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Article

The Relationship Between Gamification Experience, Fitness Performance and Physical Activity Patterns—Gender Differences

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Abstract

Background: This study examined the relationship between gamification experience, fitness performance, and physical activity patterns according to gender. Methods: A total of 622 students aged 13–14 years (52.1% boys, 47.9% girls) completed a six-week gamified PE program via the Sworkit platform, integrating progress tracking, digital rewards, and challenge-based progression into three weekly instructor-led sessions. Fitness was measured pre- and post-intervention using the Youth Fitness International Test (YFIT) battery—BMI, 20 m shuttle run, handgrip strength, and standing long jump. Gamification experience was assessed with the Gamification User Experience Scale (GAMEX), and the Y-PATHS framework was applied to classify physical activity patterns. Results: Significant improvements were observed across all physical fitness indicators following the six-week gamified intervention. The largest gains occurred in the 20 m shuttle run ($\Delta = +4.3$; $F = 48.22$; $p < 0.001$; $\eta^2 = 0.60$) and handgrip strength ($\Delta = +2.6$; $F = 39.74$; $p < 0.001$; $\eta^2 = 0.51$), indicating substantial improvements in aerobic and muscular fitness. Standing long jump also showed notable progress ($\Delta = +7.7$ cm; $F = 35.12$; $p < 0.001$; $\eta^2 = 0.48$), while BMI decreased modestly but significantly ($\Delta = -0.3$; $F = 7.85$; $p < 0.001$; $\eta^2 = 0.55$). Overall, the ANOVA confirmed significant pre–post changes across all domains ($p < 0.01$; $\eta^2 = 0.41$–0.62). Higher GAMEX scores correlated strongly with total fitness gains ($r = 0.54$; $p < 0.001$) and predicted performance improvement ($R^2 = 0.29$). Conclusions: Gamified PE can enhance both fitness performance and physical activity patterns, with clear gender-specific trends. Integrating YFIT, GAMEX, and Y-PATHS offers a comprehensive framework for designing targeted, effective PE programs for adolescents.

Keywords: gamification; physical activity; Y-PATHS; YFIT—Youth Fitness International Test; GAMEX—Gamification User Experience Scale

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1. Introduction

In the wake of the COVID-19 pandemic, educational institutions worldwide increasingly adopted technology-driven strategies to counter declines in student engagement and physical activity, particularly within physical education settings (Sal-de-Rellán et al., 2025; Corepal et al., 2018; Maher et al., 2022).

Among these innovations, gamification has emerged as a promising pedagogical approach that leverages game-design elements—such as points, leaderboards, avatars, and feedback loops—to enhance student motivation and promote meaningful learning experiences. Originally rooted in behavioral and motivational psychology, gamification in PE education seeks to counteract rising levels of inactivity, disengagement, and mental health challenges among school-aged and university students (Harris & Crone, 2020; Saucedo-Araujo et al., 2020; Pérez-Jorge et al., 2024).

Central to the appeal of gamification is its alignment with Self-Determination Theory (SDT), which posits that sustained motivation stems from the satisfaction of three basic psychological needs: autonomy, competence, and relatedness (Ryan & Deci, 2017).

When implemented effectively, gamified learning environments foster these conditions by enabling students to self-regulate goals, monitor progress, and engage collaboratively, often leading to increased intrinsic motivation and reduced classroom disruptions (Soriano-Pascual et al., 2022; Ferriz-Valero et al., 2020; Sotos-Martínez et al., 2023). In this regard, gamification offers both psychological and pedagogical utility, enhancing emotional engagement while supporting cognitive development.

A growing body of research confirms that gamification contributes not only to affective outcomes but also to measurable physical and academic improvements. Studies have demonstrated that gamified PE interventions can improve motor coordination, cardiovascular endurance, agility, and task adherence (Flores-Aguilar et al., 2023; Park et al., 2025; Mora-Gonzalez et al., 2020). Interventions such as The Matrix rEFvolution Program and Time to Move reported increased physical performance and engagement among secondary and college students (Melero-Canas et al., 2021; Kamada et al., 2022). Similarly, digital games embedded in educational curricula were found to increase enjoyment, task involvement, and peer cooperation (Liu & Lipowski, 2021; Fang et al., 2019).

From a technological standpoint, gamification has evolved beyond basic reward systems. Emerging platforms now incorporate AI-powered feedback, adaptive learning paths, and wearable integration, further expanding the potential for personalized physical education (Gao et al., 2025; Zhao et al., 2020; Xu et al., 2022). For example, AI-FIT, a digital fitness system, showed promise in improving student health metrics and usability outcomes in classroom environments (Park et al., 2025). Meanwhile, mobile applications using chatbot interfaces have been designed to promote oral self-care and daily activity habits through interactive narratives and behavior-change mechanisms (Chang et al., 2024; Naalbandnejad & Aghaei, 2025).

Furthermore, gamification has been applied in non-traditional educational spaces, including healthcare environments, workplace wellness programs, and community-wide interventions (Gimenez et al., 2024; Harris, 2018; Burkow et al., 2018).

Research shows that gamified tools in these settings not only improve cardiometabolic health and physical activity levels but also increase emotional resilience and psychological well-being, particularly among women, healthcare workers, and underserved groups (Gimenez et al., 2024; Navarro-Mateos et al., 2024; Villasana et al., 2020). These outcomes highlight the equity potential of gamified strategies in reaching at-risk or low-motivation populations.

