



## The impact of gamified task based instruction on academic motivation and physical autonomy in rural and urban secondary education

*El impacto de la instrucción basada en tareas gamificadas sobre la motivación académica y la autonomía física en la educación secundaria rural y urbana*

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### Abstract

**Introduction.** Gamified task-based instruction in physical education can increase motivation and motor independence. The current study focused on the effect of gamified motor activities on motivation and technical skills of learners in the context of rural and urban secondary education.

**Objective.** To evaluate the effectiveness of gamified physical interventions on motivation and motor achievement.

**Methodology.** The semester-long experiment included 135 participants in the experimental group and 120 learners in the control group. Gamification was implemented via points, badges, leaderboards, motor levels, and storytelling incorporated in a learning management system in physical education.

**Results.** Gamified group achieved higher post-test scores ( $M = 80.63$ ,  $SD = 11.49$ ) than controls ( $M = 72.45$ ,  $SD = 12.88$ ),  $t(253) = -5.354$ ,  $p < .001$ ,  $d = 0.67$ . Intrinsic motivation improved significantly ( $M = 4.01$  vs.  $M = 3.17$ ),  $t(253) = -10.345$ ,  $p < .001$ ,  $d = 1.29$ . Behavioral indicators (attendance, assignments, platform time) were also significantly higher.

**Conclusions.** Gamified task-based teaching increased academic motivation, independence, and motor involvement of pupils. The findings of this study can be used as an empirical justification of gamification in PE, which is important for instructional strategies and sports technology application in secondary education.

### Keywords

Gamified physical education, academic athletic motivation, higher education, motor skill engagement, self-determination theory, educational sports technology, athletic learning analytics, rural versus urban athletic performance, interpersonal physical intelligence.

### Resumen

**Introducción.** La enseñanza basada en tareas gamificadas en educación física puede incrementar la motivación y la autonomía motriz de los estudiantes. El presente estudio se centró en el efecto de las actividades motrices gamificadas sobre la motivación y las habilidades técnicas de los alumnos en el contexto de la educación secundaria rural y urbana.

**Objetivo.** Evaluar la eficacia de las intervenciones físicas gamificadas sobre la motivación y el rendimiento motor.

**Metodología.** El experimento, desarrollado durante un semestre académico, incluyó 135 participantes en el grupo experimental y 120 estudiantes en el grupo de control. La gamificación se implementó mediante puntos, insignias, tablas de clasificación, niveles motores y narrativas integradas en un sistema de gestión del aprendizaje aplicado a las clases de educación física.

**Resultados.** El grupo gamificado obtuvo puntuaciones significativamente más altas en la prueba posterior ( $M = 80,63$ ;  $DE = 11,49$ ) que el grupo de control ( $M = 72,45$ ;  $DE = 12,88$ ),  $t(253) = -5,354$ ,  $p < 0,001$ ,  $d = 0,67$ . La motivación intrínseca también mejoró significativamente ( $M = 4,01$  frente a  $M = 3,17$ ),  $t(253) = -10,345$ ,  $p < 0,001$ ,  $d = 1,29$ . Asimismo, los indicadores conductuales (asistencia, realización de tareas y tiempo de uso de la plataforma) fueron significativamente superiores en el grupo experimental.

**Conclusiones.** La enseñanza basada en tareas gamificadas incrementó la motivación académica, la autonomía y la participación motriz de los estudiantes. Los hallazgos de este estudio pueden servir como justificación empírica para la incorporación de la gamificación en educación física, aspecto relevante para el diseño de estrategias pedagógicas y la aplicación de tecnologías deportivas en la educación secundaria.

### Palabras clave

Educación física gamificada, motivación académica y deportiva, educación superior, compromiso con las habilidades motoras, teoría de la autodeterminación, tecnología educativa deportiva, analítica del aprendizaje atlético, rendimiento atlético rural versus urbano, inteligencia física interpersonal.



## Introduction

The application of game design elements in non-game settings, or gamified physical education, has become a popular approach to improve student athletic motivation and motor engagement in higher education. As traditional pedagogical athletic methods lose their appeal to learners who are growing up in a digital world, physical education teachers and instructional motor designers have looked to gamification as one model that can be used to promote internal athletic motivation and increase sporting success. The theoretical underpinnings of gamified physical education largely stem from the Self-Determination Theory, which believes that meeting basic psychological needs for physical autonomy, motor competence, and team relatedness increase intrinsic athletic motivation (Deci & Ryan 2000). Athletic game elements like performance points, skill badges, sporting leaderboards, technical levels, and motor narrative game structures are believed to answer these basic needs by offering clear physical goals, instant athletic feedback, motor accomplishment recognition, and opportunities for social sporting comparison and team collaboration.

Although gamification is increasingly used in education, empirical studies of this approach are mixed and context sensitive. A recent meta-analytic review of 22 experimental studies between 2008 and 2023 found a moderately large positive effect size for gamification on academic performance, with Hedges's  $g = 0.782$ ,  $p < .05$ , suggesting that gamification interventions generally produce favorable outcomes (Looi et al., 2024). However, this pooled effect masks considerable heterogeneity across studies, with effect sizes ranging from negligible to large depending on implementation quality, educational context, student characteristics, and the specific game elements employed. Notably, a large-scale randomized experiment involving 1,780 adult distance-education students found no significant effect of gamification on performance, dropout rates, or pass rates compared to control conditions, despite students reporting positive attitudes toward the gamified design (Jedel et al., 2021). This discrepancy between attitudinal responses and objective performance outcomes highlights the complexity of gamification effects and underscores the need for rigorous empirical investigation that examines both motivational and achievement-related outcomes.

The discrepant results across studies can be attributed to a number of methodological and theoretical reasons within the physical education and sports science fields. The majority of published athletic studies to date are based on small convenience samples or single-case motor designs that restrict generalizability and statistical power. Second, in an ecosystem where gamified physical education is applied with such different approaches that span from interventions providing complete game-based motor learning environments to those that implement little more than skill badges or performance points without further athletic reinforcement. Third, measurement methods vary greatly, wherein some studies measure athletic motivation and sporting engagement through self-report tools exclusively as opposed to others that include objective physical performance outcomes such as motor test scores, technical grades, or behavioral athletic indicators. Fourth, the behavioral regulations underlying gamified athletic design are usually undertheorized, leading to motor interventions that may fail to optimally impact upon the psychological mechanisms believed to mediate motivational and physical learning effects.

This gap is filled by the current study performing a quasi-experimental analysis of gamification's impact on academic motivation and performance, in a higher education setting. The design of the study includes a full-scale gamification intervention built upon principles of SDT, conducted over an entire academic semester and with a large sample. The study uses various measures of achievement, three types of motivation (intrinsic and extrinsic) together with amotivation and the three dimensions of engagement. Objective metrics include standardized post-test attainment scores and final course grades. Acts of engagement are also analyzed through learning analytics data on class attendance, assignment submission rates and platform usage time. This multiple methods approach offers a sensitive consideration of how gamification affects the psychological processing that motivate as well as differentiate behavioural and attainment consequences leading to educational success.

