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The Power of Play: Investigating the Effects of Gamification on Motivation and Engagement in Physics Classroom

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Abstract: The aim of this study was to investigate and analyze how first-grade high school students experience a positive classroom environment (excitement, competition, connectedness, satisfaction, and aspiration) by applying gamification as a teaching strategy in physics classes. An experimental study was conducted within the teaching topic of conservation of momentum and energy, in which N = 69 students in three classes took part. In the experimental group, one class with n = 23 students engaged in physics lessons, using gamification as a teaching strategy. In contrast, the control group comprised two classes with n = 46 students. The My Class Inventory questionnaire was used for this study. The study's results revealed statistically significant differences in the perception of the student learning experience between the control and experimental groups. The experimental group rated the student learning experience significantly better than the control group. Gamification as a strategy contributes positively to the student learning experience, fostering collaboration among students when tackling challenging problems. It is essential to highlight that even if we do not entirely depart from traditional teaching methods, simply changing our strategy can lead to significant improvements. In our case, gamification can create a more engaging student learning experience, making students more motivated and involved. Consequently, this shift could result in a better understanding and mastery of physics concepts.

Keywords: students learning experience; gamification; students; physics teaching

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1. Introduction

Modern pedagogy strives for a more human approach, openness, focus on the holistic development of students, and collaborative learning, where teaching is seen as an interactive process (Brtan, 2018). Therefore, the student learning experience is a frequent topic of pedagogical research aimed at improving the working process of teaching and school and is considered an essential factor in the quality of teaching and the quality of students' development and adaptation.

A student learning experience is a key component of the school environment, influencing the quality of the educational process and the effectiveness of educational outcomes (Pianta et al., 2012). Researchers highlight that a positive classroom environment enhances students' academic performance, motivation, self-esteem, and overall well-being (Koth et al., 2008; Roeser et al., 2000). Understanding the factors that contribute to a stimulating, positive student learning experience is crucial for improving the quality of education (Govindarajan & Srivastava, 2020). Active student engagement is essential for achieving learning outcomes (Yu et al., 2021), and creating an environment that fosters such engagement remains a priority (Akbari et al., 2016).

In recent years, gamification—incorporating game design elements into non-game contexts—has gained traction in educational settings as a strategy to boost student engagement and motivation. Studies have demonstrated that gamification can enhance levels of student engagement, improve specific skills, and optimize learning outcomes (Dicheva et al., 2015; Hanus & Fox, 2015; Muñoz-Merino et al., 2017). In physics education, gamified environments have been associated with increased student motivation and academic achievement (Rose, 2015; Tolentino & Roleda, 2019).

Research indicates that active gamification is particularly effective in secondary education compared to other educational levels (Parra-González et al., 2021). This approach offers valuable perspectives on enhancing student engagement within e-learning environments by fostering greater learning motivation. In particular, the findings suggest that computer science educators could adopt gamification techniques to boost middle school students' motivation, satisfaction, and academic performance, offering insights into how these methods could be integrated effectively into their teaching practices.

Based on the studies analyzed, the game elements most commonly used in the literature are identified and mapped with the effects they produce on learners. Furthermore, these empirical effects of gamification are clustered into six areas: performance, motivation, engagement, attitude toward gamification, collaboration, and social awareness (Antonaci et al., 2019). This categorization highlights the multifaceted impact of gamification strategies on the educational experience, emphasizing its potential to enhance cognitive outcomes and social and emotional learning.

To explore the potential of gamification in enhancing students' learning experiences, this study focuses on its application within the context of physics education. The central objective is to investigate how gamification strategies influence students' perceptions of their classroom environment. Specifically, the study seeks to understand whether incorporating game-like elements can foster a more positive and engaging learning environment.

Guiding this investigation is the research question: *How does the application of gamification strategies affect students' perceptions of the classroom environment in physics education?* This question aims to clarify the relationship between gamification and key classroom dynamics, such as student engagement, motivation, collaboration, and emotional well-being. Understanding these aspects is critical for educators aiming to enhance learning environments through innovative teaching strategies.

Based on this inquiry, the study proposes the following hypothesis: *Gamification strategies significantly enhance students' perceptions of a positive classroom environment in physics education.* This hypothesis assumes that gamification has the potential to create a more dynamic, interactive, and supportive classroom atmosphere by stimulating motivation, encouraging healthy competition, and fostering social connectedness.

2. Background

2.1. Challenges in Student Engagement and Gamification as a Solution

Students' difficulties in learning physics concepts are often caused by preconceived ideas, which can be called misconceptions, alternative concepts, or mental models. These students' intuitive ideas about physical phenomena arise from insufficiently understood everyday experiences. They usually do not match the models the scientific community accepts (Novak & Gowin, 1984) and are very resistant to change (McDermott & Redish, 1999). One of the research studies showed that 50% of the students questioned thought that they had to work very hard to master the content, and even more than 25% of them thought that there was too much of the content (Angell et al., 2004). Regarding Croatia, physics is among students' least favored subjects, often due to its complexity and strong ties to mathematics (Marušić & Sliško, 2009). Many students perceive physics as abstract and difficult, contributing to their negative attitudes (Ćosić, 2015). In some studies, (Jugović, 2010) it was found that girls achieve better results in physics than boys. However, they are not inclined to continue learning it, and it is equally important for girls and boys to be successful in solving problems in physics. It is also noted that the students' negative image of science has not changed for decades, i.e., a continuous turning away of students from science can be observed (Simel, 2016).

Moving further, we can state that actively motivating students to participate in classroom activities has always been challenging. Teachers continuously seek innovative methods to enhance engagement, with gamification emerging as a popular strategy (Chans & Portuguez Castro, 2021).

