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ГЕЙМИФІКАЦІЯ ВИЩОЇ ОСВІТИ: ТРИЕДНІСТЬ PBL ЯК ІНСТРУМЕНТ МОДЕРНІЗАЦІЇ ОСВІТЬОГО ПРОЦЕСУ

Вікторія САВІЦЬКА ✉

Західноукраїнський національний університет,

Тернопіль Україна

savitska.vika@ukr.net

<https://orcid.org/0000-0002-9438-1734>

Оксана КРИЧКІВСЬКА

Західноукраїнський національний університет,

Тернопіль, Україна

oknysem@ukr.net

<https://orcid.org/0000-0003-3007-0248>

HIGHER EDUCATION GAMIFICATION: THE TRINITY OF PBL AS A TOOL FOR EDUCATIONAL PROCESS MODERNIZATION

Viktoriia SAVITSKA ✉

West Ukrainian National University,

Ternopil, Ukraine

savitska.vika@ukr.net

<https://orcid.org/0000-0002-9438-1734>

Oksana KRYCHKIVSKA

West Ukrainian National University,

Ternopil, Ukraine

oknysem@ukr.net

<https://orcid.org/0000-0003-3007-0248>

АНОТАЦІЯ

Формулювання проблеми. Стаття присвячена проблемам модернізації освітнього процесу у вищій школі на основі використання ігрових технологій та їхніх елементів. Актуальність дослідження зумовлена виявленими можливостями триєдності PBL (Points, Badges, Leaderboards) як інструменту підвищення мотивації навчання серед студентів.

Матеріали і методи. Методологічну основу становлять загальнотеоретичні та емпіричні методи дослідження. Здійснено огляд сучасної наукової літератури, періодичних видань, науково-методичних джерел з проблеми гейміфікації вищої освіти, їхній аналіз, структурування, інтерпретацію та побудову логічних висновків. Систематизацію перспектив розвитку гейміфікації у вищій освіті здійснено з використанням SWOT аналізу.

Результати. У статті розглянуто зміст основних наукових підходів щодо визначення поняття «гейміфікація у вищій освіті». Проаналізовано проблеми та можливості використання ігрового компоненту PBL в освітньому процесі закладів вищої освіти. Запропоновано інноваційні варіанти застосування найуніверсальніших ігрових компонентів PBL в освітньому процесі вищої школи у вивченні будь-якої дисципліни. Проведене дослідження дозволило за результатами узагальнення теоретичних джерел, аналітичної інформації та проведення SWOT-аналізу обґрунтувати доцільність застосування технологій гейміфікації у вищій освіті.

Висновки. На основі здійсненого аналізу літератури, запропоновано варіанти використання триєдності PBL як інструмента модернізації освітнього процесу у вищій школі. Використання ігрових методик з урахуванням триєдності PBL в освітньому процесі може стати одним з механізмів підвищення вмотивованості та інтересу студентів до вивчення дисциплін, посилення їхньої залученості до навчання, а також підвищення рівня компетентностей, які вони набувають. Отримані результати можна застосувати під час проєктування різних освітніх курсів, у процесі вивчення яких передбачається використання ігрових технологій.

КЛЮЧОВІ СЛОВА: гейміфікація вищої освіти; ігрові технології; модернізація освітнього процесу; триєдність PBL (PBL – Points, Badges, Leaderboard); перспективи розвитку.

ABSTRACT

Formulation of the problem. The article is devoted to the problems of modernization of the educational process in higher education based on the use of game technologies and their elements. The relevance of the study is due to the identified opportunities for the trinity of PBL (Points, Badges, and Leaderboards) as a tool to increase learning motivation among students.

Materials and methods. The methodological basis is generally theoretical and empirical research methods. A review of modern scientific literature, periodicals, and scientific and methodological sources on the problem of gamification of higher education, their analysis, structuring, interpretation, and construction of logical conclusions was fulfilled. Systematization of prospects for the development of gamification in higher education using SWOT analysis was carried out.