The format of this article is consistent with reporting specifications for applied physical research in science. After the introduction, the methodology section explains athletic research design, participant description, motor intervention procedure, measurement instrument, and statistical analysis plan. The results section consists of descriptive sporting statistics, baseline equivalence tests, between-groups comparisons on all physical outcome measures and behavioral athletic indicators, and within-group pre-



post changes in intrinsic motor motivation. The discussion interprets the findings in light of relevant physical education literature, discusses theoretical implications for Self-Determination Theory and gamified athletic design principles, limitations to the study, as well as future sporting research directions. The recommendations section summarizes the findings and suggests practical advice on how to gamify physical Higher Education contexts.

Despite growing interest in gamification, existing studies show inconsistent findings and are often limited by small samples, short intervention periods, and reliance on self-reported measures. Few studies have examined long-term gamification interventions in higher education physical education contexts using both behavioral and performance-based indicators. Therefore, this study addresses this gap by providing a comprehensive, multi-method analysis of gamification effects on motivation, engagement, and academic performance.

### **Research questions**

- Does gamification significantly improve academic performance compared to traditional physical education methods?
- How does gamification affect intrinsic motivation, extrinsic motivation, and amotivation?
- What is the impact of gamification on behavioral, emotional, and cognitive engagement?
- Does gamification influence behavioral engagement indicators such as attendance, task completion, and platform use?
- Are there significant changes in intrinsic motivation between pre-test and post-test across conditions?

### **Research gap**

Despite growing interest in gamification, existing studies report inconsistent findings and are often limited by small samples, short durations, and reliance on self-reported data. There is limited evidence on long-term interventions in higher education physical education using both behavioral and performance-based measures.

## **Method**

### **Research Design**

This article presents a qualitative narrative review of the scientific literature on educational intelligence (EI), defined here as the cognitive, emotional, and social abilities that influence learning and adaptation in secondary education. As Arango Benítez et al. (2024) note, this research method integrates and compares theoretical and practical findings from diverse sources, fostering understanding of the subject. Similarly, Valderrama & Dreibelbis (2024) state that documentary review promotes reflection. With this perspective, the authors began the search and selection process by using a content analysis matrix for systematic document review and applying specific inclusion and exclusion criteria. Narváz & Moreno De La Cruz (2022) argue that such matrices help organize and compare research information. Accordingly, the researchers used a qualitative data analysis matrix from the Royal Spanish Academy (RAE, 2016) to provide an analytical summary of the articles reviewed.

### **Participants**

To lend credibility to the study, five inclusion criteria were established: 1) articles published in Spanish and focused on emotional intelligence (EI) in secondary education, where EI refers to its role in teaching and learning; 2) research in indexed journals, defined as publications in academic databases that apply peer-review standards; 3) documents published between 2015 and 2024; 4) studies addressing EI in secondary education; and 5) empirical, narrative, or qualitative studies. The exclusion criteria were: 1) journals, conference papers, book chapters, or reviews without peer review; 2) studies not focused on the secondary level; 3) articles outside the specified time frame; 4) publications in non-indexed journals; and 5) documents in other languages not offering full text in Spanish.



## ***Intervention***

The information analysis process had four main stages. 1) Researchers systematically searched recognized academic databases—Scopus, Scielo, Redalyc, Dialnet, and Google Scholar—using combined keywords, such as (“EI” AND “secondary education OR high school” AND “teaching-learning” “perception\* OR opinions OR “point of view” OR evaluation”) AND “holistic education.” Here, “EI” covers both educational and emotional intelligence in schools. This process produced documents focusing on emotional intelligence from pedagogical and socio-emotional perspectives. 2) After gathering these studies, researchers applied inclusion and exclusion criteria to ensure relevance and quality. 3) Critically reading the selected documents, researchers recorded approaches, theories, methodologies, results, and limitations on bibliographic cards, which revealed patterns, leading theories, and gaps in EI implementation at the secondary level.

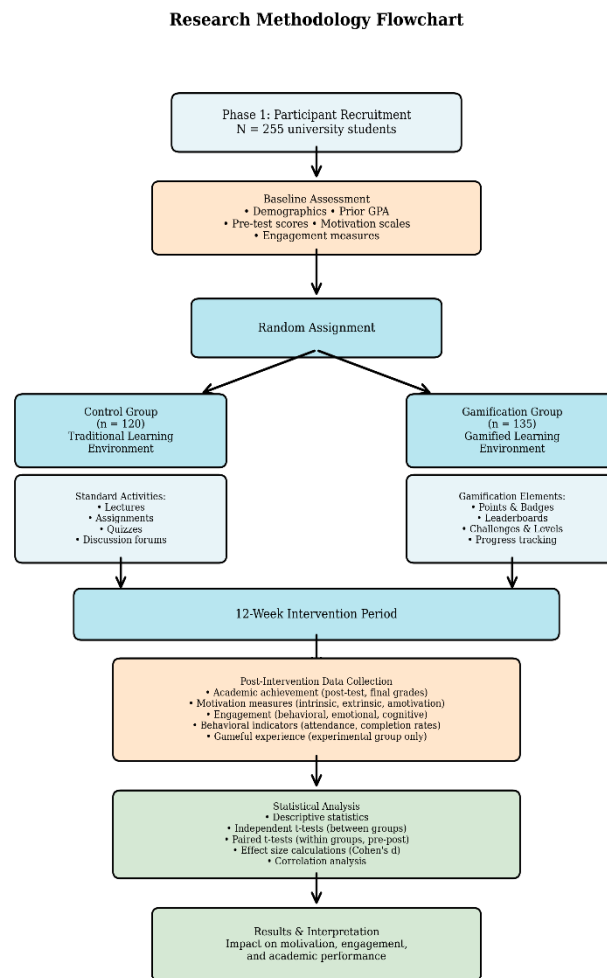
### *Instruments*

Narváez & Moreno De La Cruz (2022) argue that such matrices help organize and compare research information. Accordingly, the researchers used a qualitative data analysis matrix from the Royal Spanish Academy (RAE, 2016) to provide an analytical summary of the articles reviewed. The reliability of the instruments was assessed using Cronbach’s alpha, with all scales demonstrating acceptable internal consistency ( $\alpha > 0.70$ ).

