Gamification in higher education: methodology

Yuliia V. Yechkalo[1], Viktoriia V. Tkachuk[1], Kateryna A. Shurupova[1], Viktoriia M. Zinchenko[2] and Anzhelina V. Puhach[3]

[1]*Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine*
[2]*Donetsk State University of Internal Affairs, Kryvyi Rih Faculty, 21 Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine*
[3]*Kyiv Institute of the National Guard of Ukraine, 7 Oborony Kyivy Str., Kyiv, 03179, Ukraine*

Abstract

This study examines the implementation of gamification in higher education, focusing on its effectiveness and pedagogical conditions. The research presents a structural-functional model for gamification in higher education, comprising objective, content, methodological-organizational, diagnostic, and resultant blocks. Two key pedagogical conditions are proposed: developing positive motivation through quasi-professional activities and strengthening the practical orientation of the educational process. A pedagogical experiment was conducted to validate these conditions and the methodology, involving control and experimental groups of students. The effectiveness of gamification was evaluated using motivational, cognitive, and operational criteria, each with four levels: high, sufficient, medium, and low. Results showed significant improvements in the experimental group across all criteria, with increases in high and sufficient levels and decreases in medium and low levels. The study concludes that the developed methodology and pedagogical conditions contribute to the effective use of gamification in higher education. This research provides valuable insights for educators and institutions seeking to implement gamification strategies to enhance student engagement, motivation, and learning outcomes in higher education settings.

Keywords

gamification, higher education, methodology

1. Introduction

In an era where the job market increasingly demands digital literacy and soft skills [1], gamification research investigates methods to integrate these crucial 21st-century competencies into the curriculum more effectively. Moreover, the potential of gamification to offer adaptive, personalized learning experiences aligns with the growing need for methodology that cater to diverse learning styles and needs [2].

The data-rich nature of gamified systems contributes significantly to the growing body of knowledge on learning analytics and evidence-based educational practices [3]. This intersection with data-driven education not only enhances our understanding of student performance and engagement but also provides educators with powerful tools to refine and improve their teaching strategies [4]. Furthermore, gamification research intersects with cognitive science, offering new perspectives on how game elements can enhance learning, memory retention, and knowledge application, thereby deepening our understanding of the learning process itself.

The recent shift towards remote and blended learning [5], accelerated by events like the COVID-19 pandemic [6, 7] and Russian invasion of Ukraine [8, 9], has made research on gamification in online learning environments particularly relevant. As higher education institutions adapt to these new modalities, insights from gamification research can inform the development of engaging and effective online teaching methods. The interdisciplinary nature of gamification research, spanning various fields from STEM to humanities, offers insights into versatile teaching methodologies applicable across different disciplines, enhancing its value and applicability in diverse academic contexts [10, 11, 12].

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uliaechk@gmail.com (Y. V. Yechkalo); viktoriya.tkachuk@gmail.com (V. V. Tkachuk); shurupova@knu.edu.ua (K. A. Shurupova); vicik-210898@ukr.net (V. M. Zinchenko); avpuhach@gmail.com (A. V. Puhach)
0000-0002-0164-8365 (Y. V. Yechkalo); 0000-0002-5879-5147 (V. V. Tkachuk); 0000-0002-2957-4185 (K. A. Shurupova); 0000-0003-3080-4272 (V. M. Zinchenko); 0000-0003-1907-9380 (A. V. Puhach)

The exploration of gamification often involves integrating emerging technologies such as virtual reality, augmented reality, and artificial intelligence [13, 14, 15]. This aspect of the research contributes to broader discussions on technology in education, pushing the boundaries of what's possible in teaching and learning. Moreover, gamification research offers new perspectives on assessment methods, potentially leading to more authentic and comprehensive evaluation of student learning, addressing long-standing concerns about traditional assessment practices in higher education.

Lastly, as the higher education sector becomes increasingly competitive, research on innovative teaching methods like gamification can provide institutions with a competitive edge in attracting and retaining students.