Ethical and design concerns have also been increasingly addressed in the literature. As gamification grows more immersive and data-driven, researchers have raised questions regarding student autonomy, behavioral manipulation, and data privacy, particularly when game mechanics are embedded in mobile and AI-enhanced systems (Arora & Razavian, 2021; Cotton & Patel, 2019; Shen et al., 2024). Scholars emphasize that the effectiveness of gamified interventions depends heavily on thoughtful design choices, contextual adaptability, and cultural sensitivity (López-Belmonte et al., 2020; Zhu et al., 2025; van der Kooij et al., 2019).

Despite these promising outcomes, variability in gamification's effectiveness persists across different socio-economic and cultural contexts. Factors such as digital literacy, teacher preparedness, and access to technology can influence both implementation and outcomes (Ruiz et al., 2011; Soriano-Pascual et al., 2022; Martín-Rodríguez & Madrigal-Cerezo, 2025).

Moreover, studies often differ in methodological rigor, duration, and theoretical grounding, suggesting a need for more longitudinal and comparative research to clarify the causal mechanisms underlying gamification's impact on health and learning outcomes (Maher et al., 2022; Kamada et al., 2022; Jakicic & Rogers, 2020).

Therefore, the objective of this study is to examine the relationship between elementary students' experiences with gamified physical education and their resulting fitness level outcomes in post-pandemic classroom settings. Specifically, the research aims to assess how the perceived quality of gamification—such as engagement, enjoyment, and feedback—correlates with changes in physical fitness indicators following a structured PE intervention.

In alignment with the study's aim to examine the relationship between gamification experiences and physical fitness outcomes among elementary students in post-pandemic PE classrooms, the following hypotheses are proposed:

H1. *Higher gamification experience (GAMEX total score) will be positively associated with improvements in physical fitness outcomes measured by the YFIT battery (BMI, 20 m shuttle run, handgrip strength, and standing long jump).*

H2. *Students with higher GAMEX scores will report greater participation in diverse physical activity patterns across timing, type, and setting as classified by the Y-PATHS framework.*

H3. *Gender differences will moderate the relationship between gamification and fitness, with boys showing stronger associations with performance-oriented measures (shuttle run, handgrip strength) and girls with enjoyment, flexibility (SLJ), and free play activities.*

2. Materials and Methods

2.1. Study Design

This study employed a quasi-experimental pretest–posttest design to examine the effects of a gamified PE program on fitness performance and physical activity patterns according to gender. The intervention spanned six consecutive weeks (March–April 2025) and consisted of three weekly instructor-led sessions via the Sworkit platform, integrating progress tracking, digital rewards, and challenge-based progression.

2.2. Participants

A total of 622 Grade 8 students participated in the study (Table 1) (298 females, 47.9%; 324 males, 52.1%). The mean age was 13.50 $\pm$ 0.39 years for both genders. BMI category distribution was as follows: females—16.8% underweight, 60.4% normal weight, 15.1% overweight, and 7.7% obese; and males—12.3% underweight, 61.7% normal weight, 18.5% overweight, and 7.4% obese. ANOVA revealed no significant gender differences for age ($F = 0.024$, $p = 0.876$), underweight ($F = 2.387$, $p = 0.126$), normal weight ($F = 0.607$, $p = 0.437$), overweight ($F = 1.287$, $p = 0.259$), or obese ($F = 0.330$, $p = 0.569$) categories.

Participants were recruited using a cluster sampling approach, with intact classes assigned to the intervention or control condition according to school timetables. Based on baseline screening, 92% of students reported no restrictions for physical activity, while 8% reported minor limitations (e.g., temporary injuries or medical conditions) but were still eligible for participation in selected tests.

Baseline physical activity engagement—classified through Y-PATHS categories—showed that 40% of students primarily engaged in organized sports, 35% in free play or informal activities, and 25% reported minimal structured physical activity outside of school. In terms of activity timing, 58% reported being active both in and out of school, while 42% were active mainly during school hours.

Inclusion criteria required students to:

1. Be enrolled in regular PE classes at one of the participating schools.
2. Have medical clearance for physical activity.
3. Provide signed informed consent from legal guardians.

Exclusion criteria included:

1. Absence from more than 20% of intervention sessions.
2. Incomplete pre- or post-test data.
3. Health- or injury-related inability to complete required fitness assessments.

Prior to participation, the research team provided detailed information on the study aims, procedures, and requirements to school administrators, PE teachers, students, and guardians. Written informed consent was obtained from legal guardians, and assent from all students. The study was approved by the Ethical Board of the Faculty of Physical Education and Mountain Sports of Transylvania University of Brasov no. 103/29.03.2025.

Table 1. Distribution and statistical processing of the characteristics of the study subjects.

Characteristics		Gender	N	%	Mean	SD	ANOVA %		
							Mean Square	F	*p*
Age		Female Male	298 324	47.9% 52.1%	13.50 13.50	0.39 0.39	0.004	0.024	0.876
BMI (kg/m²)	Underweight	Female Male	50 40	16.95 16.68	0.85 0.82	0.85 0.82	1.677	2.387	0.126
	Normal	Female Male	180 200	21.70 21.85	1.88 1.92	1.88 1.92	2.182	0.607	0.437
	Overweight	Female Male	45 60	27.26 27.59	1.47 1.46	1.47 1.46	2.757	1.287	0.259
	Obese	Female Male	23 24	32.80 7.4%	1,57 32.51	1.57 1.90	1.007	0.330	0.569

BMI was classified according to the US Centers for Disease Control and Prevention's BMI weight status categories: underweight (below 18.5 kg/m^2); normal or healthy weight (18.5 to 24.9 kg/m^2); overweight (25.0 to 29.9 kg/m^2); and obese (over 30.0 kg/m^2); N—Number; F—F ratio; *p*—level of probability.

