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The use of gamification in secondary schools in Great Britain and France

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Abstract. The aim of the research was to analyse the impact of various types of gamification on student motivation and learning achievements compared to traditional teaching methods. The research methodology included three main methods: structural-conceptual analysis, comparative analysis, and a pedagogical experiment conducted over four months (March-June 2024) involving 68 students equally from two countries: Great Britain and France. The research determined that gamification incorporates various elements and mechanisms, such as point and level systems, badges and achievements, leaderboards, learning quests, game scenarios, and role-playing games, which contribute to increased student motivation and activity. It was found that integrating these elements into the learning process stimulates the development of critical thinking, team interaction, and cognitive skills. After conducting the experiment, changes in motivation levels in the groups differed: in the control group, the proportion of students with low motivation levels (1-3 points) decreased by approximately 1-3%, while in the experimental group this proportion decreased to 12%, which is half of the initial level. In the control group, high scores (6-7) increased by 1-3%, while the proportion of high scores (6-7) in the experimental group increased 2-2.5 times compared to the results before the experiment. The level of knowledge also increased: in the control group, the proportion of correct answers improved to 60%, while this indicator in the experimental group reached 88-97%. The application of gamification methods enhanced the level of intrinsic motivation, interest, and learning activity among students, facilitated better material assimilation, and promoted the development of critical thinking and teamwork skills. Traditional methods ensured only a basic level of knowledge assimilation and moderate motivation, highlighting the effectiveness of the innovative approach in education. The obtained results can be used by secondary school teachers to implement gamification elements in curricula to enhance motivation and improve student learning achievements

Keywords: students; online platforms; game elements; enhancing motivation; learning activity

INTRODUCTION

Students interact with digital technologies and interactive gaming environments, causing traditional teaching approaches to lose effectiveness in engaging attention and stimulating interest. This manifests in decreased concentration and interest, particularly in the study of exact and natural sciences. The use of game mechanics in the educational process allows for the activation of cognitive activity and facilitates deeper material assimilation. However, the implementation of such approaches faces certain difficulties related to insufficient teacher experience and the limited capabilities of modern platforms, which do not always align with educational requirements. This creates a need to research the impact of interactive technologies on student engagement and performance, in order to identify the most effective teaching strategies that combine motivation, practical activity, and effective knowledge acquisition.

The authors W. Oliveira *et al.* (2022) explored the use of personalised gamification in education, analysing how tailoring game elements to individual students affects motivation, engagement, logical thinking quality, and learning outcomes. They identified key trends: adapting task difficulty levels, personalising rewards and feedback, integrating social and team elements, and utilising analytics, which contribute to enhanced learning effectiveness and the development of students' cognitive and social skills. Clarification of the role of gaming innovations

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became possible thanks to the work of authors A. Vrcelj *et al.* (2023b), which investigated teachers' attitudes towards gamification and documented a combination of interest in innovation with concerns regarding implementation complexity. Furthermore, the researchers pointed out the need to prepare teachers to create their own gamified materials, as ready-made solutions do not always meet the needs of specific classrooms. Concurrently, a study on the impact of gamification on grammar acquisition conducted by G. Koç & S.S. Sütçü (2023) proved that the use of points, levels, and interactive tasks positively influences the quality of grammatical structure assimilation in adolescents. Specifically, gamification is beneficial for students with lower initial academic motivation, as it creates additional incentives for participation.

A contribution to understanding digital teacher training was made by the research of T. Liu *et al.* (2023), who analysed gamified online learning programmes and showed that such programmes strengthen digital competence and promote active professional development of teachers. They also noted that teachers respond positively to interactive and game formats, as these create a sense of progress and reduce the psychological barrier to new technologies. The issue of digital gamification in secondary school was systematised in a review conducted by A. Faure-Carvallo *et al.* (2022) to summarise the advantages and limitations of this approach. The scholars emphasised that gaming technologies are effective provided there is high-quality pedagogical design. Moreover, they highlighted the existence of differences between short-term effects, such as increased attention and lesson engagement, and long-term effects, including improved learning achievements and the formation of sustained learning motivation. In their research, G. Kaya & H.C. Sagnak (2022) demonstrated a stable increase in students' oral activity and interest, and confirmed the selection of appropriate gaming methods. The researchers also concluded that gamification promotes the development of communicative confidence among students who typically avoid active participation.

Psychological aspects of applying gamification were investigated by V.J. Sotos-Martínez *et al.* (2022). It was determined that game mechanics now facilitate the satisfaction of students' basic psychological needs and enhance their intrinsic motivation. Furthermore, gamification creates an atmosphere of healthy competition, which encourages more active completion of motor tasks. At the same time, research conducted by A.M. León *et al.* (2022) demonstrated that gamified strategies make learning reading more conscious and structured for students. They also emphasised that the impact of gaming approaches is noticeable when working with texts, particularly scientific articles, literary works, and textbooks. In mathematics education, results from a multi-case analysis conducted by V. Malvasi *et al.* (2022) to assess the use of gamification and educational games confirmed that these approaches improve the understanding of abstract concepts and promote the development of logical thinking in schoolchildren. The authors noted that the use of gaming platforms facilitates error processing and fosters a more positive attitude towards complex mathematical tasks. Researcher M.K. Bharti (2023), who investigated the overall impact of gamification on motivation and learning outcomes, proved that game mechanics now significantly enhance the learning activity and success of secondary school students. In practice, gaming approaches support not only motivation but also the development of self-regulation, as students learn to plan their own progress. In practice, this occurs through the use of game mechanics that stimulate students to plan their own progress, independently monitor task completion, and sustain motivation and active participation in the learning process.

Despite the number of works, a noticeable gap remained in the research, related to insufficient analysis of the long-term impact of gamification on student learning motivation and the stability of results. There was also a lack of comprehensive comparative studies combining different secondary school subject areas and different models of implementing gamification strategies. Furthermore, authors rarely assessed individual differences among schoolchildren, which complicated the determination of which gamification elements work for different student types. The aim of the research was to ascertain how the use of gamified teaching methods affects student motivation and the outcomes of their learning activity. The objectives of the research were: to conduct a comparative analysis of the types of gamification in the educational process; to assess the impact of gamification on student motivation and their learning achievements; to formulate recommendations for implementing gamification in the educational process.