Today, more than ever, educational technology plays a crucial role in addressing the unique needs of Generation Alpha, a cohort raised in a highly digital environment. However, traditional teaching methods, particularly in developing nations, often fail to integrate technology-enhanced learning effectively (Halloluwa et al., 2018). This calls for revising educational content and curricula to include innovative approaches such as gamification. As mobile devices and gaming are central to Generation Alpha's daily lives, incorporating mobile and gamified learning into the educational system is essential. Moreover, equipping classrooms with appropriate hardware and software is necessary to support such advancements. Since many educators lack the technological proficiency and resources to plan and implement gamified activities (Apaydin & Kaya, 2020; Murillo-Zamorano et al., 2021), investing in teacher training to develop advanced technical and pedagogical skills is imperative for successfully integrating digital gamification in education.

On the other hand, physics is also seen as a subject that promotes scientific thinking and experimentation. Addressing students' engagement through gamification offers an opportunity to reshape their perceptions and make physics more approachable and enjoyable.

The potential of gamification to facilitate physics learning lies in successful educational and entertainment practices that have already been applied in many other areas of life, such as business, health, entertainment, and non-traditional education. It is known that structured games can strongly engage students, develop their creativity, and connect their educational process with applications in different areas of daily life. The integration of gamification into education addresses the evolving learning preferences and expectations of today's students, particularly those of Generation Z and Alpha, who are deeply influenced by digital technologies and social media (Govindarajan & Srivastava, 2020).

2.2. Gamification in Education

Gamification involves using game elements in non-game contexts to motivate and engage participants (Deterding et al., 2011). It contrasts with game-based learning, which incorporates games directly into the educational process, and serious games, which simulate real-world scenarios (Plantak Vukovac et al., 2018).

From an educational perspective, gamification can be integrated into learning through traditional game mechanics such as badges, points, ranks, levels, and rewards. Using these game elements in a context that is not normally considered entertaining can make educational processes more exciting and dynamic for students (Sandusky, 2015).

Frameworks like Octalysis (Chou, 2019) identify eight core drivers of motivation, including achievement, creativity, social connection, and unpredictability. Gamification principles also emphasize fun, competition, and goal orientation (McGonigal, 2015; Nah et al., 2013). By applying these frameworks, teachers can create educational experiences that resonate with students and improve higher-order thinking skills (Bourke, 2019; Noroozi et al., 2020), motivation (Chapman & Rich, 2018; Kaya & Ercag, 2023), satisfaction

(Oliveira et al., 2023; Xi & Hamari, 2019), achievement (Su & Cheng, 2015), and student engagement (Panmei & Waluyo, 2022).

The results from 2023 showed that gamification is used for various educational purposes, at many learning levels, in various environments, and in various learning fields. In most of the studies, the positive effects of gamification and its potential to solve problems in education were reported (Zeybek & Saygı, 2024). Also, it is stated that the widespread impact of gamification across various sectors has transformed traditional engagement methods, notably in education (Christopoulos & Mystakidis, 2023). It is also very important to emphasize the structural gamification that involves incorporating game design elements into the learning process to motivate students without altering the instructional content itself (Garone & Nesteriuk, 2019). This approach relies on mechanisms such as clearly defined goals, achievement-based rewards, and systems to track progression and status, as well as incorporating challenges and feedback to sustain engagement (Garone & Nesteriuk, 2019). The most used in education are points, levels, challenges, badges, leaderboards, rewards, progress bars, stories, avatars, and feedback (Nah et al., 2013; Sailer et al., 2017; Urías et al., 2016).

In contrast, content gamification focuses on transforming the learning material itself by applying game-like elements, mechanics, and principles to make the content more engaging and interactive (Garone & Nesteriuk, 2019). This form of gamification is specifically tailored to individual learning objectives and content, making it less adaptable for reuse in other contexts (Sanal et al., 2019). Elements of content gamification include narrative and storytelling, challenges that spark curiosity and exploration, characters or avatars, and interactive feedback mechanisms that allow learners to fail and try again (Kapp, 2016). The most used in education are points, levels, challenges, badges, leaderboards, rewards, progress bars, stories, avatars, and feedback.

While Kapp (2016) emphasizes that combining structural and content gamification creates the most engaging and motivating student learning experience, the present study exclusively employed structural gamification. The instructional content remained unchanged by focusing on structural gamification, and game-like elements such as progression systems, point-based rewards, leaderboards, and feedback mechanisms were integrated into the teaching process to foster student engagement and motivation.

2.3. Research Focus

Despite the growing body of literature on gamification in education, there remains a paucity of research specifically linking gamification strategies to the enhancement of classroom environments in physics education. This gap underscores the need for studies exploring how gamification can influence students' perceptions of their learning environment, particularly in excitement, competition, connectedness, satisfaction, and a sense of belonging.

This study's primary aim was to investigate gamification's impact on students' perceptions of a positive classroom environment in physics education. Specifically, the study seeks to determine whether the application of gamification strategies influences aspects such as excitement, competition, connectedness, satisfaction, and a sense of belonging in the classroom.

To address this aim, the study is guided by the following research question:

RQ1: How does the application of gamification strategies affect students' perceptions of the classroom environment in physics education?

Based on this research question, we propose the following hypothesis:

H1. *The application of gamification strategies significantly enhances students' perceptions of a positive classroom environment in physics education.*

By exploring this hypothesis, the study aims to contribute to understanding how gamification can be effectively utilized to create engaging and supportive learning environments in physics education.

3. Materials and Methods

3.1. Participant Selection

To ensure a random distribution of students and comparable baseline knowledge before the intervention, the study relied on the pre-existing class organization determined by the school administration, which randomly assigns students to classes at the beginning of the school year. All participants were selected based on their enrollment in the first grade of high school, having met the entrance requirements for this educational level.

Our inclusion criteria were that all first-year high school students were enrolled in the participating physics classes. In contrast, exclusion criteria were students who were absent for more than 50% of the intervention sessions or did not complete the My Class Inventory questionnaire.