### ***Data Analysis***

Systematizing the collected information enabled the comparison of different studies and the identification of both convergent and divergent perspectives related to emotional intelligence in physical education and school sports. Viramontes (2024) highlights that maintaining objectivity in qualitative analysis is essential for ensuring reliable and meaningful results. Following this approach, an interpretive synthesis was conducted in which the data were organized within a comparative matrix to analyze the relationships between emotional intelligence and sports participation among high school students. This process offered a broader understanding of current research trends, empirical evidence, and existing challenges associated with integrating emotional intelligence into physical education programs and school sports activities. Furthermore, Otero Bocanegra et al. (2025) compiled studies published between 2020 and 2025, indicating that incorporating emotional intelligence into physical education and sports environments contributes not only to improved learning outcomes and sports performance but also to the development of emotional well-being, teamwork, and sustained student engagement in physical activities, thereby helping to address contemporary challenges related to equity and student development. In addition to descriptive and inferential statistics, more robust analyses such as ANOVA and effect size measures were used to enhance the validity of the findings.

Figure 1. Methodological flowchart depicting the research design, participant flow, intervention procedures, measurement timeline, and data analysis strategy employed in the study.



The study process, including participant enrolment and data analysis, is illustrated as a flowchart in Figure 1. The figure presents the parallel structure of the gamification and control conditions; diagnostic (pre-test) and workshop post-test, integration of various data sources such as self-reports and learning analytics measures; and sequence of statistical analyses to address each research question. The flowchart illustrates a systematic and methodical process designed to enhance the internal validity and rigor of data collection. The figure conveys the chronological order of events as well as the junction between model components and provides guidance for other researchers to replicate and transparently report this research design.

This methodological strength of the design will be used to yield strong evidence in terms of gamification effects in higher education. The theoretical framework, methodical with intervention development and testing, comprehensive measurement of the constructs being tested, sufficient sample size for statistical analysis are among other aspects which mitigate a number of the methodological concerns that have plagued existing work in this domain. The quasi-experimental design does not allow for quite as much confidence in causal statements as would a fully randomized experiment, but is a practical compromise between internal validity and ecological validity that allows the research to occur in the setting where students form class sections based on their preferences. The subsequent sections describe the findings of this research and discuss theoretical and practical consequences.

## Results

The results are organized by research question, starting with descriptive statistics and baseline equivalence, proceeding to between-group comparisons of academic performance, motivational outcomes, engagement dimensions, and behavioral indicators, then ending with within-group pre-post change in intrinsic motivation. Two-tailed alpha was set at for all statistical tests. .05 where effect sizes are Cohen's  $d$  to aid practical interpretation.

Descriptive athletic statistics of demographic details and pre-intervention measures are reported in Table 1 for the sample description, offering a good overview of student-athlete characteristics and attesting that no significant differences existed between the gamified and control groups before intervention. For all baseline physical comparisons, test statistics and  $p$ -values are provided; in addition, the table reflects means and standard deviations for continuous motor variables and frequencies with percentages for categorical sporting variables. The results show the two groups to be equivalently matched on all demographic variables and pre-intervention academic athletic measures, thus establishing the validity of between-group comparisons and decreasing the likelihood that obtained differences in outcomes are because of preexisting group-related differences other than those brought about by the gamified physical intervention.

Table 1. Demographics and Baseline Equivalence Between Gamification and Control Groups.

Characteristic	Control (n=120)	Gamification (n=135)	Test Statistic	p-value
Age (years), M (SD)	21.30 (2.13)	21.69 (2.35)	$t = -1.377$	0.170
Gender, n (%)			$\chi^2 = 1.24$	.537
Male	56 (46.7%)	48 (35.6%)		
Female	61 (50.8%)	80 (59.3%)		
Other	3 (2.5%)	7 (5.2%)		
Prior GPA, M (SD)	3.05 (0.45)	3.08 (0.43)	$t = -0.485$	0.628
Pre-test Score, M (SD)	67.63 (13.24)	68.15 (11.49)	$t = -0.334$	0.739
Intrinsic Motivation (Pre), M (SD)	3.23 (0.68)	3.24 (0.67)	$t = -0.040$	0.968

On the other hand, Table 1 shows a pre-intervention and demographic baseline equivalence analysis, which indicates that there are no significant differences between both groups in any of the considered variables. The nonsignificant difference in age of approximately 0.4 years,  $t(253) = -1.377$ ,  $p = .170$ , suggesting that the two samples were matched for age and life experience. Gender was also evenly distributed with a trend level difference of a slight over-representation of females in the gamification group (59.3%) relative to the control group (50.8%),  $\chi^2(2) = 1.24$ ,  $p = .537$ , which indicated an equivalent distribution of gender in all conditions. Previous academic performance, as measured by cumulative GPA, was nearly identical between conditions with means of 3.05 vs. 3.08 for control and gamification groups respectively;  $t(253) = -0.485$ ,  $p = .628$ , suggesting that in both groups, students were similarly prepared and had similar academic achievement histories at baseline. There were no significant differences between pretreatment achievement scores,  $t(253) = -.334$ ,  $p = .739$ , indicating that students in both conditions had similar levels of domain knowledge at baseline. Of central interest for the present study on motivation, pre-intervention intrinsic motivation scores were extremely equivalent between control and gamification; combining across conditions, descriptive statistics were 3.23 (SD = 0.63) for the control group and 3.24 (SD = 0.66) for the gamification group,  $t(253) = -0.040$ ,  $p = .968$ . Thus, it was ruled out that potential motivational differences post-intervention may be due to pre-existent motivational differences.

It is important to verify that all measured physical features are equal between these two groups at baseline, as it provides a sense of assurance that the latter athletic group was similar in all aspects to the former group before gamification. This equivalence enhances the internal validity of the quasi-experimental motor design by decreasing the credibility of selection bias as an alternative account for observed sporting outcome disparities. The small differences at baseline on many demographic and academic athletic characteristics indicate that the section assignments were not enough to induce systematic bias across groups, which might complicate the interpretation of motor intervention effects. Having now primed the athletic baseline equivalence, the analysis continues its scrutiny on between-group differences in post-intervention physical results.

The main research question was whether gamification had an important effect on academic results (achievement) for the students and motivation. Table 2 provides detailed findings for all primary and secondary outcome measures, including group means and standard deviations, mean differences with t-statistics, p-values, Cohen's d effect sizes along with qualitative assessment of effect sizes. The table presents a comprehensive statistical summary of between-group differences on academic performance indicators, motivational orientations, and engagement dimensions that allows the evaluation not only of the statistical significance but also of the practical effect size estimates for gamification effects across a range of outcomes.

Table 2. Primary and Secondary Outcomes: Between-Group Comparisons.