Results. The article considers the content of the main scientific approaches to the definition of "gamification in higher education". Problems and possibilities of using the game component of PBL in the educational process of higher education institutions are analysed. Innovative variants of the application of the most universal game components of PBL in the educational process of higher school in the study of any discipline are offered. The study allowed substantiating the feasibility of gamification in higher education based on the results of generalization of theoretical sources, analytical information, and SWOT analysis.

Conclusions. Based on the literature analysis, options for using the PBL trinity as a tool for modernizing the educational process in higher education are proposed. The use of game techniques, taking into account the trinity of PBL in the educational process, can be one of the mechanisms to increase students' motivation and interest in learning disciplines, improve the involvement in learning, and heighten the level of competencies they acquire. The obtained results can be applied in designing various educational courses in the study process where game technologies are used.

KEYWORDS: gamification of higher education; game technologies; modernization of the educational process; PBL trinity (PBL - Points, Badges, Leaderboard); development prospects.

INTRODUCTION

The problem statement. The rapid development of the information society leads to the transformation of educational technologies and provides a variety of opportunities to improve the educational process. This is extremely necessary for modern education because, of course, education is one of the key drivers of human capital development. However, Ukrainian education, including higher education, is still characterized by the use of the traditional model of teaching (noting lectures and completing formal assignments and exercises in seminars), which does not improve the quality of education. The opportunity to eliminate this shortcoming appears with the use of gamification (gamification) in the educational process of higher education institutions (HEI).

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✉ Corresponding author

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However, the emergence of a new, so-called generation of "digital aborigines" (generation Z) contributes to the actualization of gamification of the educational process. Generation Z perceives information flows quite quickly, doing several things at once, giving them instant feedback and all kinds of achievements in the form of awards, which is possible with the use of gaming educational technology.

Thus, new models and approaches are emerging based on the use of information and gaming technologies in education, including, for example, "edutainment" (from English "edutainment"-learning through entertainment), "gamification" (from English "gamification"-the use of game mechanics and elements in a non-game context), "serious games" (from English "games for learning"-games directly designed for learning or having a secondary educational value), "game-based learning" (from English "game-based learning"-an approach to learning based on the game), etc. (Seaborn & Fels, 2015). These technologies make it possible to pay more attention to the peculiarities of students' perception and processing of information (quick access to information, variability of its use, interactivity, visual presentation of information), their interests (adaptive, individual educational trajectories), and build effective communication processes and mechanisms. They, for example, help to boost student motivation. However, these technologies also have their drawbacks due to the complexity of their application and implementation.

Gamification is one of the current educational trends in modern education and involves the use of gaming technology elements in non-gaming situations. The purpose of this process is to attract and increase the students' attention, and to increase their motivation for solving practical problems and learning how to perform new activities. The need for gamification arose from the need to modernize outdated motivational schemes, where incentives and punishments no longer produce the desired effect.

Gamification is based on the use of game elements in a non-game context, i.e., it is a process in which game elements are used to achieve real goals (Faiella & Ricciardi, 2015). Gamification is typically used as an approach that involves selecting game elements to create a game environment to optimize the user experience (Dichev & Dicheva, 2017) and engage users (Sailer et al., 2017).

Undoubtedly, games can motivate the students easily to take some actions in situations where they do not always know how much they want to do so (Zichermann & Linder, 2010). Gamification is game-based and therefore so successful.

The PBL gamification model (PBL-Points, Badges, Leaderboard) is the basic model. And although this model provides a high level of feedback (scores), visualization of the participant's achievements (badges), and a leaderboard clearly shows the rating of participants, it does not take into account the use of gamification (Makarevich, 2015).

The analysis of current research. In modern research, there are many different interpretations of the concept of "gamification," but they all come down to the use of gaming technology in non-gaming situations. For example, Kevin Wehrbach (2012) views gamification as the use of game elements and game mechanics in a non-game context. Gabe Zichermann and Linder define "gamification" as the process of using game mechanics and thinking to capture an audience and address current issues facing learners (Zichermann & Linder, 2010).