Ethical approval was secured from the Ministry of Science, Education and Youth of the Republic of Croatia; the Education Agency; and the Ethics Committee of the Faculty of Science in Split. Additionally, signed parental consent was obtained for all students.

3.2. Group Assignment and Intervention Design

In accordance with the principal's recommendations, one class (n = 23) was designated the experimental group, while two other classes (n = 46) formed the control group. This selection preserved the school's preexisting class structure, supporting logistical feasibility and consistency in group assignments.

Both groups studied the same physics topics—energy, work, and power—over the same period using a shared set of lesson plans aligned with the Croatian national curriculum. Lessons for the control group employed a traditional instructional approach, which included teacher-led explanations, discussions, hands-on demonstrations, and problem-solving exercises. Worksheets provided opportunities to reinforce key concepts, and progress was assessed using standard grading methods.

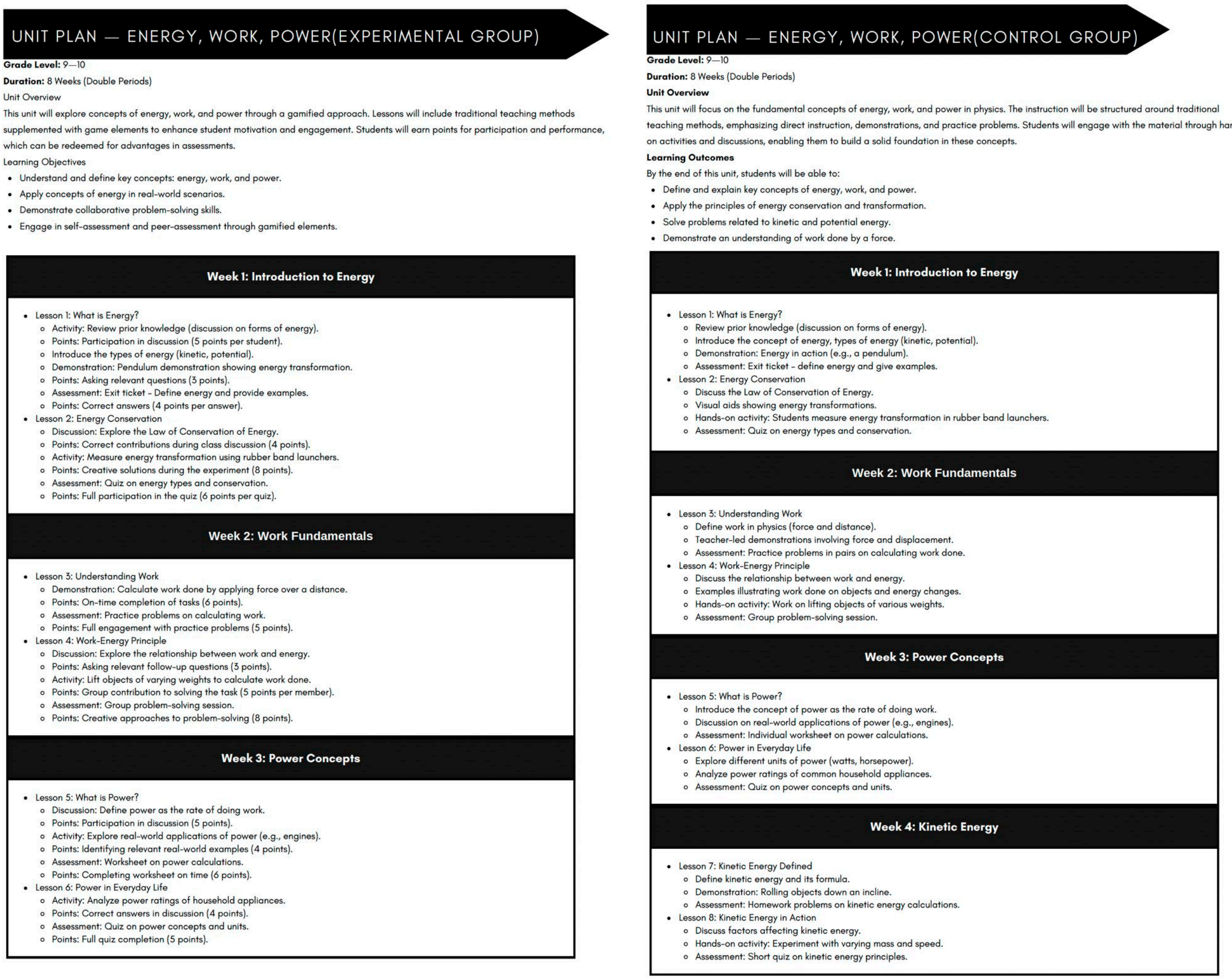
The experimental group received the same instructional content using the same traditional method, but lessons were enriched with gamified elements designed to boost engagement and motivation. A points-based system awarded students for participation, collaboration, creativity, and timely completion of assignments. Points could be redeemed for benefits such as extra credit on tests or the ability to modify test questions. The Physics Field Trip Badge was introduced as an exclusive reward for students who achieved at least 100 points during the course. Leaderboards were updated weekly to track progress and encourage healthy competition, fostering a collaborative yet competitive classroom environment.

3.3. Post-Intervention Data Collection

After completing the lessons, data were collected using the My Class Inventory questionnaire, administered via the MS Office 365 platform (MS Teams). The process took 10–15 min during a regular teacher-led session in each class. Detailed instructions ensured students understood how to complete the questionnaire. Students who were absent for more than 50% of the intervention sessions or did not complete the My Class Inventory questionnaire were excluded from the analysis.