MATERIALS AND METHODS

The study employed the method of structural-conceptual analysis, which allowed for the systematisation and generalisation of scientific approaches to gamification in education, and for the identification of key concepts, interrelationships, and principles of its implementation. Using this method, the main aspects of gamification were determined, namely the integration of game elements into the learning process, the stimulation of motivation, the development of critical thinking and teamwork, as well as the dependence of effectiveness on the age characteristics of students, learning objectives, and the curriculum. Based on the method of comparative analysis, a review of the main types of gamification was conducted using sources Pavlohak (2024), The Gamification Guide (2025), Jacob (2026), , specifically point and level systems, badges and achievements, leaderboards, educational quests and missions, game scenarios, reward systems, role-playing games, and time-limited tasks. Furthermore, online platforms such as Classcraft (n.d.), Legends of Learning (n.d.), and Minecraft Education Edition (n.d.) were examined. Additionally, the functions and operational algorithms of Labster (n.d.), PhET Interactive Simulations (n.d.), and Kahoot! (n.d.) were studied. Features of programs with gamified elements such as Quizizz (n.d.),

Gimkit (n.d.), and Classcraft Missions (n.d.) were also highlighted. These types of gamification were selected because they most effectively combine elements of motivation, interaction, and competition, contributing to increased student engagement and improved learning outcomes. The analysis was conducted taking into account aspects such as students' motivation level, intensity of cognitive activity, degree of engagement in the learning process, and the effectiveness of feedback between teacher and student.

The study also employed the method of pedagogical experiment, which was conducted over four months, from March to June 2024. The sample included 68 secondary school students, with 34 participants from the United Kingdom and 34 from France. For ethical and confidentiality reasons, the names of the participating schools were not disclosed. The schools were selected on the basis of their representativeness of secondary education, comparable educational profiles, and prior experience in the implementation of digital and gamified learning platforms. Inclusion criteria required participants to be enrolled in grades 8-9 at the time of the experiment, to attend classes regularly, to have parental consent for participation, and to possess basic digital skills necessary for working with online platforms. Exclusion criteria included absence from more than 20% of classes, chronic health conditions limiting participation in active forms of learning, prior experience of using gamified platforms in the educational process, and participation in parallel pedagogical experiments that could affect motivation and learning outcomes. Ethical requirements in accordance with the Helsinki Principles (World Medical Association, 2013) were observed, including the anonymity of responses, the right to withdraw from participation without negative consequences, and the secure processing and storage of the obtained data. The students were divided into control and experimental groups in a 1:1 ratio, with equal representation from both countries. In the control group, instruction was delivered through traditional methods, including lectures, quizzes, written assignments, and practical exercises. In the experimental group, teaching was organised through a gamification-based approach that incorporated point and level systems, badges and achievements, leaderboards, educational quests and missions, game scenarios, reward systems, role-playing games, and time-limited tasks, with particular emphasis on mathematics and natural sciences. To assess the effectiveness of the experiment, the level of student motivation was measured before and after the intervention using the Student Motivation Scale (n.d.), which evaluates subject interest, achievement orientation, and activity in the learning process. Responses were recorded on a seven-point scale, which allowed for a quantitative assessment of intrinsic and extrinsic motivation. The scale was adapted, resulting in the following questions being isolated:

1. I am interested in learning this subject.
2. I strive to achieve success in my studies.
3. I try to work actively during lessons.
4. I complete tasks because I want to learn more.
5. I feel satisfaction when I complete learning tasks.
6. I make an effort even when the task is difficult.
7. I can say that I have high intrinsic motivation.

Furthermore, at the beginning and end of the experiment, students were asked to complete seven multiple-choice tasks, which allowed for the determination of improvement or decline in their learning outcomes and the assessment of the effectiveness of the applied teaching methods. The tasks were as follows:

Task 1. Definition of the term

What is gamification in the learning process?

a) Using games for entertainment during lessons

b) Applying game elements to increase student motivation and engagement in learning

c) Mandatory completion of computer games during lessons

d) Solely using points and rankings without tasks

Task 2. Examples of gamification elements

Which of the listed elements is not an example of gamification?

a) Points and rankings

b) Virtual medals and badges

c) Homework without any additional rewards

d) Challenges and quests

Task 3. Mathematics + Gamification

Students are completing an algebra learning quest. They receive 10 points for correctly solving an equation.

How can the task be made more gamified?

a) Awarding extra points for solving speed

b) Reducing the number of equations

c) Eliminating any rewards

d) Prohibiting teamwork

Task 4. Scientific Experiments

Students are performing a series of virtual chemistry experiments in a programme where they receive "energy" for each successful task. Which gamification principle is used here?

a) Balance of difficulty and reward

b) A traditional lecture

c) Teamwork only

d) Assessment solely at the end of the semester

Task 5. Motivation and Engagement

How does gamification affect student motivation?

a) It decreases interest in the subject

b) It increases activity and the desire to learn

c) It makes learning more difficult

d) It replaces the teacher

Task 6. Reward Strategies

Students receive points when they complete mathematical tasks and can exchange them for "virtual items". What type of gamification is used?

a) Negative reinforcement

b) Positive reinforcement

c) Social pressure

d) Random encouragement

Task 7. Choosing a Gamification Programme

Which feature is most important when selecting an educational programme with gamification elements for mathematics and natural sciences?

a) The presence of bright colours

b) The balance between learning objectives and game mechanics

c) The ability to play without completing tasks

d) A large number of advertising banners

Student responses were checked and evaluated by six secondary school teachers from the United Kingdom and France who acted as independent assessors. The teachers were selected according to the following criteria: at least five years of teaching experience in secondary education, experience in using digital learning platforms, and knowledge of assessment methodologies used to evaluate learning achievements in accordance with national educational standards in the United Kingdom and France. Teachers were excluded if they had less than five years of teaching experience, lacked experience with gamified or interactive platforms, participated in parallel pedagogical experiments that could affect the objectivity of assessment, or refused to comply with confidentiality requirements during the marking process.