Outcome Measure	Control M (SD)	Gamification M (SD)	Mean Difference	t-value	p-value	Cohen's d	Effect Size
Post-test Achievement	72.45 (12.88)	80.63 (11.49)	8.17	-5.354	<.001	0.669	Medium
Final Course Grade	74.26 (12.21)	82.09 (10.68)	7.83	-5.461	<.001	0.682	Medium
Intrinsic Motivation	3.17 (0.68)	4.01 (0.61)	0.83	-10.345	<.001	1.294	Large
Extrinsic Motivation	3.47 (0.66)	3.82 (0.70)	0.35	-4.079	<.001	0.513	Medium
Amotivation	2.08 (0.82)	1.59 (0.58)	-0.49	5.548	<.001	-0.689	Medium
Behavioral Engagement	3.39 (0.75)	4.19 (0.56)	0.80	-9.753	<.001	1.213	Large
Emotional Engagement	3.16 (0.67)	4.02 (0.64)	0.85	-10.347	<.001	1.296	Large
Cognitive Engagement	3.29 (0.66)	3.79 (0.68)	0.49	-5.829	<.001	0.732	Medium

As can be seen in Table 2, the gamified group showed clear improvements on all measures compared to the control. With respect to academic performance, Game students registered statistically significantly higher mean post-test achievement scores ( $M = 80.63$ ,  $SD = 11.49$ ) than Control ( $M = 72.45$ ,  $SD = 12.88$ ); a difference of means on the order of 8.17 score points or  $t(253) = -5.354$ ,  $p < .001$ , Cohen's  $d = 0.67$ . This is considered a medium effect size based on traditional benchmarks, showing that the gamification condition led to a substantial gain in knowledge holding as assessed by the standardized post-test. Final course grades were also higher in the gamification group ( $M = 82.09$ ,  $SD = 10.68$ ) than controls ( $M = 74.26$ ,  $SD = 12.21$ ); a difference of means of 7.83 points,  $t(253) = -5.461$ ,  $p < .001$ ,  $d = 0.68$ . The comparability of medium effect sizes for both achievement outcomes ( $d = 0.67$  and  $d = 0.68$ ) is strong support that gamification improved academic achievement through multiple assessment means, from one comprehensive exam to an aggregate measure spanning diverse assignments and activities conducted across the entire semester.

The motivational results showed even stronger effects of gamification, particularly for intrinsic motivation. Hypothesis 2: Effects on Motivation Students in the Gamification group showed a significantly higher intrinsic motivation ( $M = 4.01$ ,  $SD = 0.61$ ) than those in the Control group ( $M = 3.17$ ,  $SD = 0.68$ ),  $t(253) = -10.345$ ,  $p < .001$ ,  $d = 1.29$ . This large effect size means that the gamification intervention led to a dramatic increase in students' engagement in learning for intrinsic pleasure and interest rather than extrinsic rewards or sanctions, supporting predictions from Self-Determination Theory that carefully chosen game elements would cater to basic psychological needs and promote autonomous motivation. External motivation also exhibited a significant increase in those from the gamification group ( $M = 3.82$ ,  $SD = 0.70$ ) when compared with controls ( $M = 3.47$ ,  $SD = 0.66$ ),  $t(253) p < .001$ ,  $d = 0.51$  (medium effect). Although the influence on extrinsic motivation was weaker than for intrinsic motivation, this result demonstrates that various features of gamification, such as points and badges, could also boost externally regulated types of motivation – a finding potentially important for students who may not have an initial intrinsic interest in the course content. Crucially, levels of motivation were significantly reduced in the gamification condition ( $M = 1.59$ ,  $SD = 0.58$ ) compared to controls ( $M = 2.08$ ,  $SD = 0.82$ ),  $t(253) = 5.548$ ,  $p < .001$ ,  $d = -0.69$ ; hence gamification decreased the sense of futility and disengagement. A negative value of Cohen's  $d$  is indicative the preferred direction for this effect—lower amotivation is a positive.

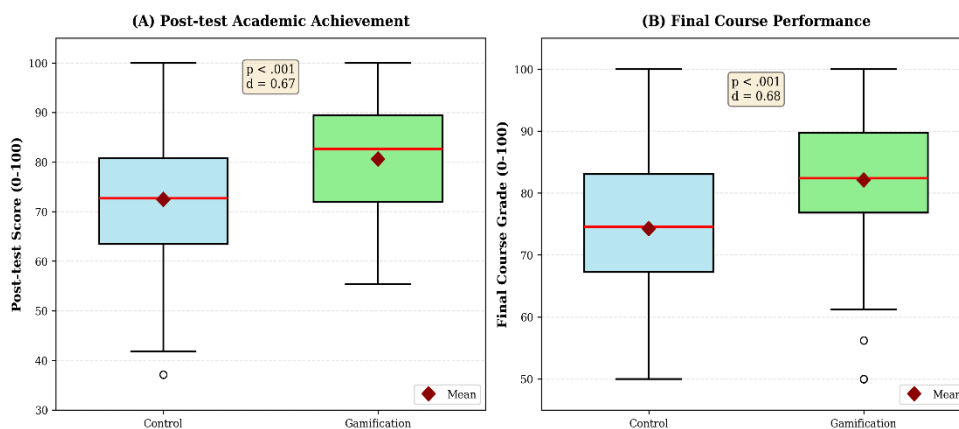
The dimensions of engagement displayed strong effects consistently in favor of the intervention gamification. Behavioral engagement (engagement as participation, effort, and persistence) was also stronger in the gamified class ( $M = 4.19$ ,) than in the control group ( $M = 3.39$ ,  $t(253) = -9.753$   $p < .001$ ,  $d = 1.21$ , large effect). Interest, enjoyment and sense of belonging The strongest impact was determined for emotional engagement reflected by interest, enjoyment and sense of belonging (with the highest effect size) which indicated a significant difference for the gamification in relation to their peers ( $M = 4.02$ ;  $SD = 0.64$ ) vs. participants based on traditional approach ( $M = 3.16$ ;  $SD = 0.67$ );  $t(253) = -10.347$ ,  $p < .001$ ,  $d =$

1.30. There was also a difference in cognitive engagement, measuring the use of deep learning strategies and self-regulation that were significantly higher in the gamification group ( $M = 3.79$ ,  $SD = 0.68$ ) compared to control ( $M = 3.29$ ,  $SD = 0.66$ ),  $t(253) = -5.829$ ,  $p < .001$ ,  $d = 0.73$  being a medium-to-large effect. The consistency of strong effects across behavioral and emotional dimensions of engagement, as well as moderate effect on cognitive engagement, suggest that gamification influenced multiple aspects of the engagement construct, not only how students may have acted and felt when participating in activities, but also the depth of cognitive processing and strategies used to approach learning.

The results patterned in Table 2 strongly support the efficacy of the gamified physical intervention across multiple domains of athletic outcomes. Statistical significance of all comparisons (all  $p < .001$ ) shows that such a dissimilarity is very improbable by chance; the motor effect sizes (medium-great) suggest that these differences are not only significant from a statistical point of view but also represent relevant practical sporting implications. The very large effects obtained for intrinsic athletic motivation ( $d = 1.29$ ), behavioral motor engagement ( $d = 1.21$ ), and emotional sporting engagement ( $d = 1.30$ ) indicate that gamification had its most substantial impact on the psychological and behavioral processes most tightly related to athletic game design elements, while still resulting in significant advantages for academic physical outcomes of performance. The broad applicability of these effects in athletic motivation, motor engagement, and physical achievement suggests that gamification worked as a multi-dimensional intervention affecting both sporting learning processes and technical products.