3.4. Analysis of Classroom Dynamics

The dynamics of the classroom environment were shaped by the structured lesson plans and the instructional methodologies implemented for the experimental and control groups. Seven lesson plans were applied uniformly across both groups, developed in alignment with the Croatian national curriculum and focusing on the chapter *Energy, Work, and Power*. These plans, divided into introduction, development, and conclusion phases, were reviewed and approved by physics education experts to ensure their pedagogical rigor (Figure 1a,b). While the content and structure of lessons were consistent across groups, their delivery differed significantly.



UNIT PLAN — ENERGY, WORK, POWER(EXPERIMENTAL GROUP)

Grade Level: 9—10

Duration: 8 Weeks (Double Periods)

Unit Overview

This unit will explore concepts of energy, work, and power through a gamified approach. Lessons will include traditional teaching methods supplemented with game elements to enhance student motivation and engagement. Students will earn points for participation and performance, which can be redeemed for advantages in assessments.

Learning Objectives

- Understand and define key concepts: energy, work, and power.
- Apply concepts of energy in real-world scenarios.
- Demonstrate collaborative problem-solving skills.
- Engage in self-assessment and peer-assessment through gamified elements.

Week 1: Introduction to Energy

- Lesson 1: What is Energy?
  - Activity: Review prior knowledge (discussion on forms of energy).
  - Points: Participation in discussion (5 points per student).
  - Introduce the types of energy (kinetic, potential).
  - Demonstration: Pendulum demonstration showing energy transformation.
  - Points: Asking relevant questions (3 points).
  - Assessment: Exit ticket - Define energy and provide examples.
  - Points: Correct answers (4 points per answer).
- Lesson 2: Energy Conservation
  - Discussion: Explore the Law of Conservation of Energy.
  - Points: Correct contributions during class discussion (4 points).
  - Activity: Measure energy transformation using rubber band launchers.
  - Points: Creative solutions during the experiment (8 points).
  - Assessment: Quiz on energy types and conservation.
  - Points: Full participation in the quiz (6 points per quiz).

Week 2: Work Fundamentals

- Lesson 3: Understanding Work
  - Demonstration: Calculate work done by applying force over a distance.
  - Points: On-time completion of tasks (6 points).
  - Assessment: Practice problems on calculating work.
  - Points: Full engagement with practice problems (5 points).
- Lesson 4: Work-Energy Principle
  - Discussion: Explore the relationship between work and energy.
  - Points: Asking relevant follow-up questions (3 points).
  - Activity: Lift objects of varying weights to calculate work done.
  - Points: Group contribution to solving the task (5 points per member).
  - Assessment: Group problem-solving session.
  - Points: Creative approaches to problem-solving (8 points).

Week 3: Power Concepts

- Lesson 5: What is Power?
  - Discussion: Define power as the rate of doing work.
  - Points: Participation in discussion (5 points).
  - Activity: Explore real-world applications of power (e.g., engines).
  - Points: Identifying relevant real-world examples (4 points).
  - Assessment: Worksheet on power calculations.
  - Points: Completing worksheet on time (6 points).
- Lesson 6: Power in Everyday Life
  - Activity: Analyze power ratings of household appliances.
  - Points: Correct answers in discussion (4 points).
  - Assessment: Quiz on power concepts and units.
  - Points: Full quiz completion (5 points).

(**a**)

UNIT PLAN — ENERGY, WORK, POWER(CONTROL GROUP)

Grade Level: 9—10

Duration: 8 Weeks (Double Periods)

Unit Overview

This unit will focus on the fundamental concepts of energy, work, and power in physics. The instruction will be structured around traditional teaching methods, emphasizing direct instruction, demonstrations, and practice problems. Students will engage with the material through hands-on activities and discussions, enabling them to build a solid foundation in these concepts.

Learning Outcomes

By the end of this unit, students will be able to:

- Define and explain key concepts of energy, work, and power.
- Apply the principles of energy conservation and transformation.
- Solve problems related to kinetic and potential energy.
- Demonstrate an understanding of work done by a force.

Week 1: Introduction to Energy

- Lesson 1: What is Energy?
  - Review prior knowledge (discussion on forms of energy).
  - Introduce the concept of energy, types of energy (kinetic, potential).
  - Demonstration: Energy in action (e.g., a pendulum).
  - Assessment: Exit ticket - define energy and give examples.
- Lesson 2: Energy Conservation
  - Discuss the Law of Conservation of Energy.
  - Visual aids showing energy transformations.
  - Hands-on activity: Students measure energy transformation in rubber band launchers.
  - Assessment: Quiz on energy types and conservation.

Week 2: Work Fundamentals

- Lesson 3: Understanding Work
  - Define work in physics (force and distance).
  - Teacher-led demonstrations involving force and displacement.
  - Assessment: Practice problems in pairs on calculating work done.
- Lesson 4: Work-Energy Principle
  - Discuss the relationship between work and energy.
  - Examples illustrating work done on objects and energy changes.
  - Hands-on activity: Work on lifting objects of various weights.
  - Assessment: Group problem-solving session.

Week 3: Power Concepts

- Lesson 5: What is Power?
  - Introduce the concept of power as the rate of doing work.
  - Discussion on real-world applications of power (e.g., engines).
  - Assessment: Individual worksheet on power calculations.
- Lesson 6: Power in Everyday Life
  - Explore different units of power (watts, horsepower).
  - Analyze power ratings of common household appliances.
  - Assessment: Quiz on power concepts and units.

Week 4: Kinetic Energy

- Lesson 7: Kinetic Energy Defined
  - Define kinetic energy and its formula.
  - Demonstration: Rolling objects down an incline.
  - Assessment: Homework problems on kinetic energy calculations.
- Lesson 8: Kinetic Energy in Action
  - Discuss factors affecting kinetic energy.
  - Hands-on activity: Experiment with varying mass and speed.
  - Assessment: Short quiz on kinetic energy principles.

(**b**)

Figure 1. (**a**) Unit plan—control group; (**b**) unit plan—experimental group.