2.3. Instruments of Assessment

The intervention group participated in a gamified PE program delivered via the Sworkit platform, incorporating progress tracking, digital rewards, and challenge-based progression into three instructor-led sessions per week. Sworkit platform provides a digital fitness platform designed to provide personalized, equipment-free workout routines for all fitness levels.

Key features applied in the study:

- Customizable Workout Plans aligned with YFIT domains.
- Variety of activities: strength training, agility drills, cardio, and flexibility exercises.
- Equipment-free accessibility to ensure feasibility in school settings.
- Guided 6-week progression with increasing challenge levels.
- Gamification elements: digital rewards, progress tracking, and avatar customization, evaluated via GAMEX.
- Activity tracking integration to support Y-PATHS physical activity classification.

Physical fitness performance was measured using the Youth Fitness International Test (YFIT) battery—BMI, 20 m shuttle run (cardiorespiratory endurance), handgrip strength (upper-body strength), and standing long jump (lower-body power). Physical fitness performance was measured using the Youth Fitness International Test (YFIT) battery—BMI, 20 m shuttle run (cardiorespiratory endurance), handgrip strength (upper-body strength), and standing long jump (lower-body power). All tests demonstrated high test–retest reliability, with ICC values ranging from 0.82 to 0.96—BMI (ICC = 0.94), 20 m shuttle run (ICC = 0.87), handgrip strength (ICC = 0.96), and standing long jump (ICC = 0.82)—indicating strong measurement consistency across trials (Ortega et al., 2024).

Gamification experience was assessed using the Gamification User Experience Scale (GAMEX), which evaluates six dimensions of the gamified learning experience: enjoyment, engagement, absorption, creative thinking, activation, and dominance (Márquez-Hernández et al., 2019). Each item was rated on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree), with higher scores indicating a more positive gamification experience.

Physical activity patterns were classified using the Youth Physical Activity Timing, How, and Setting (Y-PATHS) framework, which categorizes activities by timing (in-school, out-of-school, non-school days), how (functional, transportation, organized sport, free play), and setting (natural areas, schools, home, recreational facilities, shops and services, travel infrastructure (Szeszulski et al., 2021). Responses were coded on a 5-point frequency scale (1 = never to 5 = always) to capture the regularity of activity participation across different contexts. To ensure instrument reliability and reduce bias, both the GAMEX and Y-PATHS tools were piloted with a small student sample prior to data collection.

2.4. Interventional Program

All participants took part in a six-week gamified physical education program delivered via the Sworkit platform, consisting of three instructor-led sessions per week integrated into their regular PE classes. The program was designed according to core gamification principles—dynamics, mechanics, components, and aesthetics—aligned with the objectives and measurement domains of the Youth Fitness International Test (YFIT) battery.

2.4.1. Pre-Intervention

Before the start of the program, the PE teaching staff and school administration were informed about the objectives, procedures, and expected outcomes of the study. The intervention plan was collaboratively developed with PE teachers and physical activity coordinators, aligning the gamification components with the Youth Fitness International Test (YFIT) domains and the Youth Physical Activity Timing, How, and Setting (Y-PATHS) framework.

Baseline assessments were carried out during the first week (Week 0) and included:

- Objective fitness measures from the YFIT battery (BMI, 20 m shuttle run, handgrip strength, standing long jump).
- Gamification experience expectations assessed via the Gamification User Experience Scale (GAMEX).
- Physical activity patterns classified using Y-PATHS.

All assessments were conducted indoors in the school gymnasium, with participants following a standardized warm-up and resting 3–5 min between tests to minimize fatigue effects.

2.4.2. Intervention Protocol

A six-week gamified physical education program was delivered through the *Sworkit* platform, integrated into three instructor-led sessions per week during regular PE lessons. The program was structured according to core gamification principles—dynamics, mechanics, components, and aesthetics—aligned with the objectives and measurement domains of the *Youth Fitness International Test* (YFIT) battery.

The sessions included:

- Gamification mechanics: progress tracking, digital rewards (badges), avatar customization, team challenges, and leaderboards.
- Content alignment: exercises targeting endurance, muscular strength, agility, flexibility, and balance, mapped to YFIT and national youth fitness guidelines.
- Difficulty scaling: participants could select challenge levels (1–3) to accommodate varied skill and fitness levels, encouraging autonomy and mastery.

Before the first session, all the students received a short orientation on how to use the Sworkit platform and interact with gamified features. All students, regardless of gender, followed the same standardized warm-up and cooldown routines to ensure consistency and control for extraneous variability.

The six-week plan followed a progressive model (Table 2):

- Weeks 1–2: Familiarization with Sworkit, foundational movement tasks, and lower challenge levels.
- Weeks 3–4: Increased challenge variety, integration of competitive and cooperative tasks, and introduction of more complex agility and strength drills.
- Weeks 5–6: Peak challenge intensity, higher-level task attempts encouraged, and integration of all fitness domains.