Ethical safeguards applied not only to students but also to the participating teachers. All teachers were informed about the aims and procedures of the study and provided voluntary consent to participate as assessors. Their involvement was treated confidentially, and they retained the right to withdraw from the study at any stage without negative consequences. To ensure objectivity and compliance with ethical requirements, all student responses were anonymised before evaluation.

Student responses were evaluated on a percentage basis: 10-20% correct answers indicated a low level of material assimilation, where students barely understood the topic; 21-40% – indicated an average level of understanding, meaning students partially mastered the material but required additional explanation; 41-60% – reflected a sufficient level, where the majority of students demonstrated correct understanding of basic concepts; 61-80% – corresponded to a high level of assimilation, indicating correct and comprehensive perception of the learning material; finally, 81-100% – showed a very high level, where almost all students gave correct answers and demonstrated excellent understanding of the topic.

The dynamics of changes in student motivation and learning outcomes were tracked using the method of repeated measurements and Cronbach's Alpha reliability coefficient. In the study, Cronbach's Alpha coefficient of internal consistency was used to assess questionnaire reliability, which allows for determining how consistently individual test items measure the target construct – in this case, student motivation level. The coefficient value ranges from 0 to 1; in the presented study, the calculated Cronbach's Alpha for the questionnaire is 0.84, indicating good internal consistency and reliability of the instrument for measuring student motivation. A limitation of the study is that the experiment was conducted only in secondary schools in the UK and France over one semester, which limits the generalisability of the results to other countries, age groups, and educational levels.

RESULTS

Gamification in education is considered as the integration of game mechanics and elements into the learning process to enhance student motivation, engagement, and performance. Gamification encompasses game elements (points, levels, badges, leaderboards, quests, story-based tasks), motivational mechanisms, the development of cognitive and social skills, as well as the adaptation of learning to individual student needs (Seeletse *et al*., 2024). Specifically, properly integrated elements of game design stimulate active student participation, foster independent learning, and develop critical thinking and teamwork skills. Gamification promotes the development of critical thinking, as game-based tasks require analysis, planning, and decision-making. Students learn to evaluate their own actions, predict outcomes, and adjust strategies, thereby forming problem-solving and logical thinking skills. Team interaction manifests through group quests and collective tasks, which stimulate cooperation, communication, and the ability to work in a team, developing social skills and responsibility for the collective outcome (Gini *et al.,* 2025).

The effectiveness of gamification depends on student age, learning objectives, and the educational curriculum. For younger schoolchildren, simple tasks with visual rewards and short quests are suitable, supporting motivation and fostering interest in learning. For middle and high school students, complex game scenarios, integrated projects, and team competitions are applied, promoting a deep understanding of the material and the development of critical thinking. In exact sciences, game elements help progressively master abstract concepts and logical operations, while in humanities disciplines, they stimulate analysis, discussion, and creative thinking (Zeng *et al*., 2024). Thus, gamification in education is a multi-level system that combines the integration of game elements, motivational strategies, the development of critical thinking, and team interaction, adapted to the age and cognitive abilities of students and the specifics of the educational curriculum. The application of these aspects increases interest in learning, improves knowledge acquisition outcomes, and contributes to the formation of key competencies in schoolchildren. Gamification and its individual types positively impact the learning process, as they integrate game elements that enhance motivation, activate cognitive activity, and increase student engagement. Points and levelling systems allow students to track their own progress and receive immediate feedback, stimulating further mastery of the material. Badges and achievements encourage students to reach specific goals and independently improve their skills, while leaderboards foster a competitive spirit and attention to the subject. Educational quests and missions form complex

cognitive activity, forcing the application of knowledge in practice, analysis of results, and planning of next steps. Game scenarios and role-playing games model real-world problem situations, promoting the development of teamwork problem-solving skills and improved communication. Time-limited tasks stimulate thinking speed, concentration, and prompt decision-making, which is effective in mathematics and the natural sciences (Kien & Nguyen, 2021). Collectively, these gamification mechanisms increase motivation levels, student activity, and the effectiveness of feedback between teacher and student, making the learning process more interactive, structured, and effective. Table 1 summarises the key elements and mechanisms of gamification that are actively used in secondary education to enhance student motivation and engagement.

Table 1. Comparative analysis of gamification elements and mechanisms applied in secondary education

Element/Mechanism	Practical Application in the Learning Process
Points and Levelling System	Students receive points for completed tasks, participation in discussions or projects; accumulated points allow them to "advance" to new difficulty levels, motivating them to tackle more complex tasks.
Badges/ Achievements	The teacher awards badges for mastering specific skills or achieving certain results; students see their successes, which increases intrinsic motivation.
Leaderboards/ Rankings	Display student progress within the class or group; students strive to improve their positions, and the teacher can stimulate teamwork and healthy competition.
Educational Quests and Missions	Series of tasks or projects with specific goals that integrate different subjects; students plan actions, conduct research, and report results, forming critical thinking.
Game Scenarios	Implementation of thematic storylines into lessons (e.g., historical reenactment or scientific expedition), helping students immerse themselves in the material and increasing engagement.
Reward System	Students receive bonuses, additional tasks, or public recognition for successes; this stimulates consistency in learning and encourages active participation.
Role-Playing Games	Students perform roles (researcher, project manager, historical figure), promoting the development of strategic thinking, team interaction, and responsibility for decisions made.
Time-Limited Tasks	Tests or practical tasks with a timer increase concentration, thinking speed, and the ability to make decisions under tight deadlines; simultaneously, effective planning is practised.