The work of many scientists is devoted to the study of gamification of higher education. The integration of gamification into higher education has emerged as a significant trend in recent years. Deterding et al. [16] define gamification as the application of game-design elements and game principles in non-game contexts.

Numerous studies have reported positive effects of gamification on student engagement and motivation in higher education. Hamari et al. [17] conducted a comprehensive literature review, finding that gamification generally produces positive effects, particularly in educational contexts. Subhash and Cudney [18] corroborated these findings in their systematic review, highlighting increased engagement and motivation among students.

Dicheva et al. [19] found that gamification can significantly increase student participation in course activities and overall engagement with course materials. However, the impact on academic performance and learning outcomes remains less conclusive. While Tsay et al. [20] reported improved grades and knowledge retention in their empirical study, Hanus and Fox [21] found no significant difference compared to traditional teaching methods in a longitudinal study.

Nah et al. [22] identified points, badges, and leaderboards as the most used game elements in higher education settings. However, Landers and Landers [23] argue for the incorporation of more complex elements such as narrative and role-playing to enhance learning outcomes. Kapp [24] emphasizes the importance of integrating gamification with learning management systems for seamless implementation and data collection.

Several studies highlight technical difficulties and resource constraints as major challenges in implementing gamification. Iosup and Epema [25] reported on these challenges in their experience implementing gamification in technical higher education. Toda et al. [26] raised concerns about ensuring proper alignment with learning objectives and potential negative effects of gamification.

Mekler et al. [27] stress the need for careful design to avoid overemphasis on extrinsic motivation, which can potentially undermine intrinsic motivation for learning. This underscores the importance of thoughtful implementation strategies that balance motivational elements with educational objectives.

Sylvester [28] also note that gamification can positively impact learning and contribute to improving student success. Specifically, they note that by playing games, students can develop skills that can be useful in real life and increase their motivation to learn.

Kurni and Srinivasa [29] have demonstrated that gamification can enhance students' interest in the educational process, increasing their readiness to engage with new material. Moreover, gamification can assist students in identifying their strengths and weaknesses in learning, enabling them to better understand their needs and plan their efforts accordingly.

Research by Sailer et al. [30] indicates that the implementation of gamification in the educational process can positively influence students' motivation to learn. Gamification facilitates the creation of a more dynamic and engaging learning environment, thereby increasing students' interest in the learning process. Furthermore, gamification allows students to participate in competitions and challenges, which stimulates their activity and competitiveness.

Summarizing the analyzed scientific works [31, 32, 33, 34], we separated the key components and strategies of implementing gamification in higher education. Gamification in education employs several key components: point systems and badges for rewarding achievement, leaderboards for fostering competition, levels and challenges for progression, narrative elements for context, and immediate feedback for reinforcement. Implementation strategies include designing courses as quests or missions,

utilizing digital platforms with gamification features, creating team-based activities, incorporating role-playing elements, and using mobile apps for flexible learning. These components and strategies aim to enhance engagement, motivation, and learning outcomes by integrating game-like elements into educational contexts (figure 1).