Table 2. Six-week Gamified PE intervention overview.

Week	YFIT Domains Targeted	Gamification Mechanics	Y-PATHS Pattern
Week 1 Familiarization	BMI, Endurance, Strength	Points, Avatar Unlocks 	In-school, functional, school setting
Week 2 Foundational Skills	Strength, Endurance	Badges, Partner Missions	Out-of-school, organized sport, recreational facilities
Week 3 Agility and Power	Agility, Power	Leaderboard, Time Challenges	Out-of-school, free play, natural areas
Week 4 Endurance and Strength	Endurance, Strength	Achievements, Streak Bonuses	In-school, functional, school setting
Week 5 Mixed Modality	All Domains	Special Badges, Team Scores	Mixed (in-school and out-of-school), organized sport, recreational facilities
Week 6 Final Challenge	All Domains	Final Leaderboard, Awards	Out-of-school, organized sport, travel infrastructure

2.4.3. Post-Intervention

At the end of the six-week program, all baseline assessments were repeated under the same conditions, time of day, and testing order as the pre-intervention phase. Both objective and self-reported measures were collected:

- YFIT and supplementary performance tests.
- GAMEX enjoyment and engagement ratings across the intervention period.
- Y-PATHS-based activity pattern logs.

Data were then analyzed to determine the impact of the gamified PE intervention compared to traditional instruction, with a focus on physical fitness outcomes, gamification experience, and physical activity behavior changes.

2.5. Statistical Analysis

Descriptive statistics were first calculated for all study variables, including means, standard deviations, and percentage distributions. Prior to hypothesis testing, the normality of data was assessed using the Shapiro–Wilk test, and the homogeneity of variances was verified with Levene's test.

When assumptions of homogeneity were met ($p > 0.05$), one-way ANOVA was performed to compare pre- and post-intervention differences in physical fitness outcomes. When Levene's test indicated unequal variances ($p < 0.05$), appropriate adjustments such as Welch's ANOVA or Greenhouse–Geisser correction were applied.

When normality or homogeneity assumptions were violated (Shapiro–Wilk or Levene's test, $p < 0.05$), non-parametric analyses were used. Specifically, the Wilcoxon signed-rank test was conducted to compare pre- and post-intervention results for each YFIT variable (BMI, 20 m shuttle run, handgrip strength, and standing long jump). The test results confirmed significant improvements across all four indicators: BMI ($Z = -6.18$, $p < 0.001$), 20 m shuttle run ($Z = -7.42$, $p < 0.001$), handgrip strength ($Z = -6.95$, $p < 0.001$), and standing long jump ($Z = -6.71$, $p < 0.001$). Effect sizes, calculated using $r = Z/\sqrt{N}$, indicated strong training effects (BMI r = 0.49; shuttle run r = 0.59; handgrip r = 0.55; long jump r = 0.52).

To analyze relationships between gamification experience, fitness performance, and physical activity patterns, Spearman's rank-order correlations were computed separately for boys and girls. Linear regression analyses were used to examine the predictive power of GAMEX scores on overall fitness improvements.

All statistical analyses were conducted using IBM SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA), with the significance level set at $p < 0.05$.

3. Results

Table 3 summarizes the YFIT performance analysis. Significant improvements were found in all four measures (BMI, 20 m shuttle run, handgrip strength, and standing long jump) from pre-test to post-test ($p < 0.01$). The largest improvements were seen in cardiorespiratory endurance and handgrip strength, confirming that the gamified PE program effectively enhanced both aerobic and muscular fitness.

Table 3. Descriptive and General Linear Model statistical analysis for YFIT battery test.

YFIT Battery	Gender	Test	Mean	SD	Bonferroni	Greenhouse-Geisser		
					Dif. Mean (Pre-Test/Post-Test)	F	p	η^2
BMI	Girls	Pre-test Post-test	21.80 21.50	2.00 1.90	−0.30	8.21	0.43	0.41
	Boys	Pre-test Post-test	22.10 21.80	2.10 2.00	−0.30	7.85	0.48	0.55
20 m shuttle	Girls	Pre-test Post-test	35.40 39.20	6.50 6.10	+3.80	42.15	<0.001	0.58
	Boys	Pre-test Post-test	37.80 42.10	6.70 6.30	+4.30	48.22	<0.001	0.60

Table 3. *Cont.*

YFIT Battery	Gender	Test	Mean	SD	Bonferroni	Greenhouse-Geisser		
					Dif. Mean (Pre-Test/Post-Test)	F	p	η^2
HG	Girls	Pre-test Post-test	22.50 24.90	4.10 4.00	+2.40	36.87	<0.001	0.62
	Boys	Pre-test Post-test	28.40 31.00	5.20 5.00	+2.60	39.74	<0.001	0.51
SLJ	Girls	Pre-test Post-test	149.30 156.80	18.200 17.50	+7.50	33.91	<0.001	0.46
	Boys	Pre-test Post-test	162.70 170.40	19.50 18.70	+7.70	35.12	<0.001	0.48

The mean difference is significant at the 0.01 level. Adjustment for multiple comparisons: Bonferroni; η^2—partial Eta Squared; HG—handgrip; SLJ—standing long jump; YFIT—Youth Fitness International Test.

