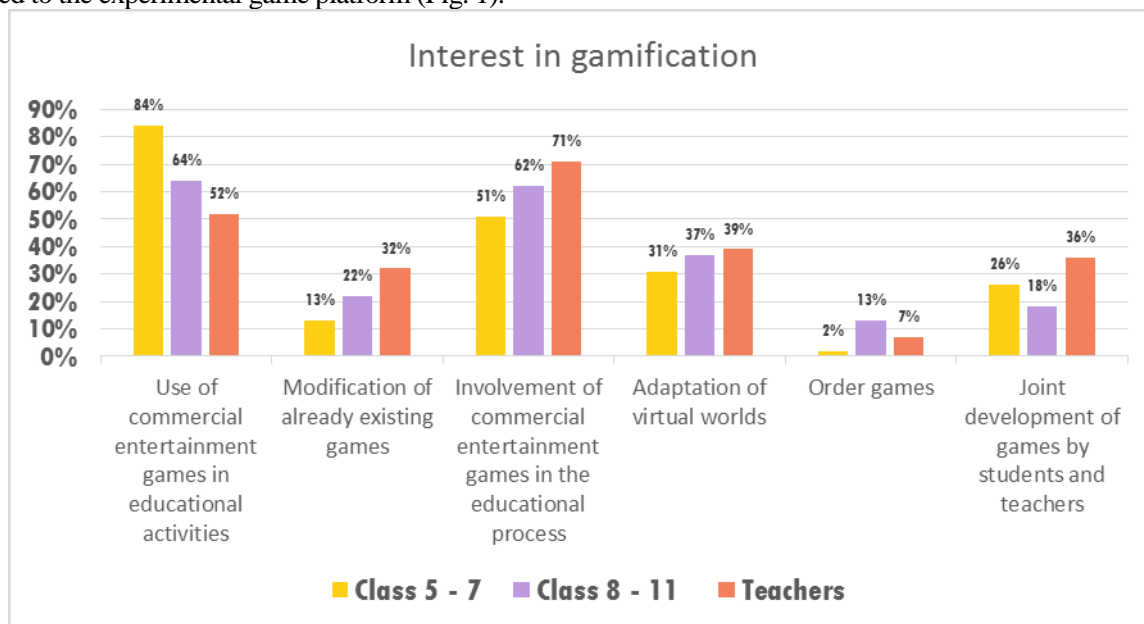

Fig. 1. Survey results of the experimental game platform participants.

Figure 1 shows a decrease in students' interest in ordinary, albeit multifaceted, games with age. However, we can see that the interest of students in creating their game products is increasing.

A third of respondents from among teachers modify existing games and adapt them for their activities. The use of developmental games in the educational process is the most common type of gamification, both among students and among teachers. The joint development of games by students and teachers is gaining popularity.

The implementation of gamification in information technology classes at TNPU takes place through the use of web resources or various services. The most popular among them are presented in figure 2.
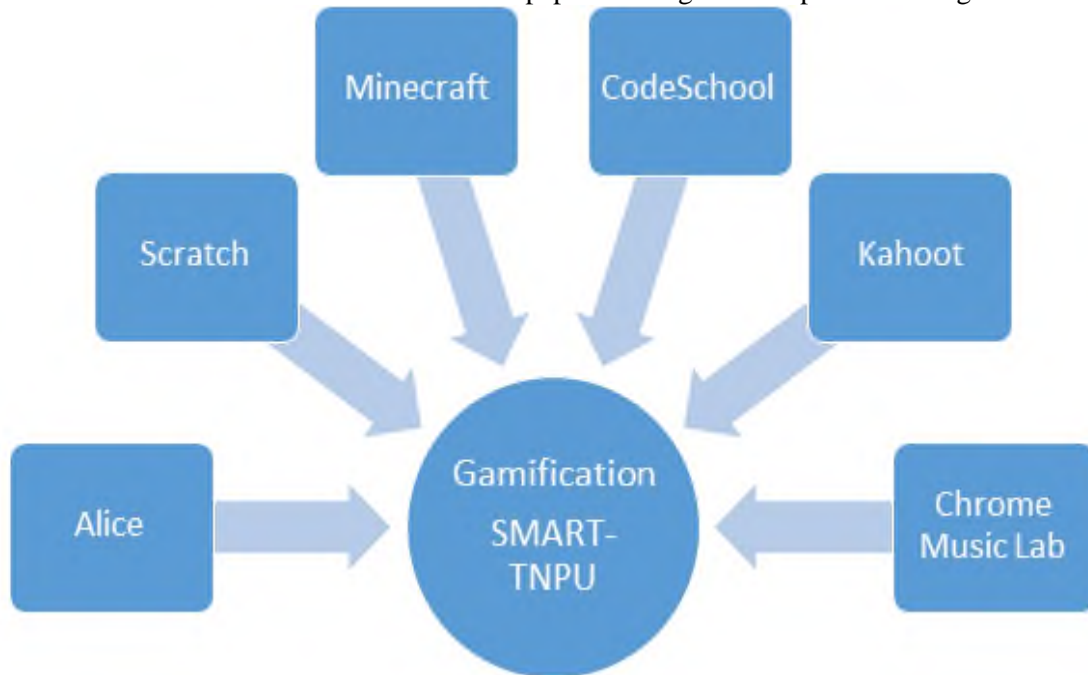

Fig. 2. Gamification fields in the system SMART-TNPU.