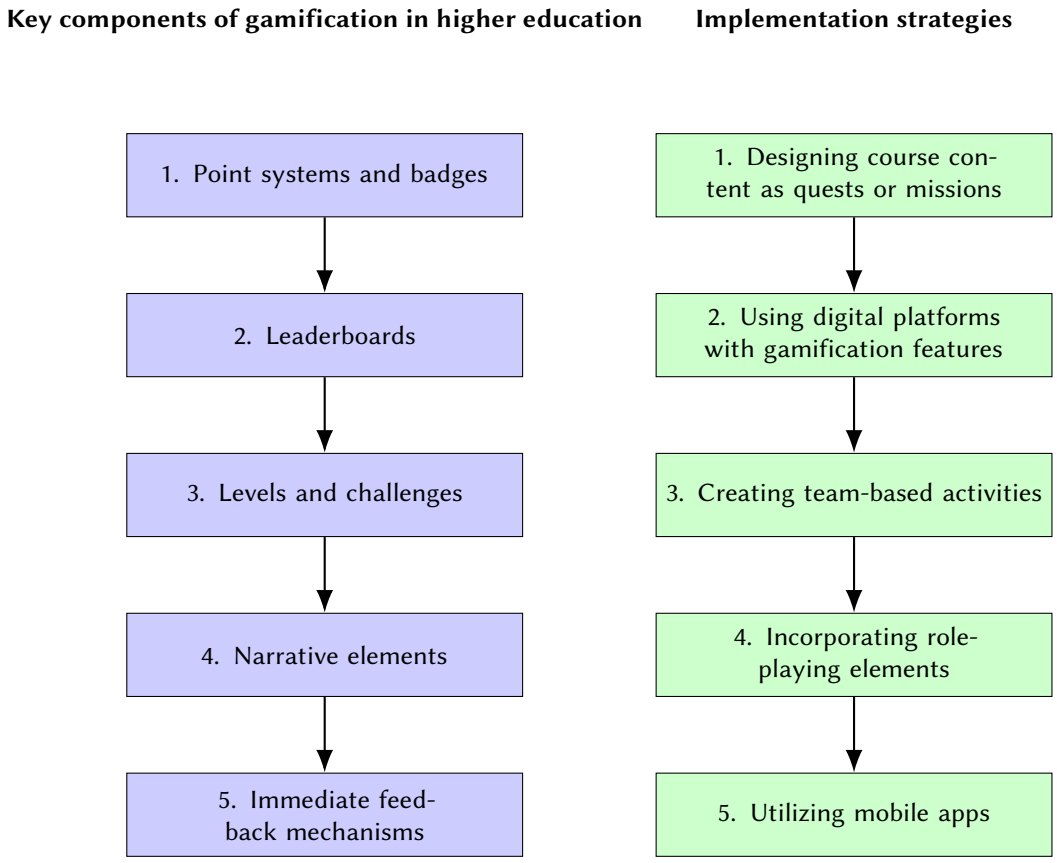

Figure 1: Key components and implementation strategies of gamification in higher education.

The *aim* of this study is to investigate the effectiveness of gamification in higher education by developing and validating a structural-functional model and pedagogical conditions for its implementation.

2. The methodology of using gamification in higher education

The method of using gamification in higher education has gained significant relevance in recent years. As traditional teaching methods struggle to engage digital-native students, gamification offers an innovative approach to enhance motivation, participation, and learning outcomes. By incorporating game elements into educational contexts, institutions can create more interactive and immersive learning experiences [35, 36].

The successful implementation of the gamification methodology in higher education requires the definition of pedagogical conditions. Based on the analysis of literature, we propose the following pedagogical conditions which, in our opinion, significantly increase the effectiveness of gamification use in higher education:

1. Development of positive motivation for using gamification by engaging students in quasi-professional activities, thereby simulating problematic situations that arise in practice.
2. Strengthening the practical orientation of the educational process, based on the principles of variability and combining traditional and innovative methods, forms, and types of activities that include components preparing future professionals for their career activities.

The first pedagogical condition focuses on developing positive motivation for gamification use by engaging students in quasi-professional activities that simulate problematic situations encountered in practice. This condition is crucial for several reasons. Firstly, motivation is a key factor in the success of any educational approach [37], including gamification. By creating a positive attitude towards gamification, students are more likely to engage fully with the gamified elements of their courses. This increased engagement can lead to better learning outcomes and a more enjoyable educational experience. Secondly, the use of quasi-professional activities provides a context for gamification that is directly relevant to students' future careers. This relevance can enhance intrinsic motivation, as students can see the practical application of what they are learning. It bridges the gap between theoretical knowledge and practical skills, making the learning process more meaningful. Thirdly, simulating problematic situations that occur in practice prepares students for the challenges they may face in their future professions. This approach not only motivates students but also develops their problem-solving skills and critical thinking abilities. By facing these simulated challenges in a gamified environment, students can learn from failures without real-world consequences, encouraging experimentation and innovation. Lastly, this condition aligns with the principles of experiential learning, which posits that people learn best by doing. By actively participating in quasi-professional activities, students can construct their own understanding of concepts and develop skills that are directly applicable to their future careers.