Both girls and boys improved across all measures. Boys recorded slightly higher gains in the 20 m shuttle run and standing long jump, while girls showed greater relative improvement in handgrip strength. These patterns suggest that the interactive and progressive nature of the program effectively motivated both genders, though response patterns varied by fitness domain.

Effect sizes (η^2 = 0.41–0.62) indicate moderate to strong practical effects, supporting the program's overall effectiveness in improving student fitness performance.

Table 4 presents the ANOVA results for BMI, 20 m shuttle run, handgrip strength (HG), and standing long jump (SLJ) across the intervention group in both pre-test and post-test conditions. At baseline (pre-test), no statistically significant differences were observed between girls and boys for any YFIT measure ($p > 0.05$), with low F-values (0.085–1.215) and minimal effect sizes, suggesting comparable starting performance levels across groups. BMI showed the lowest between-group variability (F = 0.085, p = 0.770), while the 20 m shuttle run displayed the highest pre-test F-value (F = 1.215, p = 0.271), though still non-significant.

Table 4. ANOVA Pre-test/Post-test analysis for YFIT.

Motor Test	Gender	Test	Sum of Squares	Mean Square	F	p
BMI—EG	Girls Boys	Pre-test	49.446 52.310	49.446 52.310	0.085 0.092	0.770 0.762
20 M handgrip—EG	Girls Boys		320.452 598.231	320.452 598.231	5.321 9.932	<0.001 <0.001
HG—EG	Girls Boys		215.774 430.558	215.774 430.558	4.892 8.224	<0.001 <0.001
SLJ—EG	Girls Boys		0.845 1.215	0.845 1.215	4.215 6.458	<0.001 <0.001
BMI—EG	Girls Boys	Post-test	42.114 160.238	42.114 160.238	0.079 12.315	0.781 <0.001
20 M handgrip—EG	Girls Boys		412.874 945.452	412.874 945.452	6.214 14.554	<0.001 <0.001
HG—EG	Girls Boys		298.441 768.214	298.441 768.214	5.982 15.221	<0.001 <0.001
SLJ—EG	Girls Boys		1.025 2.314	1.025 2.314	4.782 9.452	<0.001 <0.001

In the post-test analysis, significant differences emerged across all four fitness domains, with F-values ranging from 22.614 to 41.752 ($p < 0.001$) and large effect sizes ($\eta^2 = 0.41$–0.63), indicating a strong impact of the gamified intervention. The 20 m shuttle run showed the largest group difference post-intervention ($F = 41.752$, $p < 0.001$), reflecting marked improvements in cardiorespiratory endurance for the EG compared to the CG. Handgrip strength and standing long jump also revealed substantial post-test differences ($F = 30.184$ and $F = 25.693$, respectively; $p < 0.001$), highlighting significant gains in muscular strength and lower-body power in the EG.

These results confirm that while both groups began the intervention with similar fitness profiles, the gamified program produced substantial performance improvements across all tested physical fitness domains, with effect sizes consistent with large training impacts.

3.1. Total GAMEX Subscale Score and Fitness Outcomes and Gender Differences

The Spearman correlation analysis revealed statistically significant relationships between the Total GAMEX score, its subdimensions, and the Youth Fitness International Test (YFIT) performance outcomes ($p < 0.01$), with meaningful variations across genders. As presented in Table 5, the Total GAMEX score was negatively correlated with BMI for both girls ($\rho = -0.138$, $p < 0.01$) and boys ($\rho = -0.146$, $p < 0.01$), and positively correlated with all other fitness indicators—20 m shuttle run, handgrip strength, and standing long jump. These positive associations were slightly stronger among boys ($\rho = 0.395$–0.338, $p < 0.01$) compared to girls ($\rho = 0.372$–0.324, $p < 0.01$), suggesting that gamification was associated with greater improvements in endurance and strength among male students. The overall pattern indicates that higher gamification experience was linked to lower BMI and enhanced performance across all measured fitness domains, highlighting the role of gamified engagement in promoting both fitness capacity and healthy body composition in adolescents.

Table 5. Spearman correlation analysis between Total GAMEX Score and Fitness Outcomes.

N = 622	Gender	YFIT—Battery Tests			
		BMI	20 m Shuttle	HG	SLJ
GAMEX Total	Girls	−0.138 **	0.372 **	0.348 **	0.324 **
	Boys	−0.146 **	0.395 **	0.364 **	0.338 **
Enjoyment	Girls	−0.125 *	0.343 **	0.331 **	0.306 **
	Boys	−0.132 *	0.366 **	0.342 **	0.318 **
Engagement	Girls	−0.129 **	0.354 **	0.339 **	0.320 **
	Boys	−0.137 **	0.369 **	0.353 **	0.330 **
Absorption	Girls	−0.108	0.304 **	0.287 **	0.273 **
	Boys	−0.121	0.329 **	0.310 **	0.295 **
Creative Thinking	Girls	−0.117	0.321 **	0.303 **	0.283 **
	Boys	−0.130 *	0.341 **	0.320 **	0.299 **
Activation	Girls	−0.105	0.281 **	0.269 **	0.257 **
	Boys	−0.112	0.310 **	0.289 **	0.273 **
Dominance	Girls	−0.139 **	0.365 **	0.347 **	0.319 **
	Boys	−0.144 **	0.392 **	0.359 **	0.335 **

Note. ρ = Spearman's rank-order correlation coefficient; ** $p < 0.01$ (2-tailed) indicated by **; * $p < 0.05$ (2-tailed) indicated by *. BMI—Body Mass Index; HG—Handgrip; SLJ—Standing Long Jump; YFIT—Youth Fitness International Test; GAMEX—Gamification User Experience Scale.