In the control group, traditional teaching methods were employed exclusively. Lessons began with an introduction that outlined learning objectives and activated prior knowledge through discussion. Core concepts, such as energy conservation and transformation, were explained using teacher-led presentations supported by visual aids and hands-on demonstrations. Students engaged in practice exercises using worksheets that reinforced key concepts but were not part of formal assessments. The instructional approach focused on clarity, structure, and active participation without the use of gamification.

For the experimental group, the same curriculum content was enhanced with gamified elements to foster engagement and motivation. Gamification strategies included a points-based reward system, leaderboards, and badges to recognize achievements. Points were awarded for activities such as participation, correct answers, timely task completion, and collaborative efforts. These points could be redeemed for benefits like test-related advantages, such as additional points or the ability to modify questions. The gamification framework included a points-based system for rewarding activities such as participation and teamwork, as outlined in Table 1. Rewards for accumulated points are detailed in Table 2.

Table 1. Activities through which students could earn points.

Activity	Points per Activity	Maximum Points per Activity
Active participation in discussions	5 points	25 points
Asking relevant questions	3 points	15 points
Correct answer to a teacher's question	4 points	20 points
Homework submitted on time	6 points	30 points
Creative or innovative problem-solving	8 points	16 points
Contribution to teamwork	5 points	15 points
Presentation of work or project	10 points	20 points
Taking group notes (during team activities)	4 points	12 points

Table 2. Benefits students could redeem for future tests based on the accumulated points.

Benefits	Points
1 extra point on the test	10 points
Question substitution (swap one question for another)	20 points
50:50 help (eliminate two incorrect options in a multiple-choice question)	30 points
One free question (one question answered correctly without effort)	40 points
Exemption from one essay or task	50 points
5 additional points to the total test score	70 points

The teacher independently managed the points system using a digital tracking tool (e.g., a spreadsheet) to monitor student activities in real-time. For specific tasks, self-reporting was required, with students providing evidence of their accomplishments for verification. Notably, teaching assistants were not involved in this process, ensuring that the gamified system was directly integrated into regular teaching practices.

Worksheets in the experimental group incorporated point-tracking mechanisms, encouraging students to actively engage in earning rewards. Weekly leaderboards displayed progress, fostering a competitive yet collaborative environment among students. Introducing badges (Figure 1), such as the *Physics Field Trip Badge* (Figure 2), added an additional layer of motivation by rewarding students who achieved specific milestones, such as earning 100 points during the course. This badge served as recognition of effort and symbolized access to exclusive learning opportunities, further incentivizing sustained engagement.

While both groups followed the same structured lesson plans, the gamified framework in the experimental group created a dynamic and interactive student learning experience. These enhancements were designed to promote engagement and collaboration while aligning with the Croatian national curriculum. Importantly, this study focused on the effects of gamification on the classroom environment rather than assessing mastery of physics concepts. The comparison between the traditional and gamified approaches underscores the potential of gamification to foster a more vibrant, collaborative, and positive learning experience.

Figure 2. Physics Field Trip Badge.

3.5. Instrumentation and Reliability

The study utilized the My Class Inventory questionnaire, developed by Fraser and Fisher (1982), to assess the impact of gamification on the classroom environment. This instrument evaluates five key dimensions of classroom dynamics: satisfaction, cohesion, friction, difficulty, and competitiveness (Fraser & Fisher, 1982). Each dimension captures distinct aspects of the classroom experience—satisfaction reflects how content students are with their class, cohesion measures their ability to collaborate effectively, friction gauges the presence of conflict, difficulty assesses the perceived challenge of the coursework, and competitiveness examines the degree of rivalry among students.

The questionnaire demonstrated strong reliability across most dimensions, with an overall reliability coefficient of $\alpha = 0.839$. Satisfaction emerged as the most reliable dimension ($\alpha = 0.851$), followed by friction ($\alpha = 0.832$), cohesion ($\alpha = 0.741$), and difficulty ($\alpha = 0.721$). The competitiveness factor exhibited a lower reliability ($\alpha = 0.416$), which was improved by recalculating the mean correlation of items, excluding one problematic statement. This adjustment aligned with recommendations for short scales, ensuring that the instrument effectively captured relevant classroom dynamics (Mills et al., 2010). Table A1 shows the factor structure of the student learning experience questionnaire, together with the corresponding reliability coefficient (Appendix A).

These results confirmed the suitability of the My Class Inventory for assessing the classroom environment in the context of this study.

Although the instrument's robustness was a prerequisite for obtaining reliable data, this study did not aim to evaluate the questionnaire itself. Instead, it focused on how gamification influenced classroom dynamics, particularly in fostering satisfaction and cohesion. The findings from the My Class Inventory provided valuable insights into how gamification strategies enhanced the overall positive student learning experience, contributing to a deeper understanding of its potential educational benefits.

4. Results

The computer programs Excel and SPSS 26 were used for statistical data processing. Methods of descriptive statistics and the non-parametric Mann–Whitney test were used for quantitative data analysis. Table 3 shows the descriptive statistics for the distribution of participants by gender and group, where f represents frequency. Table 4 shows the descriptive indicators of class satisfaction, cohesion, friction, difficulty, and competitiveness of the students in the experimental group.

Table 3. Descriptive indicators for the distribution of participants in terms of gender and group.

	Property	f	%
Gender	female	50	76.9
	male	15	23.1
Group	control	42	64.6
	experimental	23	35.4

Table 4. Descriptive indicators of class satisfaction, cohesion, friction, difficulty, and competitiveness by the students in the experimental group.