The second pedagogical condition emphasizes strengthening the practical orientation of the educational process based on the principles of variability and combining traditional and innovative methods, forms, and types of activities. This condition is essential for the following reasons. Firstly, a strong practical orientation ensures that the gamification elements are not just entertaining but also educational and relevant to students' future careers. This alignment between gamification and practical skills development can increase the perceived value of gamified activities, leading to higher engagement and motivation. Secondly, the principle of variability allows for a diverse range of gamified activities that can cater to different learning styles and preferences. This diversity can help maintain student interest and engagement over time, preventing the novelty of gamification from wearing off. Thirdly, combining traditional and innovative methods creates a balanced approach to education. While gamification introduces new and exciting elements to the learning process, traditional methods provide a solid foundation and familiarity. This combination can help students transition smoothly into gamified learning environments without feeling overwhelmed. Fourthly, incorporating various forms and types of activities that prepare future professionals for their careers ensures that gamification is not just a superficial addition to the curriculum but an integral part of skill development. This integration can help students see the direct connection between their gamified learning experiences and their future professional activities. Lastly, this condition promotes the development of a wide range of skills and competencies. By engaging in diverse activities, students can develop not only domain-specific knowledge but also soft skills such as teamwork, communication, and adaptability, which are crucial in modern professional environments.

These pedagogical conditions became the basis of the methodology model.

For a visual representation of the methodology of applying gamification in the educational process of a higher school, a structural-functional model was developed that includes the goal, objectives, structural blocks (objective, content, methodological-organizational, diagnostic, resultant), which, through the implementation of the corresponding pedagogical conditions, make it possible to achieve the effective use of gamification in higher education. The model is shown in figure 2.

The objective block characterizes the purpose and objectives of the researched process. The purpose and objectives of the educational process are determined by the social order of society and are implemented in accordance with the Standards of Higher Education of Ukraine. The content block of the model includes the pedagogical conditions for the effective use of gamification. The methodological-organizational block includes the technology of using gamification in higher education institutions. The diagnostic block includes criteria for the effectiveness of using gamification (motivational, cognitive, operational), as well as levels (high, sufficient, average, low). The resultant block provides for establishing a clearly defined result of the implementation of the model, that is, the transition to a higher level of effectiveness in the use of gamification.