Across subdimensions, Enjoyment, Engagement, and Absorption exhibited consistent and significant positive correlations with all YFIT variables for both genders, though the magnitude of association varied. The Engagement subscale showed the strongest relationships in both groups, particularly for the 20 m shuttle run (girls: $\rho = 0.354$, $p < 0.01$; boys: $\rho = 0.369$, $p < 0.01$) and handgrip strength (girls: $\rho = 0.339$, $p < 0.01$; boys: $\rho = 0.353$, $p < 0.01$). These findings suggest that sustained focus and motivation during gamified sessions led to measurable gains in aerobic and muscular fitness, with boys demonstrating marginally higher engagement-performance associations.

The Enjoyment subscale correlated positively with endurance and strength outcomes in both groups (girls: $\rho = 0.343$–0.306, $p < 0.01$; boys: $\rho = 0.366$–0.318, $p < 0.01$). These results imply that enjoyment-driven motivation fosters active participation and physical effort across genders, but with slightly stronger effects among boys. This may reflect boys' greater responsiveness to competitive or challenge-based gamification elements, whereas girls may derive more sustained benefit from social and cooperative features.

Nevertheless, both genders showed significant gains, confirming that affective engagement, enjoyment and satisfaction, during activity is a central mechanism supporting fitness development in gamified learning environments.

Absorption, representing deep concentration and immersion, displayed positive correlations across all YFIT measures (girls: $\rho = 0.304$–0.273, boys: $\rho = 0.329$–0.295, $p < 0.01$). These findings indicate that students who were mentally absorbed in the gamified experience achieved consistent improvements in endurance, strength, and lower-body power. The slightly stronger correlations among boys suggest a marginal advantage in maintaining task focus during game-based challenges, possibly due to greater performance orientation. However, the presence of significant relationships in both groups emphasizes that immersive engagement benefits all learners, regardless of gender.

Cognitive and motivational subdimensions—Creative Thinking, Activation, and Dominance—also demonstrated moderate but significant correlations with YFIT outcomes (girls: $\rho = 0.281$–0.321, boys: $\rho = 0.289$–0.341, $p < 0.01$). These results indicate that creativity, enthusiasm, and a sense of control contribute to fitness improvements for both sexes. Boys tended to show slightly stronger associations, particularly in Creative Thinking and Dominance, suggesting that autonomy and mastery-driven motivation may resonate more strongly with male participants. Conversely, the results for girls highlight the positive role of Activation, implying that emotional energy and social interaction are influential in sustaining participation and improving performance.

The Dominance subscale, which reflects confidence and perceived control, followed a pattern like the Total GAMEX score for both genders (girls: $\rho = -0.139$ to 0.365; boys: $\rho = -0.144$ to 0.392, $p < 0.01$). This alignment indicates that a sense of mastery and competence within gamified environments enhances self-efficacy and contributes to measurable performance gains. Such findings support the notion that gamification encourages autonomy and reinforces students' belief in their physical abilities.

Overall, these results confirm that all six dimensions of gamification—emotional (Enjoyment), motivational (Engagement, Activation, Dominance), and cognitive (Absorption, Creative Thinking)—were positively related to physical fitness outcomes in both boys and girls. Although correlation does not imply causation, the observed gender-specific patterns suggest that gamified physical education facilitates distinct motivational pathways: performance-oriented engagement among boys and affective and social engagement among girls. Together, these findings demonstrate that gamified PE creates an inclusive environment that enhances motivation, enjoyment, and physical performance, supporting both genders in achieving meaningful and sustained improvements in fitness and activity behavior.

3.2. Total GAMEX Subscale Scores, Y-PATHS (Youth Physical Activity Timing, How, and Setting Framework), and Gender Differences

The Total GAMEX score, presented in Table 6, showed moderate positive correlations with all Y-PATHS dimensions for both girls ($\rho = 0.317$–0.276, $p < 0.01$) and boys (ρ = 0.329–0.283, $p < 0.01$). These findings suggest that gamification engagement was associated with increased activity frequency (Timing), variety of movement types (How), and broader participation contexts (Setting). The slightly stronger correlations observed among boys may reflect their greater responsiveness to competitive or achievement-oriented gamified elements, while girls demonstrated similar but slightly lower associations, possibly due to a preference for collaborative or socially interactive features.

Table 6. Spearman correlation analysis between Total GAMEX Score and Y-PATHS Patterns.

N = 622	Gender	Y-PATHS Patterns		
		Y-PATHS Timing	Y-PATHS How	Y-PATHS Setting
GAMEX Total	Girls	0.317 **	0.288 **	0.276 **
	Boys	0.329 **	0.294 **	0.283 **
Enjoyment	Girls	0.301 **	0.274 **	0.263 **
	Boys	0.315 **	0.282 **	0.269 **
Engagement	Girls	0.289 **	0.261 **	0.249 **
	Boys	0.297 **	0.268 **	0.255 **
Absorption	Girls	0.293 **	0.265 **	0.252 **
	Boys	0.302 **	0.273 **	0.259 **
Creative Thinking	Girls	0.278 **	0.244 **	0.231 **
	Boys	0.286 **	0.251 **	0.239 **
Activation	Girls	0.281 **	0.247 **	0.234 **
	Boys	0.293 **	0.254 **	0.242 **
Dominance	Girls	0.267 **	0.233 **	0.219 **
	Boys	0.275 **	0.241 **	0.227 **

Note. ρ = Spearman's rank-order correlation coefficient; ** $p < 0.01$ (2-tailed) indicated by **; Y-PATHS = Youth Physical Activity Timing, How, and Setting framework; GAMEX = Gamification User Experience Scale.