Let's analyze which of the outlined sites are most often used in the educational process, namely in computer science classes with the aim of learning basic concepts and forming practical experience in creating game projects (Fig. 2). As we can see, the most widespread service used by informatics teachers in the process of teaching students algorithmization and programming is Scratch (50 % of the surveyed teachers use them in their teaching activities). The second most popular among computer science teachers is Code school (12 %), every 10th teacher uses other platforms.
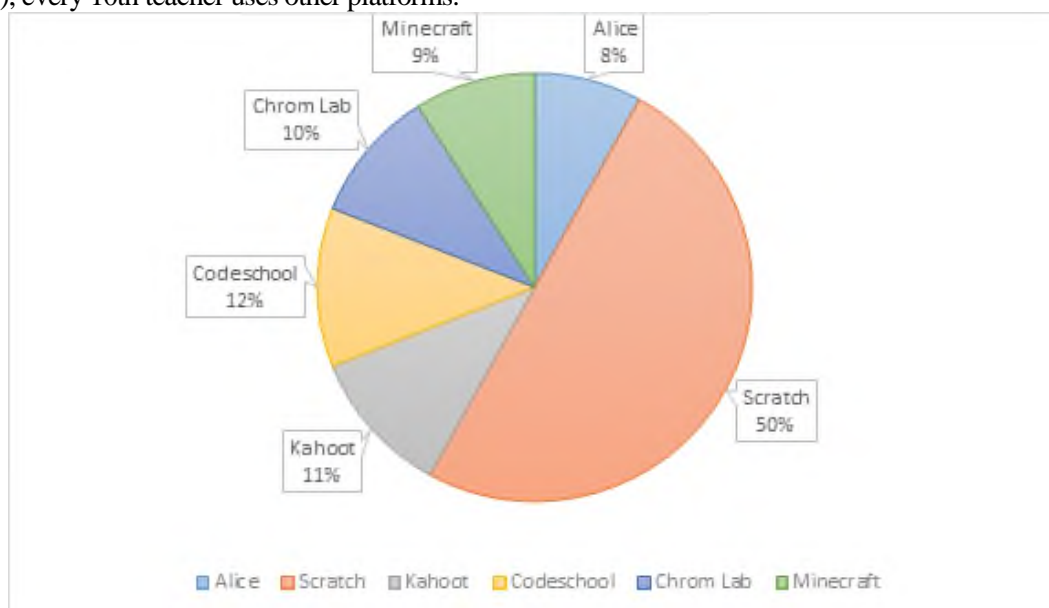

Fig. 3. Diagram of services used for creating game projects.

In a general computer science course, the process of studying the basics of algorithmization and programming has some problematic issues. Due to the complexity of the topic, individual students lose motivation to study. This problem outlines the need to choose specifically game methods and gamification technologies so that they correspond to the educational level of each participant in the educational process and contribute to increasing interest and the formation of relevant competencies.

Therefore, when studying the course "Fundamentals of computer science with elements of programming" at TNPU, teachers actively involve students in the development of their own game projects on various platforms [4, p. 156–161].

The Ministry of Education and Science in its computer science textbooks suggests that students use Scratch to learn algorithmization and programming, which can be used both online and installed on your personal computer. Now students, especially high school students, more often select personalized games like Minecraft in the educational process [5].

It is clear that despite the advantages of Minecraft, it is not absolutely appropriate to use it in learning the basics of algorithmization and programming in schools. Of all the resources mentioned above, the best replacement for Scratch would be Code Studio. The Code Studio functionality offers an introduction to the basics of algorithmization, and provides an opportunity to play popular games, while applying algorithms to form algorithmic thinking as a component of digital competencies. Figure 4 shows an example project in Code Studio.

Fig. 4. An example of a game project on the CODE platform.

Some teachers use the Blockly resource, which is less popular, but no less useful than Scratch or Minecraft, in their activities. The teachers note that the main audience of users of this resource are junior and high school students. It contains simple tasks by combining blocks of different shapes and colors, the process is similar to putting together puzzles and is suitable for use by students of primary and 5–6 grades [5]. However, a more in-depth analysis of the resource proves that it can also be used for high school students.

The study of informatics in high school is divided into standard level and professional level. In specialized classes of the senior school, 5 hours a week are devoted to the study of informatics. It is here that much attention is paid to the study of programming languages and various technologies, including gaming [6, p. 9–14].

Another problematic aspect in terms of this section is the motivation of students to learn the basics of digital technologies. It is often thought that their study is not necessary at school. This opinion is supported by the following argument: not all graduates will or want to connect their lives with computer sciences, including programming, but it is worth noting that learning the basics of algorithmization and computer technologies contribute to the development of object-oriented, abstract way of thinking in pupils and students.