Source: compiled by the authors based on Pavlohak (2024), The Gamification Guide (2025), Jacob (2026)

The comparative analysis determined that different types of gamification in secondary education differ in their functional focus and impact on the learning process. Points and levelling systems, as well as badges and achievements, primarily motivate students, demonstrating progress and specific achievements, which stimulates intrinsic motivation and the desire to tackle more complex tasks. Leaderboards and rankings are distinguished by their social aspect, as they foster healthy competition and team interaction, making students evaluate their own results in comparison with others. Educational quests and missions and game scenarios are focused on developing critical thinking and deep immersion in the learning material, integrating various subjects and forming skills in planning, analysis, and research work. The reward system is distinguished by its stimulating nature, encouraging consistency in learning and active participation in the process. Role-playing games concentrate on developing strategic thinking, team interaction, and responsibility for decisions made, while time-limited tasks focus on thinking speed, concentration, and prompt decision-making. The main difference between the types of gamification lies in the direction of their impact: some stimulate motivation and progress, others social interaction, critical thinking, or concentration and task execution efficiency, allowing them to be combined for the comprehensive development of students.

Points and levelling systems, badges and achievements, leaderboards, educational quests and missions, game scenarios, reward systems, role-playing games, and time-limited tasks function in practice as tools that structure students' learning activities and make them more manageable, measurable, and motivational. According to Pavlohak (2024), such mechanics form a sense of progress in high school students, as each element demonstrates a clear connection between the completed task and the achieved result. For example, a points and levelling system makes it possible to transform complex topics in algebra or geometry into sequential stages, where students receive points for correct solutions and advance to higher levels after mastering a block of material. Badges and achievements are useful in natural sciences when it is necessary to mark mastery of a specific skill – for instance, understanding chemical reaction formulae or successfully performing a virtual laboratory experiment. The study by Jacob (2026) highlights that leaderboards are effective for short, intensive topics where it is relevant to maintain competitiveness and thinking speed, such as training computational skills, working with formulae, chemical equations, or graph analysis. However, they should be applied cautiously to avoid excessive pressure; in higher grades, they are most appropriate for extracurricular activities, preparatory exercises, or practice tools for material review. Educational quests and missions work well in topics requiring interdisciplinary integration, for example in projects where students must calculate parameters of body motion, model an ecosystem, analyse statistical data, or create a simple mathematical model of a natural phenomenon. Game scenarios allow students to immerse themselves in the roles

of researchers, engineers, or analysts, and such a format, according to The Gamification Guide (2025), helps retain complex information better and increases the level of understanding of abstract concepts. The reward system reinforces interest in lengthy or complex topics, as students receive virtual bonuses for sequential steps, completion of intermediate tasks, participation in teamwork, module completion, or independent improvement of results. Role-playing games are useful in natural sciences, where students can "try on" the role of a biologist, physicist, or ecologist, performing modelling, data analysis, or problem-solving. Time-limited tasks are suitable for training thinking speed and skill automation, for example when solving equations, performing chemical substitutions, or analysing functions.

Online platforms with gamified elements demonstrate high effectiveness in teaching high school students; however, their application should be appropriately differentiated depending on the subject and type of tasks. Classcraft (n.d.) and Classcraft Missions (n.d.) create a comprehensive gaming environment with scenarios, levels, rewards, and role models, which is effective in the natural sciences, where students complete quests, simulate research situations, and work in teams, enhancing their analytical and critical thinking skills. Labster (n.d.) and PhET Interactive Simulations (n.d.) provide the capability to conduct virtual experiments and simulate physical, chemical, and biological processes in a safe interactive environment, facilitating a deep understanding of complex natural phenomena. Kahoot! (n.d.), Quizizz (n.d.), and Gimkit (n.d.) focus on revision, rapid testing, and skill training through points, leaderboards, and timers, which is useful in mathematics for developing computational skills, logical thinking, and reaction speed. Platforms that stimulate creativity and project activities, such as Minecraft Education Edition (n.d.) and Legends of Learning (n.d.), enable students to model mathematical objects, construct structures, visualise abstract concepts, and conduct integrated research in natural sciences using narrative-role scenarios.

Thus, the effectiveness of gamification programmes depends on the extent to which the platform aligns with the subject and type of learning activity, combining motivational mechanisms with the opportunity for practical knowledge consolidation and the development of critical and logical thinking in high school students. Furthermore, gamification platforms demonstrate high effectiveness when they combine interactive elements with educational content, adapting tasks to the subject specificity and student level. The use of points, leaderboards, timers, quests, and role scenarios stimulates motivation, the development of computational and logical skills, as well as critical thinking. Therefore, the successful implementation of such platforms in the educational process contributes to the simultaneous increase in student engagement and the quality of knowledge acquisition.

Student motivation and learning outcomes can vary depending on age, learning objectives, subject specificity, and teaching methods, including the application of traditional or gamified approaches. The choice of appropriate learning strategies determines the level of engagement, activity, and effectiveness of material assimilation. To determine the initial conditions of the pedagogical experiment, the baseline motivation level in the control and experimental groups was analysed. Data are presented in Table 2.

Table 2. Baseline student motivation level in the control and experimental groups prior to the experiment

Question (Student Motivation Scale)	Score	Control Group (CG) (%)	Experimental Group (EG) (%)
1. I find it interesting to study this subject	1	4	3
	2	7	5
	3	10	10
	4	29	28
	5	26	27
	6	13	15
	7	11	12
2. I strive to achieve success in learning	1	4	2
	2	6	5
	3	13	12
	4	31	30
	5	23	25
	6	13	15
	7	10	11
3. I try to work actively in lessons	1	5	4
	2	8	5
	3	17	14
	4	33	30
	5	21	24
	6	10	14
	7	6	9

Table 2. Continued

Question (Student Motivation Scale)	Score	Control Group (CG) (%)	Experimental Group (EG) (%)
4. I complete tasks because I want to learn more	1	6	4
	2	9	7
	3	15	15
	4	32	30
	5	19	22
	6	11	14
	7	8	8
5. I feel satisfaction when completing learning tasks	1	6	4
	2	9	6
	3	16	16
	4	34	32
	5	19	22
	6	9	12
	7	7	8
6. I make an effort even when the task is difficult	1	7	5
	2	10	7
	3	18	17
	4	31	30
	5	17	20
	6	9	13
	7	8	8
7. I can say that I have high intrinsic motivation	1	8	6
	2	11	8
	3	20	20
	4	29	28
	5	16	18
	6	9	12
	7	7	8

Note: the table shows the percentage of students who responded to the question on a seven-point scale
Source: compiled by the authors