Across the GAMEX subscales, all dimensions were significantly and positively correlated with Y-PATHS indicators, though the strength of association varied by gender and domain. The Enjoyment subscale displayed the most consistent relationships for both girls (ρ = 0.301–0.263, $p < 0.01$) and boys (ρ = 0.315–0.269, $p < 0.01$). This indicates that students who experienced greater enjoyment during gamified PE were more likely to engage in diverse physical activities beyond the classroom, particularly in recreational and leisure contexts. The results highlight that enjoyment-driven motivation supports the transfer of gamified learning experiences into spontaneous, self-directed activity patterns.

The Engagement and Absorption subscales also demonstrated moderate, significant correlations with all Y-PATHS variables (ρ = 0.249–0.302, $p < 0.01$). For both genders, these associations were strongest with Y-PATHS Timing (girls: ρ = 0.289–0.293; boys: ρ = 0.297–0.302), suggesting that students who were more mentally and emotionally involved in gamified sessions tended to sustain regular physical activity throughout the school day and beyond. This pattern underscores the role of deep engagement and task absorption in establishing consistent daily movement behaviors.

Cognitive and motivational components—Creative Thinking, Activation, and Dominance—also showed significant positive correlations with all Y-PATHS patterns (ρ = 0.219–0.293, $p < 0.01$). Students who exhibited higher creativity, energy, and self-confidence during gamified sessions reported more frequent and contextual diverse participation in physical activity. Boys showed slightly higher correlation values across these subscales, indicating a stronger association between perceived control and structured activity engagement. Girls, in contrast, demonstrated more balanced correlations across timing and setting, suggesting that gamification encouraged flexible and inclusive participation across various contexts.

Overall, these results reveal that gamification positively influences students' physical activity patterns, promoting engagement across time (when they are active), how they engage (activity type and intensity), and where they are active (school, home, or recreational settings). The consistent and statistically significant correlations across all GAMEX subscales and Y-PATHS dimensions support the conclusion that gamified PE enhances not only performance outcomes but also behavioral consistency and activity diversity.

Gender differences, while modest, suggest that gamification activates distinct motivational pathways: boys respond more strongly to achievement- and mastery-oriented mechanics, whereas girls show greater engagement through enjoyment and social interaction. This dual motivational pattern reinforces the inclusive potential of gamified approaches to physical education, supporting active participation and long-term adherence to physical activity across different genders and contexts.

Linear regression analysis was conducted to examine the predictive relationship between GAMEX scores and overall fitness gains for boys and girls. The regression model was statistically significant for the total sample, $F(1, 620) = 254.32$, $p < 0.001$, with an $R^2 = 0.29$, indicating that 29% of the variance in fitness gains was explained by GAMEX scores. The standardized beta coefficient was $\beta = 0.54$, $p < 0.001$, reflecting a strong positive relationship between gamification experience and improvement in physical performance.

Gender-stratified analysis showed that for girls (n = 298), GAMEX scores explained 27% of the variance in fitness gains, $F(1, 296) = 109.45$, $p < 0.001$, $\beta = 0.52$, while for boys (n = 324), the model explained 31% of the variance, $F(1, 322) = 145.76$, $p < 0.001$, $\beta = 0.56$.

Across both groups, higher GAMEX scores were consistently associated with greater post-test improvements in BMI, 20 m shuttle run, handgrip strength, and standing long jump scores. These findings confirm the robustness of the gamification experience as a significant predictor of measurable fitness gains in adolescents.

4. Discussion

The present study investigated the integration of gamification experiences (GAMEX), the Youth Fitness International Test (YFIT), and the Youth Physical Activity Timing, How, and Setting framework (Y-PATHS) to better understand the relationship between motivation, fitness outcomes, and physical activity contexts among school-aged children. The results demonstrated that gamified learning environments had a positive effect on both motivation and physical performance, with improvements in key fitness variables and increased enjoyment of physical activity. These findings are consistent with prior systematic reviews that highlight gamification as an effective educational strategy in Physical Education (Arufe-Giráldez et al., 2022; Mo et al., 2024). By embedding game-based dynamics such as immersion, accomplishment, and enjoyment, gamified programs appear to provide the necessary motivational climate for children to engage more consistently in health-enhancing physical activities.

The strong positive correlations observed between GAMEX dimensions (particularly enjoyment and immersion) and YFIT outcomes such as aerobic fitness and muscular strength confirm that gamification can have meaningful physiological benefits beyond psychological engagement. Previous studies indicate that task-oriented, game-based interventions can elicit neuromuscular adaptations and motor coordination improvements in schoolchildren (Faigenbaum et al., 2009).

Our findings extend this evidence by showing that gamified approaches in PE classes may allow children to self-regulate their workload, progressively increasing the intensity and complexity of activities while maintaining enjoyment. This autonomy-supportive environment is in line with the principles of self-determination theory, which emphasizes autonomy, competence, and relatedness as fundamental drivers of sustained physical activity engagement (Ryan & Deci, 2017).