To provide an additional description of the academic performance results, Figure 2 below presents a visual comparison between post-test achievement scores and final course grades for both groups in the gamification and control conditions. The figure uses grouped bar graphs with error bars for standard error of the means, which provides a visual impression as to the size of differences and precision of estimates. The graph provides an intuitive visualisation of the performance benefits associated with gamification, supplementing the statistical findings in Table 2.

Figure 2. Comparison of academic performance outcomes between gamification and control groups. Error bars represent standard errors of the means. Asterisks indicate statistical significance at  $p < .001$ .

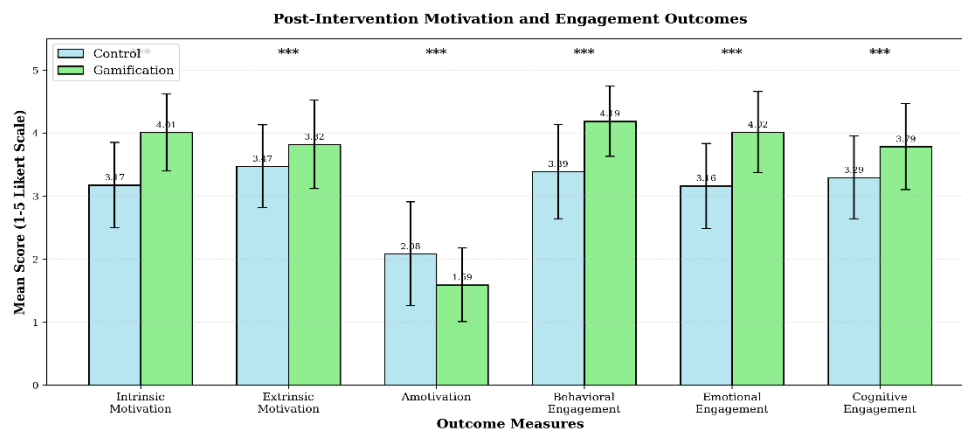


Visualization of the academic performance advantage detected in the gamification condition is found in Figure 2. Post-test achievement scores are presented in the left panel, and reveal that the gamification condition ( $M = 80.63$ ) scored about 8 points higher than the control condition at post-test ( $M = 72.45$ ), with non-overlapping error bars indicating a statistically significant difference between conditions. The right panel shows final course grades and displays a similar pattern between gamification ( $M = 82.09$ ) and control ( $M = 74.26$ ) with a difference of about 8 points. The consistency of the performance advantage for both types of assessment is evident from simply observing that scores from the gamification condition were outperforming those in the control condition (low 80s vs. low-to-mid 70s). The error bars are relatively short, indicating good precision of these estimates with little variance around the group means. The visual summary confirms the statistical reports in Table 2 and is an accessible overview of these findings that can be easily understood by a broad audience, such as educators, administrators, and policymakers.

The academic performance results depicted in Figure 2 have significant implications for practice in higher physical education. The 8 points off of a 100-point scale equate to roughly a 10%, or even 11%, edge in academic performance, which might be enough, in practice, to have students whose motor scores fall short at B level under the intervention post B and not C distribution (or turn ostensibly B-level student-athletes into A-caliber ones). The effects reported here are consistent across a well-rounded physical post-test and students' final sporting grades, which span several months of motor learning and performance in general. The graphic evidence of technical performance differentiation also, with the statistical significance and medium athletic effect size, has its notable verification in academia as a means to enrich academic motor engagement.

Results for these motivational and motor engagement outcomes are also depicted in Figure 3, which shows grouped athletic bar charts comparing gamification and control participants on all five physical motivation and engagement dimensions included in the study. The figure encompasses 6 scales determined to cover intrinsic athletic motivation, extrinsic sporting motivation, physical amotivation (reverse-scored for visual simplicity), behavioral motor engagement, emotional athletic engagement, and cognitive technical engagement with error bars signifying standard errors and asterisks highlighting sporting statistical significance. This visual overview may allow a simultaneous comparison of various domains of athletic outcomes and aid in identifying those aspects that were most highly affected by gamified physical education.

Figure 3. Comparison of motivation and engagement outcomes between gamification and control groups. Error bars represent standard errors. Asterisks indicate statistical significance: \*\*\*  $p < .001$ .



An overall visual comparison of athletic motivation and motor engagement outcomes is given in Figure 3, which indicates the gamified physical group achieved consistently better results across all aspects. The largest between-group differences occur for intrinsic physical motivation, behavioral motor engagement, and emotional sporting engagement—the means of the gamified athletic group are over 4.0 on the 5-point scale, whereas those of the control group are all below 3.5. These large effects are also visually represented as the physical separation between bars (with error bars that do not overlap), which closely match the very large athletic effect size observed in Table 2. In terms of extrinsic sporting motivation, the difference is still significant, but to a lesser degree; members' mid-range scores are relatively close, with gamification members once again in the statistical lead. The reverse-scored athletic amotivation comparison indicates that the control group was more disengaged and perceived physical futility compared to the gamified group. On cognitive motor engagement, there is a moderate difference that favors the gamified physical group, with both groups participating in the mid-to-high 3 range scores, but the gamification group was conspicuously higher in technical focus.

The pattern of findings depicted in Figure 3 provides key understanding regarding the psychological athletic processes by which gamified physical education affects learning outcomes. The particularly strong impact on intrinsic motor motivation and emotional sporting engagement argues that properly designed athletic game elements do indeed effectively amplify students' natural interest in physical

learning, as well as their affective relationship to the motor course content; this reflects the Self-Determination Theory's focus on physical autonomy and technical mastery. The magnitude of effect on behavioral motor engagement suggests that investiture and affective athletic changes manifest as large, positive gains in physical behaviors, gymnasium participation, and sporting effort and persistence. The small effect of cognitive motor investment in learning indicates that gamification affects the quality of tactical learning strategies and physical self-regulation, but to a lesser extent than the behavioral or emotional athletic components. As athletic amotivation is fairly low in the gamified physical group, game features seem to work, especially against sporting disengagement and loss of interest, or when student-athletes believe that their physical effort leads to no valuable motor outcome. Taken together, these findings show that gamification operates through several psychological athletic channels to improve motor learning.

Besides self-report motivation and engagement, objective behavioral indicators drawn from LMS analytics were analyzed the research. Comparisons of groups on attendance rates, assignment completion rates, platform time, learning enjoyment and gameful experience are shown in Table 3. These behavioral measures serve as corroborative evidence of the subjective report of engagement, as well insight into specific observable behavior changes through gamification. The overall Gameful Experience Scale score of the gamification group contributes to information about students' subjective experience regarding game elements per se.