Analysis of the results presented in the table indicates that at the initial stage, the level of learning motivation among students in the control and experimental groups was generally similar. In both groups, the majority of students rated their motivation at levels 4-5 points, indicating a moderate level of motivation. The control group showed a slightly higher percentage of responses for the rating "4" (29-34%) compared to the experimental group (28-32%). Differences between the groups were minor, with a difference within 1-2% for these ratings. Higher scores (6-7) were less common, and their proportion in both groups was similar. In particular, the absence of significant differences at the outset indicates equal initial conditions for both groups, allowing for a correct comparison of their results after the implementation of experimental methodologies. The reasons for this similar motivation level may be related to traditional teaching approaches, which at that time no longer fully met the needs of students. This may contribute to reduced activity and interest in the learning process, which explains the absence of significant differences at the initial stage. Overall, at the start, both groups have a similar motivational structure, which allows for assessing the effectiveness of subsequent pedagogical interventions and gamification methodologies. The general pattern of responses demonstrates the absence of statistically significant initial differences between the study participants. The next stage involved determining the knowledge level of students in the control and experimental groups prior to the pedagogical experiment through test performance, as demonstrated in Table 3.

Table 3. Distribution of student responses in the control and experimental groups prior to the experiment

Task	Response Options	Correct Answer	CG (%)	EG (%)
1. What is gamification in the educational process?	a) Using games for entertainment during lessons b) Applying game elements to enhance student motivation and engagement in learning c) Mandatory completion of computer games during lessons d) Only using points and ratings without tasks	b	a – 20 b – 50 c – 15 d – 15	a – 18 b – 52 c – 16 d – 14

Table 3. Continued

Task	Response Options	Correct Answer	CG (%)	EG (%)
2. Which of the listed elements is not an example of gamification?	a) Points and rankings b) Virtual medals and badges c) Homework without any additional rewards d) Challenges and quests	c	a – 25 b – 28 c – 30 d – 17	a – 22 b – 30 c – 32 d – 16
3. Students complete an algebra learning quest. They receive 10 points for solving an equation correctly. How can the task be made more gamified?	a) Award additional points for solving speed b) Reduce the number of equations c) Exclude any rewards d) Prohibit working in a team	a	a – 20 b – 25 c – 30 d – 25	a – 18 b – 22 c – 28 d – 32
4. Students perform a series of virtual chemical experiments in a programme where they receive "energy" for each successful task. Which gamification principle is used here?	a) Balance of difficulty and reward b) Traditional lecture c) Only teamwork d) Solely end-of-term assessment	a	a – 18 b – 25 c – 28 d – 29	a – 20 b – 24 c – 26 d – 30
5. How does gamification affect student motivation?	a) Reduces interest in the subject b) Increases activity and desire to learn c) Makes learning more difficult d) Replaces the teacher	b	a – 20 b – 50 c – 15 d – 15	a – 18 b – 52 c – 16 d – 14
6. Students receive points when they complete mathematical tasks and can exchange them for "virtual items". Which type of gamification is used?	a) Negative reinforcement b) Positive reinforcement c) Social pressure d) Random encouragement	b	a – 22 b – 40 c – 18 d – 20	a – 20 b – 42 c – 16 d – 22
7. What feature is most important when choosing an educational programme with gamification elements for mathematics and natural sciences?	a) Presence of bright colours b) Balance between learning objectives and game mechanics c) Ability to play without completing tasks d) Large number of advertising banners	b	a – 18 b – 45 c – 20 d – 17	a – 16 b – 48 c – 18 d – 18

Note: the table indicates the correct answer for each task and the percentage of students who selected each response option, allowing for an assessment of the initial knowledge level and comparability of the groups
Source: compiled by the authors based on students' previous assessments

Analysis of the distribution of students' responses prior to the experiment revealed that the highest percentage of correct answers was observed for tasks 1 and 5. In the control group, the correct option was chosen by 50% of students (task 1 – 50%, task 5 – 50%), while in the experimental group these indicators were slightly higher – 52% and 52% respectively. The lowest percentage of correct answers was recorded in tasks 3 and 4, where in both groups the correct option was chosen by 18-20% of students (in the control group: task 3 – 20%, task 4 – 18%; in the experimental group: task 3 – 18%, task 4 – 20%). This indicates the complexity of tasks related to the application of gamification principles in mathematics and natural sciences.

The average response distribution showed that the control and experimental groups were comparable at the start; the difference in the percentage of correct answer choices between groups did not exceed a few points, which allows for the evaluation of the subsequent impact of gamification without bias. In summary, the table demonstrates that at the initial stage, both groups had a moderate level of knowledge regarding tasks where the use of gamified approaches was key, and a higher level of knowledge in tasks related to basic understanding of terminology and motivation. This establishes a baseline for comparing the effectiveness of traditional and gamified learning in the subsequent experiment. Table 4 illustrates the distribution of responses from students in the control and experimental groups after the pedagogical experiment.

Table 4. Distribution of responses from students in the control and experimental groups after the experiment

Task	Answer Options	Correct Answer	CG (%)	EG (%)
1. What is gamification in the educational process?	a) Using games for entertainment during lessons b) Applying game elements to enhance student motivation and engagement in learning c) Mandatory completion of computer games during lessons d) Using only points and rankings without tasks	b	a – 22 b – 58 c – 12 d – 8	a – 10 b – 92 c – 5 d – 3
2. Which of the listed elements is not an example of gamification?	a) Points and rankings b) Virtual medals and badges c) Homework without any additional rewards d) Challenges and quests	c	a – 28 b – 32 c – 32 d – 8	a – 8 b – 10 c – 90 d – 2