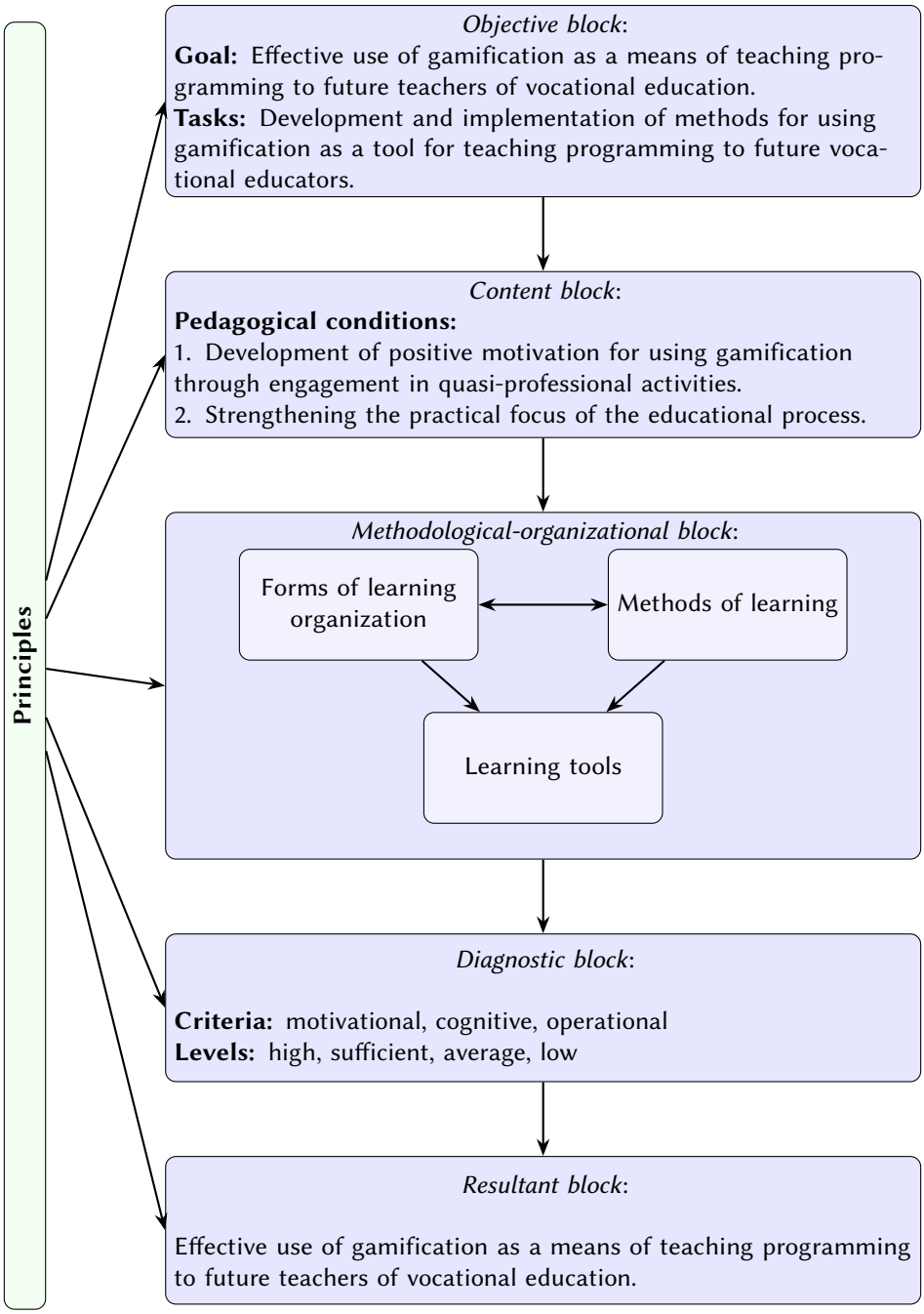

Figure 2: Structural-functional model for gamification in higher education.

3. Experimental study of the implementation of gamification in higher education

3.1. Criteria, indicators, and levels of effectiveness of gamification in higher education

To check the pedagogical conditions and methodology of using gamification in higher education formulated by us, a pedagogical experiment was conducted. The experimental study on the effectiveness of gamification in higher education involves applying scientific methods to study this educational phenomenon to obtain convincing results, generalizations, and conclusions that are useful for pedagogical practice.

An important task at the validation stage of the pedagogical experiment was to determine the levels of effectiveness of gamification use and select criteria for measuring this quality. Based on the analysis of scientific research, we identified the following criteria for evaluating the effectiveness of gamification use (table 1).

Table 1
Criteria for evaluating gamification effectiveness.

Criterion	Description
Motivational	Characterizes motives and level of interest in learning activities in higher education and self-assessment of gamification effectiveness
Cognitive	Determines the level of methodical and special knowledge
Operational	Reflects the level of formation of general and special skills

Analysis of psychological and pedagogical research shows that the following indicators can be identified for the selected criteria (table 2). Using a multi-level approach, we defined four levels of effectiveness of gamification use (table 3): high, sufficient, medium, low. The identified criteria, indicators, and levels of effectiveness of gamification use were used by us at the ascertaining and formative stages of the pedagogical experiment.