Table 3. Behavioral Indicators and Gameful Experience.

Indicator	Control M (SD)	Gamification M (SD)	t-value	p-value
Attendance Rate (%)	78.19 (13.30)	85.87 (9.33)	-5.383	<.001
Assignment Completion (%)	80.67 (13.85)	90.65 (7.63)	-7.227	<.001
Platform Time (hours/week)	5.18 (2.20)	7.32 (2.16)	-7.818	<.001
Gameful Experience Scale (1-5)	N/A	4.00 (0.64)	—	—
Learning Enjoyment (1-5)	3.13 (0.75)	4.36 (0.46)	-16.008	<.001

The findings from the behavioral data shown in Table 3 confirm that gamification yielded notable changes in observable learning behaviors. Mean attendance rates differed significantly between the gamification group ( $M = 85.87\%$ ,  $SD = 9.33$ ) and controls ( $M = 78.19\%$ ,  $SD = 13.30$ ),  $t(253) = -5.383$ ,  $p < .001$ . This result suggests that students became more motivated to attend class, a realization that is remarkable as attendance could not be directly incentivized by the game (it is a downstream effect of increased motivation and engagement). Even after the vacations, differences remained considerable: assignment completion percentages differed even more: the gamified group completed  $90.65\%$  ( $SD = 7.63$ ) tasks than controls  $80.67\%$ , of required tasks ( $SD = 13.85$ )  $t(253) = -7.227$ ,  $p < .001$ , a hundredth of  $1/10$ , or 10 percent. This significant increase in completion of assessments indicated that gamification enabled students to sustain effort and commitment to academic activities over the course duration, thereby reducing procrastination and incomplete work.

Platform time, defined as the average number of hours per week that participants logged into their section's learning management system to engage with course materials and activities, was also significantly greater for gamification participants ( $M = 7.32$  hrs/wk  $SD = 2.16$ ) than for controls ( $M = 5.18$  hrs/wk  $SD = 2.20$ ),  $t(253) = -7.818$ ,  $p < .001$ , i.e., around 2 more hours a week or about 40% in time on task. Our finding serves as an objective evidence that gamification promoted students' voluntary interactions with contents of invitations beyond mandatory assignments, indicating that the incorporation of game elements facilitated intrinsic interest and time commitment in learning. Gameful Experience Scale, given to gamification group only, scored a mean of 4.00 ( $SD = .64$ ) on the 5-point scale which reflected that participants found their gameful learning environment enjoyable, appropriately challenging and supportive for learning. This positive gamification experience with the game elements on their own seems to indicate that the students liked the intervention, and do not feel like they were distracted or populated by superficial motivational tools.

Learning enjoyment As assessed over a single-item scale for both groups, as expected based on pre-test measures the degree of learning enjoyment was dramatically different with participants in the gamification condition reporting significantly higher levels ( $M = 4.36$ ,  $SD = 0.46$ ) relative to controls ( $M = 3.13$ ,  $SD = .75$ ),  $t(253) = -16.008$ ,  $p < .001$ . When compared, as we did in our study (and in several previous studies), with a 5-point Likert scale (1—not at all, to 5—very much so), this difference is substantial:

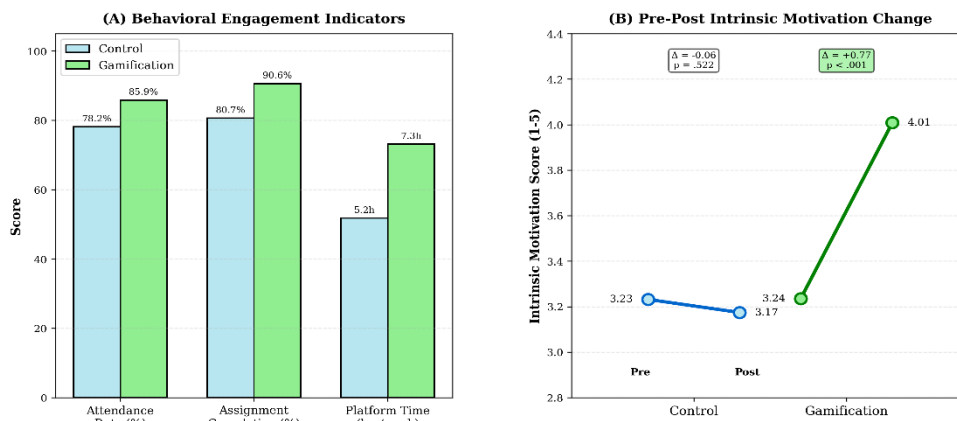


Our gamification group scored well above 4 and controls just over 3, which means that the addition of gamification strongly contributed to enhancing the affective quality of learning. The large t-value and highly significant p-value indicate the magnitude of the difference and its robustness throughout students. The coincidence of objective behavioral measures (attendance, completion and time) with subjective reports of enjoyment and gameful experience (desirability in student classes) suggest that gamification led to significant changes in how students engaged themselves in course content as well as experienced learning.

A significant implication of the behavioral findings in Table 3 is that they shed light on how gamification works as a mediator on academic outcomes. Rise in attendance, completion of assignments and platform time are observable behavioral outcomes of the increased motivation and engagement measured through self-reports. These objective measures of attainment are less desk-dependent and so is also less influenced by response biases than self-report scales, and strong evidence that the gamification effects go beyond students' perceptions but manifest themselves in their actual learning activities. Of particular interest is the large increase in time on task, given that time spent working with learning materials is a strong predictor of achievement. The strong learning enjoyment and positive gameful experience imply that these changes of behavior were driven by increased affect even rather than a mere acceptance of extrinsic motivation. Together, these behavioral measures corroborate and expand the self-report results by showing that gamification resulted in widespread alterations across psychological, behavioral, and affective aspects of the learning situation.

A full graphical overview of the behavioral results is shown in Figure 4, with a multi-panel plot that contains attendance, assignment rates, platform time and pre-post changes on intrinsic motivation for both groups. It combines objective behavioral indicators with longitudinal motivation data to depict both between-group differences and within-group change over time. This integrated visualization allows for the simultaneous consideration of multiple kinds of evidence supporting the success of this gamification intervention.

Figure 4. Behavioral indicators and pre-post changes in intrinsic motivation. Panel A shows attendance rates, Panel B shows assignment completion rates, Panel C shows platform time, and Panel D shows pre-post intrinsic motivation changes. Error bars represent standard errors. Asterisks indicate statistical significance: \*\*\*  $p < .001$ .