That is why in the organization of training at TNPU, teachers use technologies of two types of gamification: structural and content, which involves the identification and application of individual or limited combinations of elements of game technologies (Figure 5).

Fig. 5. Types of gamification of the educational space.

Because of the primary value of game elements and mechanisms in gamified environments and mixed results in educational environments, many researchers hypothesize a relationship between game elements and learning outcomes.

In order for gamification in education to be successful and effective, teachers of the Department of Informatics implement the adaptation process according to the following stages (Fig. 6). ?????????
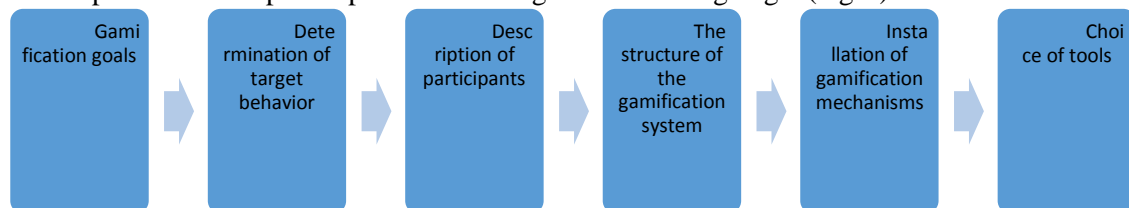

Fig. 6. Scheme of the game technologies implementation in the educational process in TNPU.

The purpose of using gamification technologies when studying the course of computer science disciplines is aimed at achieving compliance with the SMART system, that is specific, measurable, achievable, relevant, time-bound.

Therefore, the developed and tested structure of the gamification system, which is implemented at TNPU, has two levels. The micro level involves the process of participation from the motivation to start an action (in the student) to receiving the feedback (from the teacher or the system itself); the macro level is characterized by the construction of a complete story, which should interest the student to go through it from beginning to end. Feedback should be built in such a way that a new motivation for action arises, that is, the whole process should be cyclical. The system is designed to create such a gaming environment that would bring joy and a sense of personal development to the participants.

In the course of the conducted experiment, participants who completed the course have been surveyed on a Likert scale about the perception of gamification of the course according to the following dimensions: cognitive, emotional and social.

It was observed that more than 90 % of the students who completed the course believed that the level of difficulty of the tasks corresponded to the knowledge gained [11; 12].

On the emotional side, most students were motivated by the competitive environment and watched the achievements on the leaderboard. Although it is important to note that there were participants who did not agree to the use of their real names, it was therefore important to use avatars to maintain anonymity.

Finally, regarding the social aspect, it was observed that more than 70 % of the students agreed that working together helped to solve the tasks.

In the educational space of TNPU gamification is a relatively new way of learning, which has its own implementation features. Gamification can be considered successful if it copes with the complex challenges of the digital society and helps all participants in the educational process to form appropriate digital competences for the modern digital world.

However, it is worth noting that gamification cannot be considered as the only universal tool for overcoming difficulties in the organization of the educational process. Only under the condition of a successful combination of rich Ukrainian pedagogical experience with the new technologies it's possible to achieve high results in the training of a modern computer science teacher.

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МЕТОДИКА ВИВЧЕННЯ СЕМАНТИКИ МОВ ПРОГРАМУВАННЯ СТУДЕНТАМИ ЗАКЛАДІВ ПРОФЕСІЙНОЇ ОСВІТИ

Показано, що в закладах професійної (професійно-технічної) освіти включення до змісту навчання мов та методів програмування блоку питань, присвячених семіотиці мов програмування сприятиме успішній реалізації системи їх фундаментальної підготовки в предметній галузі «Інформаційні технології». Методична система навчання, побудована в рамках методичної теорії, сприяє оволодінню студентами знаннями та вміннями з семіотики мов програмування. Викладено основні теоретичні та методологічні положення, на підставі яких побудовано методичну систему навчання семіотики мов програмування та метамодель методики навчання у вигляді методичної теорії, яка визначила модель нашого дослідження. На підставі класифікації моделей синтаксису і семантики мов програмування, проведеної для побудови концептуального базису методичної теорії навчання семіотики мов програмування, нами були виділені наступні розділи для навчання семіотики мов програмування: формальний синтаксис мов програмування; змістовна операційна семантика мов програмування; формальна операційна семантика мов програмування; формальна дедуктивна семантика мов програмування; денотаційна семантика мов програмування. На етапі відбору змісту елементів проєктованої нами моделі методичної системи навчання семіотиці мов програмування центральне місце посідає проблема постановки цілей навчання, оскільки відбір змісту інших елементів спрямовано досягнення поставлених цілей. Семіотичні навчальні моделі включають систему завдань, при яких предметна сфера діяльності розгортається в рамках конкретних методів навчання, що передбачають текстові виклади навчальних проблем або завдань.

Ключові слова: освітній процес; семантика мови програмування; методична система; професійна освіта.

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