Table 4. Continued

Task	Answer Options	Correct Answer	CG (%)	EG (%)
3. Students complete an algebra learning quest. They receive 10 points for solving an equation correctly. How can this task be made more gamified?	a) Award additional points for speed of solution b) Reduce the number of equations c) Exclude any rewards d) Prohibit working in a team	a	a – 32 b – 28 c – 20 d – 20	a – 88 b – 5 c – 2 d – 5
4. Students perform a series of virtual chemistry experiments in a program where they receive "energy" for each successful task. Which principle of gamification is used here?	a) Balance of difficulty and reward b) Traditional lecture c) Teamwork only d) Assessment solely at the end of the semester	a	a – 30 b – 28 c – 24 d – 18	a – 90 b – 3 c – 4 d – 3
5. How does gamification affect student motivation?	a) Lowers interest in the subject b) Increases activity and desire to learn c) Makes learning more difficult d) Replaces the teacher	b	a – 15 b – 60 c – 15 d – 10	a – 5 b – 97 c – 2 d – 1
6. Students earn points when completing math tasks and can exchange them for "virtual items". Which type of gamification is used?	a) Negative reinforcement b) Positive reinforcement c) Social pressure d) Random encouragement	b	a – 20 b – 55 c – 15 d – 10	a – 3 b – 94 c – 2 d – 1
7. Which feature is the most important when choosing an educational program with gamification elements for mathematics and natural sciences?	a) Presence of bright colours b) Balance between learning objectives and game mechanics c) Ability to play without completing tasks d) Large number of advertising banners	b	a – 18 b – 60 c – 12 d – 10	a – 5 b – 97 c – 2 d – 1

Note: the table indicates the correct answer for each task and the percentage of students who selected each answer option, which allows for the assessment of the initial knowledge level and group comparability
Source: compiled by the authors based on prior student assessments

Analysis of the results demonstrates a clear and statistically significant gap between the indicators of the control and experimental groups upon completion of the experiment. The experimental group, in which the educational process was implemented using gamification and innovative digital technologies, showed a substantially higher level of material assimilation compared to the control group, which followed the traditional methodology. In most tasks, the percentage of correct answers in the experimental group ranges from 88% to 97%, indicating an almost complete understanding by students of key concepts and principles of gamification. In contrast, the results of the control group fluctuate within the range of 30-60% depending on the task, confirming only partial assimilation of the material. The most pronounced differences are observed in tasks that require an understanding of gamification mechanisms and the ability to apply them in simulated learning situations (tasks 3 and 4): in the experimental group, correct answers constitute 88-90%, whereas in the control group – only 30-32%. Such a contrast is substantial and demonstrates that students who participated in learning based on gamified elements not only retained the material better but were also able to transfer the acquired knowledge to practical examples.

The gap between the groups is explained by the specifics of the methodologies used. Gamification elements ensured an increased level of engagement and motivation among students in the experimental group, supporting intrinsic motivation by creating conditions for autonomy, competence, and interaction with others. The interactive learning tools applied during the experiment facilitated a better understanding of the material, created a positive emotional background, and activated memory processes through multi-channel perception of information. The control group, despite noticeable progress compared to the initial results, did not demonstrate dynamics comparable to the experimental group, as traditional teaching methods primarily ensure a reproductive level of knowledge acquisition, whereas the gamification approach stimulates cognitive activity, independent inquiry, practical application of acquired information, and sustained interest in learning. The results of the pedagogical experiment also allow for an assessment of the effectiveness of applying traditional and gamified teaching methods regarding changes in motivation. Table 5 demonstrates the indicators of the control and experimental groups after the completion of the experiment. Analysis of the results presented in Table 5 indicates a positive dynamic in the level of student motivation in both groups following the experiment; however, the changes in the control and experimental groups differ substantially. In the control group, where instruction followed traditional methodologies, only a slight improvement in motivation is observed. The proportion of students with low scores (1-3 points) decreased by approximately 1-3%, while high scores (6-7) increased by 1-3%. This distribution suggests a moderate positive dynamic in learning motivation, but the overall level of interest and intrinsic motivation remains average, which is characteristic of a classical teaching approach. In the experimental group, where innovative teaching methods with elements of gamification were

applied, the changes proved more pronounced. The proportion of students with a low level of motivation (1-3 points) decreased to 4-12%, which is half the initial level. Average indicators (4-5 points) remain stable or increased by 2-5%, while the proportion of high scores (6-7) increased by 2-2.5 times, significantly exceeding the analogous indicators of the control group. This demonstrates that the application of gamification elements contributed to an increase in student interest, activity during lessons, diligence, and willingness to exert greater effort during learning.

Table 5. Level of student motivation in the control and experimental groups after the experiment

Question (Student Motivation Scale)	Score	Control Group (CG) (%)	Experimental Group (EG) (%)
1. I am interested in learning this subject	1	3	1
	2	6	2
	3	9	5
	4	27	18
	5	27	26
	6	15	24
	7	13	24
2. I strive to achieve success in learning	1	3	1
	2	5	2
	3	12	5
	4	30	20
	5	24	25
	6	15	24
	7	11	23
3. I try to actively participate in lessons	1	4	1
	2	7	2
	3	16	7
	4	32	20
	5	22	26
	6	12	25
	7	7	19
4. I complete tasks because I want to learn more	1	5	1
	2	8	2
	3	14	7
	4	32	20
	5	21	27
	6	12	25
	7	8	18
5. I feel satisfaction when I complete learning tasks	1	5	1
	2	8	2
	3	15	6
	4	33	18
	5	21	27
	6	11	24
	7	7	22
6. I make an effort even when the task is difficult	1	5	1
	2	8	3
	3	17	7
	4	30	20
	5	20	26
	6	11	25
	7	9	18
7. I can say that I have high intrinsic motivation	1	5	1
	2	10	3
	3	19	8
	4	29	20
	5	19	27
	6	10	23
	7	8	18

Note: the table shows the percentage of students who responded to the question on a seven-point scale
Source: compiled by the authors

Overall, the results showed that students in the control group, who were taught using traditional methods focused on memorising facts and performing standard exercises, achieved a basic level of knowledge acquisition but exhibited average motivation, low activity during discussions and practical tasks, and their grades were lower compared to the experimental group. At the same time, students in the experimental group, who learned using gamification elements, specifically quests, missions, game scenarios, and a system of points and rewards, demonstrated higher activity, engagement, and concentration, which led to better material assimilation and improved grades. Thus, the integration of game and motivational mechanisms increased the effectiveness of the learning process and stimulated the development of students' independent and critical thinking. As a result, students in the experimental group not only received higher grades but also developed critical thinking, teamwork skills, and the ability to independently plan their actions when completing tasks, which demonstrated the effectiveness of integrating gamification into the learning process.