Table 2
Indicators of gamification effectiveness.

Criterion	Indicators
Motivational	Stability of interest and nature of participation in the preparation process, particularly in the development and application of gamification elements
Cognitive	Completeness of knowledge (compliance with professional requirements, higher education standards); systematicity (consistency of knowledge); meaningfulness (subjective significance, independence of judgments, posing problematic questions)
Operational	Correctness and independence in performing learning actions; ability to transfer them to future professional activities; degree of independence during learning

3.2. Organization, conduct, and analysis of pedagogical experiment results

At the stage of the pedagogical experiment, we determined the levels and analyzed the effectiveness of gamification application in higher education according to the developed criteria and indicators. The experimental work consisted of two stages: ascertaining and formative. For the pedagogical experiment, we defined a control group (CG) with 12 students and an experimental group (EG) with 11 students.

Comparison of the results obtained during the ascertaining stage of the pedagogical experiment shows that the effectiveness of training future specialists in CG and EG was approximately at the same level. The majority were students with medium (CG – 41.7%; EG – 36.4%) and low levels (CG – 27.8%; EG – 30.3%), which indicates the need to implement the pedagogical conditions we developed for the effective use of gamification.

The formative stage of the pedagogical experiment took place directly in the process of training specialists of the first (bachelor's) level at Kryvyi Rih National University. The purpose of this stage of the experiment was to implement pedagogical conditions for the effective use of gamification. The process of forming the effectiveness of gamification use is based on the goal: development of motivational, cognitive, and operational components that can ensure the success of future specialists in professional activities.

In EG, the work on implementing gamification was carried out based on the gradual implementation (in combination) of objective, content, methodological-organizational, diagnostic, and resultant blocks of the developed model and taking into account the developed pedagogical conditions.

Table 3
Levels of gamification effectiveness.

Criteria	Levels	Description
Motivational	High	Student shows stable interest in learning; actively participates in the educational process
	Sufficient	Student shows episodic interest in learning; does not show particular activity in studying disciplines
	Medium	Student's interest in learning is at the level of curiosity; does not show activity in studying disciplines
	Low	Student's participation in the learning process requires constant control from teachers
Cognitive	High	Student has complete, systematic, and meaningful general and special knowledge
	Sufficient	Student has complete, meaningful general and special knowledge
	Medium	Student has partial, incomplete general and special knowledge
	Low	Student has basic general and special knowledge
Operational	High	Student acts correctly and independently in various situations, transfers skills from one type of activity to another; effectively carries out independent learning
	Sufficient	Student acts independently according to a pattern, varies known action systems, generally performs actions correctly, but experiences difficulties in transferring skills; shows weak independence in learning
	Medium	Student mostly acts correctly according to a pattern and with teacher's help, barely changes and transfers known action systems to other activities; cannot learn independently
	Low	Student reproduces certain actions only with teacher's help, cannot act independently without a pattern; degree of correctness in performing actions is insufficient; transfer to other activities is absent; cannot learn independently

The implementation of the first pedagogical condition was carried out in EG and was aimed at forming the motivational component. The assessment of the level of student motivation was carried out through questionnaires. The implementation of the second pedagogical condition was carried out in EG and was aimed at forming cognitive and operational components.

Verification of knowledge and features of gamification application in the educational process was carried out through testing. The levels of formation of the operational component of gamification effectiveness were determined by the journals of academic groups. The formation of cognitive and operational components in the process of cognitive activity occurred in parallel with educational, practical, and independent activities, which is necessary for future specialists and allows understanding the nature of developed skills and the specifics of different skills, as well as applying this knowledge and skills to perform practical tasks.

In analyzing the results of the formative experiment, the criteria and indicators developed and described above were used to assess the levels of effectiveness of gamification use. The generalized results of the formative experiment are presented in table 4.