The term "gamification" is borrowed and partially identical to the concept of "game technology" in domestic pedagogy. The game as a form of human activity and an active learning method is the foundation of game technology. However, there are some differences between these concepts. Game-based learning encourages learning through the element of competition, where the set of necessary knowledge is necessary for "survival" in the game, and this is the basis of game learning (Dicheva et al., 2015). At the same time, gamification is the application of game mechanics to make boring activities more engaging.

In the research, scientists also consider gamification as a modern learning process and analyze its components (Tkachenko, 2015), provide basic definitions of gamification (Zelenskaya & Kovinko, 2019), determine the general principles of game teaching methods, including visible game status, social activity of players, freedom of choice, freedom of loss and quick feedback between game participants (Dicheva et al., 2015). Despite the growing popularity in the field of education, the theoretical foundations of gamification remain insufficiently studied, which has led to numerous failures and criticism of the process (Loughrey & Broin, 2018). On the other hand, the use of the gamification method has not become widespread either in works on higher school didactics or in the classical domestic educational space.

The purpose of the article is to identify opportunities to use the game components of PBL (Points, Badges, and Leaderboards) in the educational process of higher education institutions as a means of increasing the motivation of students' learning activities.

METHODS OF THE RESEARCH

The methodological basis is generally theoretical and empirical research methods. The research is based on modern scientific literature and periodicals on the gamification of education, scientific and methodological sources, and literature containing statistical information on the analyzed topics, their analysis, structuring, interpretation, and construction of logical conclusions. A SWOT analysis was used to systematize the prospects for the development of gamification in higher education, assess the strengths and weaknesses, and identify opportunities and threats for further use within the digital space of higher education institutions.

RESULTS OF RESEARCH

Currently, gamification in education has two varieties: the first is based on the development of some educational games that are used in a particular university and does not become more widespread due to the narrow specifics. Another variety is games developed by third-party commercial companies (Erkens & Bodemer, 2019). They often do not take into account several requirements of the educational system and the need to address some financial and legal issues. The development of generalized approaches and tools for the use of some components of gamification (PBL trinity) in the educational process of higher education institutions may be one way to solve this problem. Existing approaches to gamification in higher education and the use of MOOCs generally rely on overly superficial and abstract implementations of game components such as scores, badges, and leaderboards, which form the so-called PBL trinity (Points, Badges, Leaderboards). The goal of the PBL trinity is to use the presented game

mechanics not separately but together, thus creating a synergistic effect. Using leader points, badges, and tables, both individually and collectively, can increase student motivation and engagement. For example, researchers at the University of Hong Kong conducted a quasi-experiment to study the effects of gamification on students. The results showed that the PBL model is effective in motivating and engaging students because, during the experiment, they made greater efforts to learn (Huang & Hew, 2015). However, the current use of game scores, badges, and leaderboards does not meet the goals and objectives of the introduction of gamification as a means of increasing motivation among students.

The elements of the PBL trinity are an important and mandatory part of the game. Points reflect the achievements and progress of players, which allows you to compare with each other and keep the necessary statistics. Badges give players status and additional, unique opportunities, motivating them to accumulate new badges to collect them. They are a visual reflection of the success of the local and global stages of the game. Leaderboards or leaderboards show the player's place among other participants in the game and motivate them to achieve more significant results.

These components are the most universal in the context of the gamification used in the educational process, as their implementation is possible in the study of any discipline. Thus, the use of the element P (Points) is a formal, direct reflection of the points of the final certification. Element B (Badges) is also, in most cases, completely useless, having no meaning other than pseudo-status (Chou, 2016). Therefore, it is necessary to identify opportunities and mechanisms to increase the effectiveness of the PBL trinity to increase learning motivation and involve freelance students in the game form of learning in various educational disciplines, considering this form the most universal and suitable for almost any educational program.