Item	Property				
	N	**Min**	**Max**	**Mean**	**Std. Dev**
Satisfaction					
Students like being in this classroom	23	1	5	2.74	1.176
Most students value what they learn in classroom	23	3	5	3.87	0.815
Students have fun in classroom	23	3	5	4.30	0.765
Students are happy in classroom	23	3	5	4.17	0.778
Students in this classroom enjoy the lessons	23	1	5	3.87	0.968
Students have real friends in classroom	23	2	5	3.74	0.864
Cohesion					
All students get along very well in the classroom	23	1	5	3.39	1.616
All the students in the classroom value each other	23	3	5	4.26	0.810
Students do not argue with each other	23	2	5	3.87	0.869
There is a friendly atmosphere in the classroom	23	3	5	3.96	0.767
Students do not argue in classroom at all	23	1	5	3.52	1.344
Friction					
A lot of students in this classroom like to argue	23	1	5	3.57	0.945
Some students in this classroom are mean to others	23	1	5	3.39	0.941
Some students feel bad when they get a bad grade	23	1	5	3.65	0.982
Some students don't like their classroom	23	1	5	3.35	1.071
Students try to cooperate with each other	23	1	5	3.35	0.935
Difficulty					
Most students cannot complete all assignments without help	23	1	5	2.61	1.076
Most of the students in the classroom do not know how to perform tasks well	23	1	5	2.65	1.112
The tasks we do are quite difficult	23	1	5	2.00	1.000
Only the best students can complete the tasks	23	1	4	2.39	0.783
Competitivenes					
Most students want their work to be better than the work of their colleagues	23	1	5	3.74	1.251
Some students always want to outperform their classmates	23	1	5	3.22	0.850
Students compete to complete the tasks first	23	1	5	3.13	1.014

Table 5 shows the descriptive indicators of class Satisfaction, Cohesion, Friction, Difficulty, and Competitiveness by the students in the control group.

Table 5. Descriptive indicators of class satisfaction, cohesion, friction, difficulty and competitiveness by the students in the control group.

Item	Property				
	N	**Min**	**Max**	**Mean**	**Std. Dev**
Satisfaction					
Students like being in this classroom	42	1	5	2.50	1.110
Most students value what they learn in classroom	42	1	5	3.21	1.240
Students have fun in classroom	42	2	5	4.00	1.012
Students are happy in classroom	42	1	5	3.60	1.251
Students in this classroom enjoy the lessons	42	1	5	3.45	1.152
Students have real friends in classroom	42	1	5	2.93	1.295
Cohesion					
All students get along very well in the classroom	42	1	5	3.35	1.012
All the students in the classroom value each other	42	1	5	3.57	1.085
Students do not argue with each other	42	1	5	3.29	1.195
There is a friendly atmosphere in the classroom	42	1	5	3.57	1.252
Students do not argue in classroom at all	42	2	5	4.21	1.025
Friction					
A lot of students in this classroom like to argue	42	1	5	3.10	1.144
Some students in this class are mean to others	42	1	5	2.64	1.008
Some students feel bad when they **get** a bad grade	42	1	5	3.00	1.148
Some students don't like their classroom	42	1	5	2.79	1.180
Students try to cooperate with each other	42	1	5	2.88	1.173
Difficulty					
Most students cannot complete all assignments without help	42	1	5	2.62	0.962
Most of the students in the class do not know how to perform tasks well	42	1	5	2.76	1.206
The tasks we do are quite difficult	42	1	5	2.74	1.326
Only the best students can complete the tasks	42	1	5	2.74	1.127
Competitivenes					
Most students want their work to be better than the work of their colleagues	42	1	5	2.86	1.221
Some students always want to outperform their classmates	42	1	5	3.14	0.977
Students compete to complete the tasks first	42	1	5	3.26	1.083

If we compare the descriptive indicators for the student learning experience, we find that the students in the experimental group gave the highest value, according to self-report, in the subscale Satisfaction with lessons for the item "Students have fun in the class", while the students in the control group gave the highest value in the subscale Cohesion for the item "Students do not argue in class at all".

The students in the experimental group gave the lowest value in the Difficulty subscale for the item "The tasks we do are quite difficult". At the same time, this was the case in the control group for the satisfaction subscale and for the item "Students like being in this class".

The Mann–Whitney U-test was used to analyze the difference in the classroom environment experience between the control and experimental groups. A p-value of 0.05 or lower is considered statistically significant. The results are shown in Table 6.

Table 6. Results of the Mann–Whitney U-test on the experience of the student learning experience between the control and the experimental group ($p < 0.05$).

Item	Mann–Whitney	Wilcoxon W	Asymp. Sig
Satisfaction			
Students have fun in classroom	318.500	1221.500	0.019
Students are happy in classroom	341.500	1244.500	0.044
Friction			
Some students don't like their classroom	282.500	1185.500	0.003
Students try to cooperate with each other	315.000	1218.000	0.016
Difficulty			
Only the best students can complete the tasks	328.000	604.000	0.029
Competitiveness			
Students compete to complete the tasks first	271.000	1308.000	0.009

It was found that there was a statistically significant difference between the control and experimental groups in four of the five subscales analyzed in at least one item. Table 7 shows the mean ranks for the observed particles in relation to the experimental or control group membership.

Table 7. Mean values of the ranks for the observed particles concerning membership of the experimental or control group.

Item	Group	N	Mean Rank	Sum of Ranks
Satisfaction				
Students have fun in classroom	C	42	31.88	1339.00
	E	23	35.04	806.00
Students are happy in classroom	C	42	29.63	1244.50
	E	23	39.15	900.50
Friction				
Some students don't like their classroom	C	42	28.23	1256.50
	E	23	40.30	888.50
Students try to cooperate with each other	C	42	29.00	1218.00
	E	23	40.30	927.00
Difficulty				
Only the best students can complete the tasks	C	42	36.69	1541.00
	E	23	26.26	604.00
Competitiveness				
Students compete to complete the tasks first	C	42	29.02	1306.00
	E	23	41.95	839.00

Analyzing the mean ranks for the observed items in relation to the group, it can be concluded that the students in the experimental group are happier in class and have more fun than the students in the control group. It was also found that the students in the experimental group tried to cooperate with each other more than the students in the control group and that the students from the experimental group competed more than those in the control group.