Based on the results of the conducted pedagogical experiment, the systematic implementation of gamification in the learning process of secondary schools can be recommended to increase motivation and improve students' learning achievements, particularly in the study of mathematical and natural sciences. The experimental group, which used integrated gamified elements – point and level systems, badges and achievements, leaderboards, educational quests and missions, game scenarios, role-playing games, and time-limited tasks – following the implementation of the methodology, saw the proportion of students with a high level of motivation (6-7 points) double, while the number of low scores decreased to 1-3%. Simultaneously, in the control group, the changes were minimal: a high level of motivation increased only to 11-15%, and a low level remained at 3-10%. Considering the obtained data, it is recommended to combine different types of gamification elements to achieve maximum effect: point and level systems, as well as badges and achievements – to stimulate individual motivation; leaderboards and role-playing games – to activate team interaction and healthy competition; educational quests, game scenarios, and time-limited tasks – for the development of critical thinking, logical skills, and decision-making speed.

Furthermore, the use of specialised online platforms with gamification elements is effective, allowing for interactive lessons, modelling experiments, organising team tasks, and quickly assessing student results. A practical recommendation is to combine digital platforms with classical teaching approaches; for students, it is useful to apply quests and game scenarios in mathematics to develop abstract thinking and analytical skills, and in natural sciences – simulations and role-playing games for a better understanding of complex processes and experimental work. Additionally, it is worthwhile to integrate a system of points and rewards to maintain sustained interest, stimulate team interaction through leaderboards and collaborative missions, and use time-limited tasks to train thinking speed and concentration. Thus, based on the research results, it can be argued that the comprehensive implementation of gamification elements increases student motivation and learning outcomes, forms practical and analytical skills, develops critical thinking and teamwork, and the use of specialised platforms ensures an effective combination of learning objectives and game-based motivation, making the learning process more engaging and productive.

DISCUSSION

The use of gamification in secondary schools in the United Kingdom and France ensured an increase in learning motivation, growth in student activity, and the formation of sustained interest in the learning process. It was established that gamification contributes to increased student motivation through the use of points, levels, badges, leaderboards, and other game mechanics, which create a sense of progress and achievement. The obtained results aligned with the conclusions of P. Andrade *et al.* (2021), who established that even partial implementation of three game elements in STEM (Science, Technology, Engineering, Mathematics) discipline software increased motivation and contributed to the assimilation of learning material. The research demonstrated that the effectiveness of gamification depends on the tools used. Specifically, the experimental group used gamification where tasks were presented as quests, missions, game scenarios with a system of points and rewards, which promoted higher activity, engagement, and concentration. Such conclusions are consistent with the research of A. Azar & N. Tan (2020), which proved that the use of platforms with gamification elements improved the language competence of middle school students. The authors recorded that the system of points and virtual rewards maintained interest in learning even in a distance format. An improvement in learning outcomes in the experimental group was established after implementing gamification strategies during the study of mathematical and natural science disciplines. Corresponding trends were observed in the research of M. Adeoye (2024), where gamification intervention demonstrates improved academic achievement of students. Gamification elements contribute to increased student engagement and stimulate active participation in completing learning tasks. Similar effects were recorded by H. Hossein-Mohand *et al.* (2021), who found that integrating gamification with project-based and flipped learning methods improved the quality of school students' mathematical preparation. The influence of gamification is evident in engaging students in learning activities. An increased level of participation in lessons and readiness for team interaction was recorded. Similar conclusions are presented in the work of K. Fuentes-Riffo *et al.* (2023), which found that the use of game elements in teaching mathematics increased motivation among students with initially low levels of interest. Student motivation in the experimental group increased more intensively than in the control group.

In the control group, where learning occurred through traditional methods, the proportion of students with high motivation scores (6-7) ranged from 16% to 18%, while low-motivated students (1-3) ranged from 18% to 22%. In the experimental group, where gamification elements were applied, the proportion of students with high scores increased to 35-48%, while low scores decreased to 8-10%. Thus, gamification ensured a gain in motivation that is more than five times greater than the results of traditional teaching, confirming its high effectiveness in engaging students in the learning process. This corresponded with the results of Z. Luo *et al.* (2021), who determined that the adoption of gamified tools was influenced by the availability of technical resources and a positive attitude towards digital innovations.

The research emphasised that role-playing games and team tasks enhance social interaction, develop communication, responsibility, and collective work skills, which increases the effectiveness of team educational projects. Confirmation of this is also contained in the work of E. Mårell-Olsson (2021), which noted that gamification contributed to the development of 21st-century skills provided students had sufficient digital literacy. Comparison of the data attested that in both countries, gamification contributed not only to emotional uplift but also to strengthening self-learning strategies. H. Dehghanzadeh *et al.* (2024) confirmed that the use of gamification in primary and secondary education supported learning through positive behavioural engagement. Online platforms with gamified tools enhance practical learning; simulations (Labster, PhET) improve the assimilation of natural sciences, while testing platforms (Kahoot!, Quizizz) develop thinking speed and material consolidation. Gamified approaches contributed to the formation of student autonomy and the development of skills for effective planning of learning activities. Similar conclusions were made by V. Arufe-Giráldez *et al.* (2022), who indicated that gamification forms long-term motivation for activity and responsibility. The results of this study are consistent with the research of P. Lam & A. Tse (2022), where observations in Hong Kong schools confirmed that elements of competition and storylines formed a positive learning environment. Such approaches contributed to increased interaction among students and the development of teamwork skills during the completion of learning tasks. In this study, approximately 60% of students in the control group achieved high results after the experiment, whereas in the experimental group this indicator reached 88-97%, corresponding to a gain of approximately 55-60% and confirming the advantage of the gamified approach.