Involving students in the game educational process requires adaptation, rethinking the PBL model for the educational process to increase the actual, real significance of its components. To this end, we have divided the "points" component into two components: rating points and "cash" points. Interpretation of rating points remains unchanged and is an assessment of the study of the methodological unit of the discipline. A novelty in the model is the introduction of "cash", which is a kind of "currency" used in the infrastructure of the educational institution and within the educational process to obtain real bonuses-achievements. Methods of obtaining "cash" points are formed in parallel with obtaining rating points using additional game techniques. Additional game mechanics are:

1. Mini-games based on the studied material. For example, an analogue of the card game "find a pair", where pairs are related entities or objects (name - definition, name - formula, cause-effect). It is very important that when using online information educational systems, mini-games can be group games, which adds excitement and interest to the game.

2. Solving additional basic level tasks. Performing this type of task is aimed at improving mechanical memorization and skills development.

3. Solving problems of increasing complexity involves the study of additional material.

4. Increasing involvement in the game. Getting additional "cash" points for regular visits to the information and educational environment (games). For example, if you regularly visit the gaming educational environment, the player defends his "cash" points and has the opportunity to take part in the points from players who did not attend the game in time. The player must be able to spend his "cash" points. These opportunities must be useful in the educational process.

One of the easiest ways to spend "cash" points is to transform them into a small number of rating points in the discipline. Other opportunities in the educational process: plus 1 point on the exam in the discipline; the right to withdraw a second ticket is not an exam; answer only theoretical questions; use of own abstracts on the test/exam; one cheat sheet (any information on sheet A6/A7).

The real significance of the "badge" or "achievement" component also needs to be enhanced. It is advisable to introduce "badges" that allow certain actions along with status "badges" for statistical achievements. The number of "badges" of one type must be strictly limited to devalue the achievement. Example:

1. Discipline professors: the owner receives bonus points for work in practical and seminar classes.

2. A good friend—the opportunity to give a duplicate of your privilege (obtained for "cash" points) to any participant in the game.

3. Inspector: the chance to visit couples with a different group.

4. Call the second opportunity to get a teacher's tip at control events.

The practical application of "points" and "badges" automatically increases the value of the third component, "leaderboards". Access to information on the participants who received significant "cash" points and "badges", which directly affect the individual progress of the educational process, gives an additional and very powerful impetus to the competitive process during training. Individual end-to-end ranking with the help of rating points should be organized as a controlled and corrective subsystem. This is because the motivational component of individual ratings is positive only if the participant is at the top of the leaderboard (from the first quarter to the third), neutral-in the middle, and neutral-negative-at the bottom (Esteves, 2017).

The positive effect of the "leaderboards" technique application is more evident during short events, the outcome of which depends on the contribution of each team member. Firstly, each event is a new opportunity to demonstrate yourself and your skills from scratch, minimizing the impact of past experiences of victories and defeats; and secondly, teamwork increases engagement based on responsibility to yourself and the team.

A schematic representation of the PBL trinity in the educational process of higher educational institutions is offered in Figure 1.

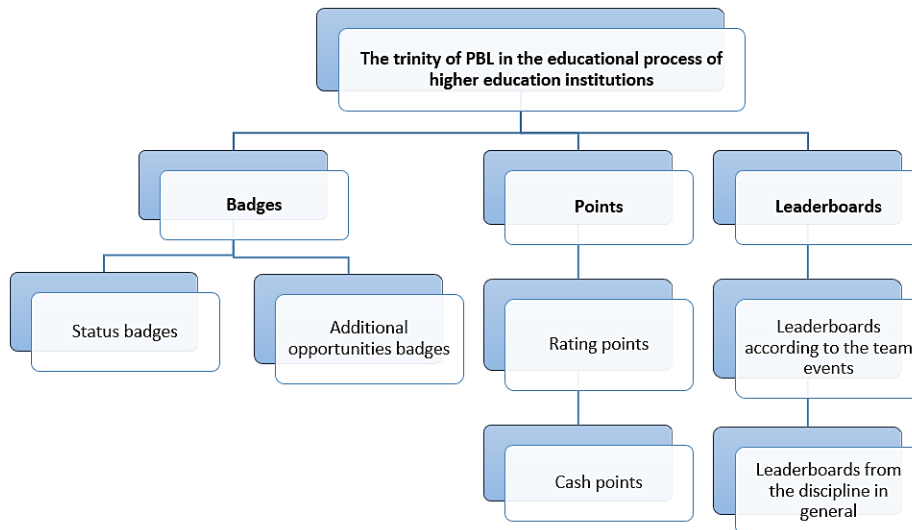


Fig. 1. The trinity of PBL in the educational process of higher educational institution