From Table 7, we can see from the mean values of the ranks for the item "Some students don't like their class" that the students in the experimental group have noticed that the changes brought about by the introduction of the gamification method in physics lessons have a worse effect on some of their colleagues, leading to tensions in the classroom environment. We can also see from the values for the item "Only the best students can complete the tasks" that the students in the control group believe that only the best students can solve the tasks in the classroom environment, which is not the case for the students in the experimental group.

5. Discussion

We can reject the initial hypotheses based on the results obtained, as a statistically significant difference was found between the control and experimental groups regarding positive classroom environment. Specifically, students in the gamified classroom reported higher satisfaction with the class, less friction among peers, fewer difficulties in solving tasks, and increased competitiveness. These findings align with similar research, which revealed significant improvements in students' critical thinking after eight weeks of gamified activities. Although the increase in problem-solving abilities was not statistically significant, students exhibited high levels of intrinsic motivation (Asigigan & Samur, 2021). Furthermore, participants described gamified STEM activities as engaging, competitive, and enjoyable, emphasizing that they facilitated both learning and practice. Rewards such as badges and prizes provided additional motivation, underscoring how gamification can transform the learning environment and enhance educational outcomes.

The findings of this study are particularly relevant in addressing the educational needs of Generation Alpha, a cohort immersed in a digital-first environment where traditional teaching methods often fail to resonate (Halloluwa et al., 2018). With mobile devices and gaming playing a central role in their daily lives, gamification presents an innovative approach to engage these students. This study highlights how gamified classrooms enhance satisfaction, reduce peer friction, and increase engagement, underscoring the importance of adapting educational strategies to align with the preferences of this digitally native generation.

The results show that students in a gamified classroom environment experience greater happiness and enjoyment, corroborating the findings of Rahman et al. (2018) and Recabarren et al. (2023). These studies demonstrated that incorporating gamification into educational settings positively influences learning outcomes by fostering fun, engagement, motivation (both intrinsic and extrinsic), and satisfaction. This reinforces the idea that gamification catalyzes the engagement and motivation required to create effective and positive learning environments (Ab Rahman et al., 2018; Recabarren et al., 2023).

A notable characteristic of gamification is its ability to strengthen student bonds and foster a competitive spirit, elements intrinsic to games. This study found these aspects to be more pronounced in the experimental group than in the control group. Several researchers emphasized the interconnected nature of competition and collaboration as key components supporting learning activities (Ab Rahman et al., 2018; Rahman et al., 2018). Similarly, Sepehr and Head (2013) demonstrated that competition enhances student satisfaction and enjoyment, making it a powerful motivator for participation in gamification tasks (Sepehr & Head, 2013).

Leaderboards, a commonly employed gamification element, have been shown to effectively boost motivation, as observed by (Fotaris et al., 2016). Students at the top strive to maintain their rank, while others are motivated to improve their positions. Chen et al. (2019) also emphasized that without sufficient challenge, the game risks becoming boring, while excessive challenge might lead students to disengage and drop out of the game entirely (Chen et al., 2019). However, Sepehr and Head (2013) caution that leaderboards can demotivate lower-ranking students, highlighting the need for thoughtful implementation (Sepehr & Head, 2013). Balancing challenge and accessibility is critical, as overly simple games may bore students, while overly difficult ones may frustrate them (Su & Cheng, 2015). As suggested by Kyewski and Krämer (2018), incorporating group-based competition can mitigate potential rivalries and foster collaboration (Kyewski & Krämer, 2018).

The findings of this study align with earlier research by Vlachopoulos and Makri (2017), which revealed that games and simulations positively influence cognitive, behavioral, and affective learning outcomes (Vlachopoulos & Makri, 2017). Students in the experimental group outperformed their peers in the control group, highlighting gamification's potential to create engaging and effective positive learning environments. Similarly, research by Kuklinski and Weinstein (2000) showed that students feel more supported by teachers when their academic needs are met, a factor closely tied to creating positive learning environments (Kuklinski & Weinstein, 2000). Samdal et al. (1998) also identified teacher support and a sense of fairness as critical predictors of positive classroom dynamics (Samdal et al., 1998).

The significant differences observed in satisfaction, connectedness, and competitiveness between the experimental and control groups underscore gamification's transformative potential. These findings resonate with Anđić et al. (2010), who emphasized the impact of positive learning environments on teaching quality and student activity. Their research noted that two-way communication and clear lesson objectives stimulate engagement and align with this study's results.

Additionally, the meta-analysis by Sailer and Homner (2020) underscores gamification's ability to enhance cognitive, motivational, and behavioral learning outcomes, particularly in schools (Sailer & Homner, 2020). Mechanisms such as memory enhancement (Fotaris et al., 2016), improved focus, and increased effort in understanding complex concepts (Alabbasi, 2018) illustrate gamification's broader educational benefits. Similarly, Zourmpakis et al. (2023) observed that adaptive gamification strategies positively impact student motivation and engagement, further supporting the findings of this study (Zourmpakis et al., 2023). Dehghanzadeh et al. (2024) also highlighted gamification as a critical tool for fostering cognitive, emotional, and behavioral engagement in K-12 education (Dehghanzadeh et al., 2024).

Recent research emphasizes the importance of integrating gamification into education. Tolentino and Roleda (2019) found significant increases in student motivation and engagement in gamified physics education settings (Tolentino & Roleda, 2019). Likewise, Núñez-Pacheco et al. (2024) demonstrated that gamification effectively aids in teaching complex concepts, such as those found in physics, by making them more accessible and engaging (Núñez-Pacheco et al., 2024). These studies align with our findings, highlighting gamification's role in modernizing education to meet the expectations of Generation Alpha.