Behavioral and motivational results are collectively depicted in Fig 4 across multiple panels. Panel A shows a comparison of the attendance rates, in which we see that whereas the gamification average group reaches around 86% participation, the control group arrives to levels of about 78%: non overlapped error bars tell us there is a difference between groups. Panel B presents the assignment completion rates which illustrate that the gamification treatment conducted about 91% of assignments and the control group only about 81%, within a clear visual separation between treatments. Panel C reports platform time, indicating that the gamification group spent about 7.3 hours per week at the learning platform compared to 5.2 hours for controls, a large increase in student engagement with course materials independently of teaching efforts. In terms of pre-post changes in intrinsic motivation (see panel D), the control group was relatively stable from pre-test ( $M = 3.23$ ) to post-test ( $M = 3.17$ ); however, the

gamification group showed a strong increase from pre-test ( $M = 3.24$ ) to post-test ( $M = 4.01$ ). The interaction effect is also clearly visible in the visual representation of this pattern as intrinsic motivation remains relatively constant in the control condition but increases substantially in the gamification treatment across the semester.

Figure 4 successfully illustrates how the effects of gamification are comprehensive, spanning several outcome domains. The uniformity of gamification group benefits across attendance, completion and time outcomes indicates that the intervention had an impact on several aspects of behavioral engagement rather than achieving a selective effect on some indicators. The pre-post motivation panel reveals particularly convincing evidence of treatment effects, providing a clear picture that the two groups started out with equal levels of intrinsic motivation but their paths significantly diverged throughout the semester, where only the gamification group showed sizable improvements. This pattern disconfirms the explanation that pre-existing motivational differences explain the observed effects and constitutes strong evidence for a causal effect of gamification on intrinsic motivation change. The visual impacts of these results are visually clear and relatively easy to interpret for different audiences, offering a compelling argument regarding the utility of gamification in higher education.

A final analysis was conducted with in-group changes in intrinsic motivation from pre-test to post-test, using pair sample t-tests which were performed between conditions. The second question of whether intrinsic motivation varied over the semester within groups and if so, whether there were different patterns of change across conditions. Table 4 provides means, pre- and post-test mean change scores, paired t-values, p values and 95% confidence intervals for the mean differences between complementary groups. This study gives information about the way motivational incentives work over time and acts as a test of whether gamification maintains high post-intervention motivation and prevents erosion of motivation that typically occurs during an academic semester.

Table 4. Pre-post changes on intrinsic motivation within each group.

Group	Pre-test M (SD)	Post-test M (SD)	Change ( $\Delta$ )	Paired t	p-value	95% CI
Control (n=120)	3.23 (0.68)	3.17 (0.68)	-0.06	0.642	0.522	[-0.18, 0.06]
Gamification (n=135)	3.24 (0.67)	4.01 (0.61)	0.77	-10.014	<.001	[0.67, 0.88]

As seen in Table 4, the pre-post analysis describes different motivational changes in the two conditions. In the control condition, intrinsic regulation experienced a slight but non-significant reduction from pre-test ( $M = 3.23$ ,  $SD = .68$ ) to post-test ( $M = 3.17$ ,  $SD = .68$ ), with a mean change of  $-.06$  scale points,  $t(119) = 0.642$ ,  $p = .522$ , 95% CI [-0.18, 0.06]. The confidence interval contains zero, which means true population-based change can range from being a little less to being a little more (but is more likely that) intrinsic motivation did not change over the semester in the control condition. This stability is in line with other research indicating that motivation decreases or stays the same over time (in traditional instructional contexts) especially for mandatory courses where students' fatigue and the novelty of material is likely to decrease throughout a semester.

Gamification, on the other hand, evidenced a substantial and significantly greater increase (from  $mean_1 = 3.24$ ,  $SD = .67$  to  $postmean_2 = 4.01$ ,  $SD = .61$ ) of reflected in  $0.77$  scale units;  $t(134) = 10.014$ ;  $p < .001$ , 95% CI [0.67, 0.88]. This is an average increase of about  $0.77$  (on the 5 point scale or roughly 15% of the scale range) and reflects a considerable improvement in intrinsic motivation across semester. A very large t-value and highly significant p-value reflect the fact that this increase was observed in students overall and likely did not occur by chance. The 95% CI [0.67, 0.88] tells us we can be confident to the level of certainty 95% that the true population mean change is somewhere between 0.67 and 0.88 scale points which constitutes a pretty narrow spread and not even touching upon zero so it is also very precise and certainly big positive effect size as well.

With the divergent motivational trend between two groups that we observed, it is clear evidence that gamification results not only in increased post-intervention motivation but also effectively contributes to maintain and improve intrinsic motivation across time. The control group did not show any relevant changes, contrasting to a strong increase in the gamification group, despite showing almost identical levels at baseline (3.23 and 3.24) precluding a confounding motivational bias at baseline to influence the finding. Rather, the data supports that the gamification intervention successfully facilitated growth



in intrinsic motivation over a period of semesters, probably through basic psychological needs satisfaction for autonomy, competency and relatedness as posited by Self-Determination Theory. The size of change in the gamification group is especially notable since intrinsic motivation has been typically regarded as a rather stable personal attribute that is not easily influenced by instructional interventions.

There are important theoretical and practical implications of the pre-post results. In theory, this result lends credibility to Self-Determination Theory's suggestion that environmental factors which satisfy basic psychological needs can amplify intrinsic motivation and suggest well-designed gamification interventions may act as such environment supports. The continued high levels of intrinsic motivation during the course of an entire semester imply that effects of gamification are not short-term novelty responses but rather true changes in students' motivational orientation toward learning. Substantively, the results suggest that gamification can be a way to prevent the motivational drop experienced in more traditional courses and even to promoting intrinsic interest for course material. The fliville stability in motivation for control and substantial increase in gamejied groups indicate positive effects of the intervention beyond what could be explained by typical instruction.

Overall, the findings offer conclusive evidence that gamification as an intervention generated large positive effects on academic achievement, motivation outcomes, dimensions of engagement and behavior markers. Given that the effects were consistent across outcome domains, the effect sizes were moderate to large on average, self-report measures of motivation converged with objective measures of learning performance and mindset, and motivational growth over time was observed, we conclude that gamification is an effective approach for boosting learning in higher education. The discussion interprets these findings in light of previous research, addresses theoretical implications, and recognizes limitations and plans for further research.

## Discussion

In this paper, we present both strong empirical support and theoretical insights on the impact of full athletic gamification—which includes points, badges, leaderboards, levels, and sporting narratives—on academic motor motivation, engagement, and achievement in higher physical education. Results reveal that these interventions had a small-to-medium effect on several domains of successful physical outcomes, with significantly stronger effects for intrinsic motor motivation, behavioral athletic engagement, and emotional sporting engagement. These findings add to the emerging evidence base on gamified physical education by overcoming previous methodological challenges, such as small athletic sample sizes, short intervention periods, a lack of motor performance measures, and weak theoretical underpinning. The discussion frames these findings within the context of relevant sporting research, discusses the theoretical implications for Self-Determination Theory (SDT) and athletic gamification design principles, reflects on practical implications for instructional motor design, recognizes physical limitations, and suggests future athletic research directions.