There are two possible options for using the PBL trinity in the educational process of free economic education (while studying some disciplines):

1. The first option goes through the whole course and helps the student throughout the study: the system of "gingerbread" (titles, incentives, appraisals, visualization of educational progress, or game script).
2. The second option is a "dot option," which is also a good help in learning. For example, courses with webinars. Sometimes webinars are boring because they are long, and you have to be constantly careful not to miss important material. Interactive tools enliven the story.

Thus, it is worth noting the increasing popularity of gamification as a modern interactive resource. Prospects for the development of gamification in higher education were assessed using the SWOT analysis presented in Table 1.

Table 1

SWOT analysis of the process of application of gamification elements in educational education of higher education institutions

Strengths	Weaknesses
<ol style="list-style-type: none"> 1. Simplifying the educational process and improving educational methods 2. No discrimination against students. 3. Visualization of complex processes. 4. Correspondence of the game to the logic of study. topics, sections, and disciplines; support of interdisciplinary connections. 5. Availability of feedback. 6. Creating a model of the functionality of future professional activity 7. Ability to deeply understand the problems posed in the game and methods of solving them. 	<ol style="list-style-type: none"> 1. Availability of low-quality content on the market of educational games. 2. High cost of computer game development for higher education. 3. Lack of templates for the use of gamification in the educational process. 4. The need for homogeneity of material and technical base of students. 5. Deterioration of students' perception of other forms of interaction with the teacher (traditional forms of work). 6. The possibility of risk of losing interest in the game in students. 7. Additional costs of temporary resources for the teacher.
Opportunities	Threats
<ol style="list-style-type: none"> 1. Increasing the interest and involvement of students. 2. Increasing the internal motivation of students. 3. Formation of the adequate attitude of students to mistakes. 4. Development of communication skills in teamwork. 5. Development of a sense of responsibility and self-confidence. 6. Use of conditionally objective rating system (rating). 7. Expanding the range of educational opportunities. 8. Professional self-development of the teacher. 	<ol style="list-style-type: none"> 1. The transition from motivation to the excitement, accompanied by a loss of original meaning. 2. Psychological threat of substituting the concepts of "reality" and "game". 3. Development of hyper-competition among students. 4. Oversaturation of the educational process with the game. 5. Development of the habit of waiting for a reward (Hernández-Sellés et al., 2019); 6. Inconsistency of the game scenario with educational goals. 7. Lack of freedom of choice for students who are not interested in the game form of mastering the material. 8. Failure of participants in the educational process to recognize the effectiveness of gamification methods.

Thus, the gamification of higher education is a much more difficult task than the usual development and distribution of entertaining computer games. The main difficulty is related to the need to determine the didactic and technological paradigm of the educational game and its effective integration into higher education institutions. The effectiveness of gamification in higher education depends on how well it is integrated into the educational environment of a particular university.

CONCLUSIONS AND PERSPECTIVES FOR A FURTHER RESEARCH

The educational process is developing continuously, systematically, and continuously, which necessitates its modernization under modern requirements, adaptation to the digital age, and the current needs of society. Gaming technology generally meets these requirements. The article confirms the growing popularity of gamification as a modern interactive resource.

Based on the analysis of literature and own pedagogical practice, some imperfections in the trinity of PBL are revealed, and variants of its modernization for use in the educational process of higher educational institutions are offered. The use of game techniques, taking into account the trinity of PBL in the educational process, can be one of the mechanisms to increase students' motivation and interest in learning disciplines, increase their involvement in learning, and increase the level of competencies they acquire.