Thus, it should be noted that the average results for the motivational, cognitive, and operational components showed positive dynamics in EG compared to CG. The number of students who demonstrated a high level of effectiveness of gamification use after the formative stage of the experiment increased by 12.1% in EG, while in CG it remained unchanged; the average value for the sufficient level in EG increased by 27.3%, and in CG – only by 3.2%; the average value for the medium level in EG decreased by 18.2%, and in CG increased by 2.8%; the average value for the low level in EG decreased by 21.2%, and in CG – by 5.6%. Comparison of the results of the ascertaining and formative experiments (by average values in %) is shown in figure 3.

Thus, the pedagogical experiment confirmed that the application of the methodology and pedagogical conditions we developed and theoretically substantiated in the educational process contributes to the effectiveness of gamification use.

Table 4
Generalized results of the formative stage of the pedagogical experiment (values in %).

Groups	Levels			
	High	Sufficient	Medium	Low
Motivational criterion				
CG	8.3	16.7	41.7	33.3
EG	27.3	36.4	27.3	9.1
Cognitive criterion				
CG	16.7	16.7	50.0	16.7
EG	27.3	45.5	18.2	9.1
Operational criterion				
CG	16.7	25.0	41.7	16.7
EG	27.3	54.5	9.1	9.1
Average value				
CG	13.9	19.5	44.5	22.2
EG	27.3	45.5	18.2	9.1

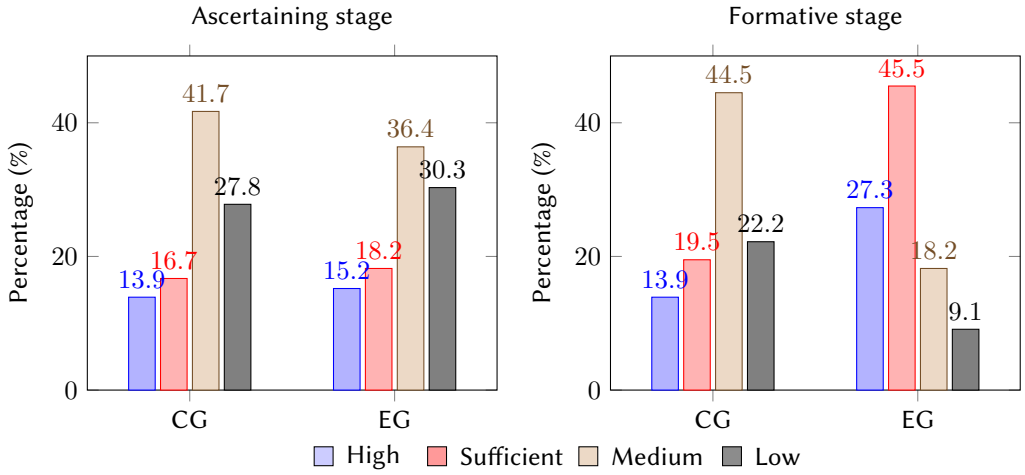

Figure 3: Comparison of results of ascertaining and formative experiments (by average values, %).

4. Conclusions

The study's findings offer significant insights into the implementation and effectiveness of gamification in higher education. The proposed structural-functional model, comprising objective, content, methodological-organizational, diagnostic, and resultant blocks, provides a comprehensive framework for implementing gamification in higher education. This model's effectiveness was demonstrated through the positive outcomes observed in the experimental group.

The two identified pedagogical conditions – developing positive motivation through quasi-professional activities and strengthening the practical orientation of the educational process – proved crucial in enhancing the effectiveness of gamification. These conditions address both the motivational aspects of learning and the development of practical skills necessary for future professional success.

The study revealed improvements across all three criteria (motivational, cognitive, and operational) in the experimental group, suggesting that gamification can positively influence various aspects of student learning and engagement. The experimental group showed significant increases in the proportion of students at high and sufficient levels of gamification effectiveness, with corresponding decreases at medium and low levels. These changes were notably more pronounced than in the control group, underlining the impact of the implemented methodology.

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