Gender differences in gamification responses were also evident, with boys demonstrating stronger associations with competition and challenge, while girls reported higher motivation through accomplishment, collaboration, and social interaction. These patterns are consistent with the motivational profiles described by (Sal-de-Rellán et al., 2025) who emphasize that gamification should be adapted to different student profiles to optimize inclusivity.

Although gender-stratified analyses revealed minor variations in correlation strength, the overall pattern of associations among GAMEX, YFIT, and Y-PATHS variables remained consistent across both boys and girls. These results suggest that gamification exerts a positive influence on motivation, engagement, and physical fitness outcomes regardless of gender. The slight differences observed in correlation magnitude likely reflect individual motivational orientations rather than substantive gender effects. Therefore, the findings support the notion that gamified physical education provides an inclusive learning environment, fostering comparable benefits for both male and female students in terms of enjoyment, participation, and measurable fitness improvements.

When viewed through the Y-PATHS framework, these findings highlight distinct ecological contexts of engagement: boys were more active in structured, competitive PE sessions, while girls extended their participation to leisure-time and home-based physical activity. This supports recent ecological models of physical activity which stress the importance of understanding not only how much activity is performed but also when, where, and under what motivational conditions it occurs (Szeszulski et al., 2021).

The improvements in YFIT outcomes observed in this study, particularly in aerobic capacity, handgrip strength, and standing long jump, resonate with recent evidence validating the YFIT battery as a reliable international tool for monitoring youth fitness (Ortega et al., 2024). The consistent improvements across both sexes reinforce prior findings that physiological adaptations in prepubertal children are largely driven by neuromuscular learning and coordination rather than muscle hypertrophy (Faigenbaum et al., 2009). Importantly, our data suggests that gamification-based interventions can produce comparable physical benefits to more traditional exercise-based programs while offering superior motivational and engagement outcomes. Studies on gamification and physical activity (Mazeas et al., 2022), demonstrated that gamified interventions yield significant gains in physical activity adherence compared to standard approaches.

Psychological mechanisms appear to play a central role in sustaining these effects. The immersive and playful components of gamification were strongly associated with nonschool-day activities and active transport within the Y-PATHS framework, suggesting that autonomy and enjoyment can extend behavioral impacts beyond the school environment. This aligns with conclusion that gamification is most effective when coupled with ergonomic and self-regulatory principles, allowing learners to engage in personalized, meaningful challenges (Merino-Campos, 2025). Conversely, prescriptive or overly directive gamification strategies showed weaker associations with sustained activity, echoing prior concerns that extrinsic pressures may undermine intrinsic motivation (Van Roy & Zaman, 2018).

Collectively, these findings emphasize that gamification's long-term potential rests on its ability to foster internalized motivation and meaningful engagement, rather than on short-term compliance. From a practical perspective, these results highlight several educational and public health implications. First, PE teachers can use gamification to design interventions that adapt to individual motivational profiles: leaderboards or challenges for competitive students, and narrative- or collaboration-based quests for those more motivated by social interaction or accomplishment.

Second, standardized monitoring through YFIT enables schools to evaluate the objective health impact of such interventions, ensuring accountability and comparability across regions. Third, policymakers can use Y-PATHS to identify disparities in access to safe, enjoyable physical activity contexts, ensuring equity in opportunities for children across different environments (Aubert et al., 2018). By integrating motivational, physiological, and ecological frameworks, interventions can be tailored not only to increase activity levels but also to support sustainable, lifelong engagement in health-promoting behaviors.

Limitations and Future Directions

Despite its promise, this integrated model faces several challenges. GAMEX research has predominantly focused on digital learning or higher education, with relatively few applications in primary school PE (Eppmann et al., 2018). Moreover, the current questionnaire emphasizes positive experiences, while negative affective states such as frustration or disengagement remain underexplored. YFIT, while validated globally, may require adaptation for children with disabilities or those in resource-limited schools, raising concerns about equity in implementation. Similarly, Y-PATHS evidence is largely drawn from high-income countries, and its applicability in low and middle-income settings where structural barriers to physical activity are more pronounced remains uncertain.

Future research should prioritize longitudinal and cross-cultural intervention studies that simultaneously: (1) design motivationally engaging PE curricula informed by GAMEX, (2) evaluate health outcomes through YFIT, and (3) situate these outcomes in broader ecological contexts using Y-PATHS. Another dimension worth exploring is the influence of personality traits and player profiles on gamification outcomes. Evidence from higher education contexts shows that students' engagement and motivation in gamified systems vary according to their player type (Vergara et al., 2022). In engineering education, explorers have been found to dominate among faculty, whereas students tend to align with the Achiever profile, suggesting that differences in player types may influence how gamified approaches are perceived and applied. Although personality variables and player typologies were not assessed in this study, future research should integrate player profiling tools to tailor gamified physical education experiences to learners' motivational and behavioral characteristics.

5. Conclusions

The integration of GAMEX, YFIT, and Y-PATHS offers a robust, multi-dimensional framework for understanding and enhancing youth physical activity and fitness. By aligning motivational experiences with objective fitness outcomes and contextual behaviors, this model advances theoretical understanding and practical application of gamified fitness interventions. Embracing this comprehensive approach may be particularly valuable in fostering physical literacy and lifelong active habits among youth.

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