The study allowed us to substantiate the feasibility of gamification in higher education based on the results of the generalization of theoretical sources, analytical information, and SWOT analysis.

The obtained results can be applied during the design of various educational courses, in the process of which the use of game technologies is envisaged.

REFERENCES (TRANSLATED AND TRANSLITERATED)

1. Zelenska, L. D., & Kovinko, K. V. (2019). Gejmifikaciya yak metod navchannya zdobuvachiv vyshhoyi osvity anglijskoyi movy [Gamification as a method of teaching English to higher education students]. *Zasoby navchalna ta naukovo-doslidnoyi roboty – Teaching and research aids*, 52, 21–35. (in Ukrainian).
2. Makarevych, O. O. (2015). Gejmifikaciya yak nevid'yemnyj chynnyk pidvyshhennya efektyvnosti elementiv dystancijnogo navchannya. [Gamification as an integral factor in improving the effectiveness of distance learning elements.] *Molodyj uchenyj – Young scientist*, 2(17), 275–278. (in Ukrainian).
3. Tkachenko, O. (2015). Gejmifikaciya osvity: formalnyj i neformalnyj prostir. [Gamification of education: formal and informal space.] *Aktualni pytannya gumanitarnyx nauk – Current issues of the humanities*, 11, 303–309. (in Ukrainian).
4. Brophy, J. (2013). *Motivating students to learn*. Routledge. <https://doi.org/10.4324/9780203858318>.
5. Chou, Y.-K. (2016). Actionable gamification: Beyond points, badges, and leaderboards. *Octalysis Media*, 1–151.
6. Dichev, C., & Dicheva, D. (2017). Gamifying education: What is known, what is believed and what remains uncertain: A critical review. *International Journal of Educational Technology in Higher Education*, 14 (1). <https://doi.org/10.1186/s41239-017-0042-5>.
7. Dicheva, D. et al. (2015). Gamification in Education: A Systematic Mapping Study. *Journal of Educational Technology & Society*, 18(3), 75–85.
8. Erkens, M., Bodemer, D. (2019). Improving collaborative learning: Guiding knowledge exchange through the provision of information about learning partners and learning contents. *Computers & Education*, 128, 452–472.
9. Esteves, J. M. (2017). The perils of gamification trivialization: How and why gamification is failing to deliver loyalty. *Academy of Management Proceedings*, 2017(1), 13560.
10. Faiella, F. & Ricciardi, M. (2015). Gamification and Learning: A Review of Issues and Research. *Journal of e-Learning and Knowledge Society*, 11(3), 1–12.
11. Hernández-Sellés, N., Muñoz-Carril, P.-C., & González-Sanmamed, M. (2019). Computer-supported collaborative learning: an analysis of the relationship between interaction, emotional support and online collaborative tools. *Computers & Education*, 138, 1–12. <https://doi.org/10.1016/j.compedu.2019.04.012>.
12. Huang, B., & Hew, K. F. (2015). Do points, badges and leaderboards increase learning and activity: A quasi-experiment on the effects of gamification. *The 23rd International Conference on Computers in Education (ICCE 2015)*. Hangzhou, Asia-Pacific Society for Computers in Education, 275–280.
13. Loughrey, K., & O Broin, D. (2018). Are We Having Fun Yet? Misapplying Motivation to Gamification. In *2018 IEEE Games, Entertainment, Media Conference (GEM)* (pp. 1–9). IEEE.
14. Sailer, M., Hense, J. U., Mayr, S. K., & Mandl, H. (2017). How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. *Computers in Human Behavior*, 69, 371–380.
15. Seaborn, K. & Fels, D. (2015). Gamification in Theory and Action: A Survey. *International Journal of Human-Computer Studies*, 74, 14–31.
16. Werbach, K. (2012). *For the Win: How Game Thinking Can Revolutionize Your Business*. Philadelphia, 148.
17. Zichermann, G. & Lindner, J. (2010). *Game-based marketing: inspire customer loyalty through rewards, challenges, and contests*. New Jersey: John Wiley & Sons.