International authors have investigated the problem of gamification, analysing its impact on student motivation, engagement, and learning outcomes within various educational systems. In particular, scholars A. Vrcelj *et al.* (2023a) found that game elements enhance student motivation and engagement. Moreover, in practice, it is effective to employ narrative or quest-based tasks that integrate learning material into engaging scenarios, stimulating active student participation. The use of game mechanisms stimulated active student participation during lessons, fostered the development of teamwork and interaction, and increased interest in learning activities. Such results align with the conclusions of S. Moral-Sánchez *et al.* (2022), in which gamification in mathematics proved to be an effective means of engaging students in STEM activities. It was established that combining gamification elements with practical tasks contributed to a better understanding of complex concepts and the development of spatial thinking. Furthermore, the use of game mechanisms sustained student motivation and increased their activity during collaborative projects. The identified influence on pedagogical readiness for gamification is consistent with the study by A. Franco-Mariscal *et al.* (2021), which found that systematic training for future teachers in the use of gamification resources enhanced the quality of their professional preparation. Similar patterns are described in the work of E. Ratinho & C. Martins (2023), which emphasises the role of gamified strategies in developing student motivation and cognitive flexibility. It was established that the application of gamified elements contributed to increased learning efficiency, as interactive tasks, point systems, and rewards stimulated student activity, engagement, and concentration. A comparison of the results revealed alignment with the conclusions of J. Attah *et al.* (2024), who demonstrated that student attitudes towards gamified learning in mathematics are predominantly positive, given conditions of interactive communication. Interactive tasks, quests, point and reward systems increase motivation and interest, which in turn promotes greater activity in completing learning tasks and improvement of academic results. Similarly, J. Ruiz *et al.* (2024) noted that gamification enhanced school students' engagement and contributed to a reduction in academic anxiety. This effect coincides with the conclusions of I. Khoudri & A. Khoudri (2023), who, when analysing the use of the Vevox platform, recorded an increase in student satisfaction, motivation, and readiness for active participation. Students in the control group were taught using traditional methods, which included explanatory lessons, written assignments, quizzes, and practical exercises, where the primary focus was on memorising facts and performing standard tasks without the integration of game or motivational elements. For example, in mathematics lessons, students completed standard textbook exercises and tests, while in science lessons, they conducted laboratory investigations in a classical form with assessment at the end of the session. This correlates with the conclusions of R. Leitao (2021), which instead showed that gamified elements fostered the formation of practical understanding of processes. The application of game elements increased student motivation and contributed to longer retention of learning information. Furthermore, the study by R. Leitão *et al.* (2021) confirmed that the use of narrative and competitive mechanisms ensures

sustainable learning outcomes and broadens students' cognitive horizons. It was established that combining game elements with interdisciplinary tasks fostered the development of critical thinking and problem-solving skills in school students. The conducted research demonstrated that gamification in secondary school stimulated student motivation, engagement, and active participation in the learning process, while simultaneously contributing to the development of cognitive, social, and emotional skills. The application of game elements supported the formation of autonomy, critical thinking, and interdisciplinary connections, enhancing the effectiveness of learning and the quality of the educational environment.

CONCLUSIONS

As a result of the comparative analysis, it was established that various types of gamification in secondary education positively influenced the learning process, as they integrated game elements that increased motivation, activated cognitive activity, and promoted student engagement; point and level systems, as well as badges, stimulated progress and independent skill improvement; leaderboards and rankings developed social interaction and teamwork collaboration; and educational quests, game scenarios, and role-playing games fostered the development of critical thinking, strategic planning, and practical application of knowledge. Furthermore, timed tasks enhanced thinking speed, concentration, and task performance efficiency, while online platforms with gamified elements, such as Classcraft, Labster, Kahoot! and Minecraft Education Edition, provided an interactive environment that allowed for adaptation of learning to the subject and task type, combining motivational mechanisms with the practical consolidation of knowledge and the development of logical and critical thinking in senior students.

The pedagogical experiment showed that the application of innovative teaching methods significantly influences the level of student motivation and engagement in the learning process. In the control group, the level of student motivation before the experiment was predominantly distributed within medium values: the largest proportion of responses fell within 4-5 points, where a stable figure of approximately 29-34% was recorded. Low motivation indicators (1-3 points) in the CG ranged from 4 to 20%, while high indicators (6-7 points) fluctuated within 6-11%. Overall, this suggests that at the initial stage, a significant portion of students demonstrated only moderate interest and insufficiently expressed intrinsic motivation. Prior to the beginning of the experiment, the level of motivation in the experimental group was comparable to that of the control group: most students rated their motivation at the level of 4-5 points (28-32% for "4" and 22-27% for "5"), the proportion of high scores (6-7) was 12-15%, and low scores (1-3) were 10-25%. After the implementation of gamification elements in teaching, the experimental group demonstrated a significant increase in motivation: the proportion of students with high scores (6-7) increased to 18-40% depending on the question, while the proportion of low scores (1-3) decreased to 8-10%. For example, regarding the question "I am interested in studying this subject", high scores increased from 27% to 48%, and low scores decreased from 18% to 8%. The control group showed minor changes: high scores increased only to 16-18%, and low scores decreased to 18-22%. A similar trend was demonstrated by knowledge results: before the experiment, correct answers in the experimental group were 18-52%, and after, 88-97%, while the control group increased only to 30-60%, confirming the effectiveness of the gamification approach for both motivation and knowledge acquisition.

Based on the results of the pedagogical experiment, recommendations are provided for the systematic implementation of gamification into the learning process of secondary schools to enhance student motivation and improve academic achievement, in mathematics and science. It is recommended to combine various gamification elements – point and level systems, badges and achievements, leaderboards, educational quests and missions, role-playing games, game scenarios, and timed tasks – to stimulate individual motivation, activate team interaction, and develop critical thinking and logical skills. The use of specialised online platforms, which allow for interactive lessons, simulation of experiments, and rapid assessment of student results, is effective. The practical combination of digital platforms with classical teaching methods fosters the development of analytical, practical, and teamwork skills, increases student interest and concentration, making the learning process more engaging and effective. Further research may focus on integrating gamification with adaptive digital platforms for personalising the learning process and enhancing learning effectiveness.

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