However, implementing gamified strategies presents challenges, as many educators lack the technical skills and resources necessary to design and execute such activities effectively (Apaydin & Kaya, 2020; Murillo-Zamorano et al., 2021). Teacher training programs must prioritize the development of advanced technical and pedagogical skills to support the successful adoption of gamification. Furthermore, equipping classrooms with the appropriate hardware and software is essential for enabling this transition.

By demonstrating gamification's ability to bridge the gap between traditional teaching methods and the digital expectations of modern students, this study underscores the urgency of revising educational curricula to include technology-enhanced learning strategies. Its findings show how gamification fosters dynamic, engaging, and inclusive learning environments, paving the way for a more effective educational experience.

This study adds to the growing body of evidence supporting gamification as a transformative educational strategy. By enhancing satisfaction, reducing friction, and promoting competition, gamification offers an innovative pathway to improve learning outcomes. Future research should explore the long-term effects of gamification and expand the target group to include primary school students, thereby deepening our understanding of its impact on motivation and positive learning environments across educational levels.

6. Conclusions

This study investigated how gamification affects high school students, focusing on how students perceive the classroom environment when exposed to the gamification strategy. Analysis of the results showed that students in the experimental group differed statistically from students in the control group in their perceptions of satisfaction, friction, and the challenge of school tasks in the student learning experience. The analysis of the results regarding the gamification elements introduced showed that the students in a gamified classroom environment rated all the examined dimensions with higher values compared to the students in the control group and differed statistically significantly in at least one particle of each category. In addition to the scientific contribution of this research, it is important to emphasize the perceived need to introduce new approaches in the implementation of the teaching process and a departure from the traditional approach. Indeed, the results show that students are more satisfied and connected in a gamified teaching environment and solve problems more easily.

Beyond its scientific contribution, this research highlights the critical need to adopt innovative approaches in the teaching process, moving away from traditional methods. The findings demonstrate that students in a gamified learning environment feel more satisfied, connected, and better equipped to tackle problems.

The increasing emphasis on the popularization of science, technology, engineering, and mathematics (STEM) underscores the importance of enhancing learning environments in these key areas, which are essential for humanity's future development. Improving performance in STEM subjects can be facilitated by transforming the classroom environment to boost student motivation and engagement. However, implementing such changes requires a systemic approach throughout the entire educational process. Addressing classroom dynamics should begin at the primary education level, suggesting that future research should extend the target group to include primary school students.

7. Limitations and Further Research

This study has several limitations that should be acknowledged. First, the small sample size (N = 69) limits the generalizability of the findings. While the results provide valuable initial insights, a larger and more diverse sample would allow for more robust statistical analyses and increase confidence in the conclusions. Additionally, the study focused on first-year high school students, meaning the findings may not be directly transferable to other age groups or educational contexts.

Another limitation lies in the factor analysis methodology. Using orthogonal (varimax) rotation assumed that the factors were independent, simplifying the interpretation of results. However, potential correlations between factors were not explored, which could provide a deeper understanding of the relationships among dimensions such as satisfaction, cohesion, and engagement. Future research should consider employing alternative rotation methods, such as oblimin, to examine potential latent correlations, particularly with larger sample sizes.

The study also evaluated the classroom environment using a validated questionnaire but did not directly measure students' learning outcomes. While the focus on engagement and satisfaction offers valuable insights, the absence of performance-based metrics means the broader academic impact of gamification remains unexplored. Future research should integrate assessments of academic achievement to provide a more holistic understanding of gamification's effects.

Moreover, the eight-week intervention period was relatively short, limiting the ability to assess the long-term sustainability of gamification's benefits. Longitudinal studies are needed to determine whether the observed improvements in the classroom environment persist over time and how they influence students' academic trajectories.

Lastly, the lack of open-ended feedback in the questionnaire restricted qualitative insights into students' experiences with gamification. In future studies, incorporating qualitative methods, such as interviews or open-ended survey questions, could complement quantitative data and provide a richer contextual understanding. Additionally, pre-intervention assessments of baseline knowledge would help ensure comparability between experimental and control groups and control for prior disparities in understanding.

Despite these limitations, this study demonstrates the potential of gamification to enhance student engagement and satisfaction, particularly in subjects that students often find challenging. By addressing these limitations, future research can build on these findings to further explore the transformative potential of gamification in education.

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Appendix A

Table A1. The factor structure of the student learning experience questionnaire, together with the corresponding reliability coefficient.

Item	Factors				
	Satisfaction	Cohesion	Friction	Difficulty	Competitiveness
Students like being in this classroom	0.884				
Most students value what they learn in classroom	0.702				
Students have fun in classroom	0.773				
Students are happy in classroom	0.650				

Table A1. *Cont.*

Item	Factors				
	Satisfaction	**Cohesion**	**Friction**	**Difficulty**	**Competitiveness**
Students in this class enjoy the lessons	0.600				
Students have real friends in classroom	0.562				
All students get along very well in the classroom		0.810			
All the students in the classroom value each other		0.781			
Students do not argue with each other		0.651			
There is a friendly atmosphere in the classroom		0.646			
Students do not argue in classroom at all		0.520			
A lot of students in this classroom like to argue			0.691		
Some students in this classroom are mean to others			0.629		
Some students feel bad when they get a bad grade			0.629		
Some students don't like their classroom			0.584		
Students try to cooperate with each other			0.583		
Most students cannot complete all assignments without help				0.787	
Most of the students in the classroom do not know how to perform tasks well				0.682	
The tasks we do are quite difficult				0.627	
Only the best students can complete the tasks				0.538	
It is difficult for students to fulfill their obligations in class				0.489	
Some students always want to be the first and the best					0.693
Most students want their work to be better than the work of their colleagues					−0.668
Some students always want to outperform their classmates					−0.510
Students compete to complete the tasks first					0.403
CROMBACH α coeficient	**0.851**	**0.741**	**0.832**	**0.721**	**0.416**

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