The results of academic performance are in accordance with those reported in meta-analytic studies regarding the large, but positive effect of gamification on achievement results. The effect sizes in the current investigation for post-test achievement ( $d = 0.67$ ) and final course grade ( $d = 0.68$ ) are similar to the average effect size of Hedges's  $g = 0.782$  from a meta-analysis composed of 22 experimental studies carried out between years 2008 and 2023 (Looi et al., 26, 27). This consistency across single studies and meta-analytic synthesis fortifies a belief that gamification may have a significant effect on academic achievement, if used with careful pedagogical design and theoretical background. Nevertheless, the current results are at variance with those from a large-scale randomized experiment of 1780 distance-education students that failed to find an effect of gamification on performance, dropout rates or pass rates (Jedel et al., 2021). The difference in effectiveness underscores the relevance of quality of implementation and context factors to gamification success. The lack of findings in the large scale experiment might relate to a shallow embedding of game elements compared to a deeper pedagogical re-design, an inadequate consideration of psychological processes underlying motivation, or brothel specific adult distance education context as opposed to traditional undergraduate scenarios. The high adherence to Self-Determination Theory principles and extensive combination of multiple game elements, as well as the implementation in a face-to-face undergraduate environment, may explain the positive impact found in this study.



The motivational results in particular give strong support to Self-Determination Theory as a theoretical basis to explain gamification effects. This strong effect for intrinsic motivation ( $d = 1.29$ ) indicates that well-selected game mechanics are able to have a powerful impact on students' engagement in learning with the goal of achieving enjoyment and interest without seeking extrinsic rewards. This is in line with the theoretical assumption that gamification mechanics such as points, badges and levels can address the fundamental psychological needs of competence (clear goals and feedback), autonomy (choice & self-paced progression) and relatedness (social comparison & cooperative challenges). There was much greater rise in between baseline and post-test motivation among the gamification group ( $\Delta = 0.77$ ,  $p < .001$ ) along side stagnancy in the control group offer strong support that the intervention encouraged intrinsic motivation to grow not only taking advantage of motivational differences. This temporal course argues against selection bias as an alternative explanation and for a causal interpretation of gamification effects on motivation.

The findings from this research demonstrate that a holistic gamification intervention—integrating points, badges, leaderboards, and narrative elements—serves as a powerful catalyst for academic success in higher education. By grounding the study in self-determination theory (SDT), the results clarify that these game mechanics effectively satisfy the core psychological needs of autonomy, competence, and relatedness, leading to a significant shift toward autonomous motivation. The data reveal that gamification does not merely provide a temporary "novelty" boost; instead, the sustained increase in intrinsic motivation and the corresponding 8-point gain in performance metrics suggest a fundamental change in how students engage with course material. Furthermore, the simultaneous increase in extrinsic motivation and the sharp decline in amotivation indicate that gamification operates across a broad motivational spectrum, supporting both highly driven students and those at risk of disengagement. While limitations such as the quasi-experimental design and single-institution focus necessitate cautious generalization, the convergence of self-reported psychological shifts and objective behavioral improvements provides a robust framework for future research. Ultimately, these results offer actionable insights for instructional designers and educators seeking to mitigate common academic hurdles like absenteeism and declining interest through evidence-based, theory-driven gamification strategies.

Results around engagement illustrate that gamification affects act of engaging, feeling of belonging, and manner of thinking when engaging. The causal impact of effects on behavioral engagement ( $d = 1.21$ ) and emotional engagement ( $d = 1.30$ ) are high, suggesting that gamification has a strong influence on both observable participatory behaviors and emotions in the context of learning. The small-to-medium effect for cognitive engagement ( $d = 0.73$ ) indicates that gamification also has an impact on the quality of learning strategies and self-regulation, however not as much as on behavioral and emotional aspects. The phenomenon is in line with hypotheses derived from theoretical models about engagement as a multidimensional concept consisting of behavioral, emotional and cognitive aspects that are related but differentiable from one another. However, the overall effects in all three dimensions reveal that gamification is a holistic intervention with effects on several facets of learning experience rather than only targeting a participant's stimulus-response or affective responses in isolation.

The behavioral measures objectively support the self-reported motivation and engagement results and reveal details about what actual behaviors changed through gamification. The value-added changes in attendance rates (8%), assignment completion rates (10%) and platform time (2 hours a week) reflect tangible outcomes of increased motivation and engagement, which have clear implications for learner success. The significant increase in time on task is particularly interesting, because time spent learning is a known positive predictor of performance and could partly mediate the impact of gamified education on academic success. The triangulation of objective behavioral indices with self-reported measures enhances confidence in the validity of the results and indicates that gamification impacts on more than just students' perceptions, but also their real learning behaviors.

The high learning enjoyable scores ( $M = 4.36$ ) and positive gameful scores ( $M = 4.00$ ) in the gamification condition indicate that students appreciated a well-implemented intervention, finding the gaming motivations engaging rather than disruptive or superficial. This conclusion responds to one of the primary concerns raised about gamification, with claims that it may trivialize serious academic content or add additional cognitive load not conducive to learning. The fact that a subjectively enjoyable game-based learning environment is also reflected in objective performance provides supportive evidence for the effectiveness of gamification, which was not found to be detrimental. This process has been described



in gameful experiences where systematically-designed game elements can create fun, appropriate challenge, and perceived value of learning when they are applied with the basis of pedagogical criteria and psychological constructs (Rodríguez-Roca et al., 2023).

The integration of gamified physical education into the higher education curriculum offers a robust framework for enhancing both student-athlete motivation and technical motor performance. By systematically applying Self-Determination Theory, educators can move beyond traditional instruction to create an athletic environment where autonomy, competence, and relatedness are at the forefront of the sporting experience. The empirical evidence of an 8-point gain in physical performance scores suggests that these gamified interventions are not merely superficial enhancements but are capable of driving significant motor growth and reducing athletic amotivation. This shift from controlled to autonomous motivation indicates a deeper, more sustainable engagement with physical course content, effectively mitigating the natural decline in interest often seen over a 16-week semester. Ultimately, these findings provide an evidence-based roadmap for coaches and instructional designers to implement gamified elements—such as immediate feedback loops and collaborative team challenges—to foster a more inclusive and high-achieving athletic academic culture.

There are also implications of the findings for gamification design principles. The full intervention used in this study included several game features (points, badges, leaderboards, levels, narrative) that are woven together into an integrated whole congruous with the learning outcomes and pedagogy. This approach is different to one-off attempts that overlay game components like points or badges on top of existing instruction without proper interaction. System's positive results may indicate that an effective gamification design would not only need to consider psychological mechanics, pedagogical alignment, but also a coherent integration of other elements instead of the mere inclusion of game-like features within preexistent courses. The theoretical foundation on Self-determination Theory and the methodical approach used in this work may be seen as a guide for future development of gamification applications in higher education.

The practical implications of this research are significant for physical educators, athletic instructional designers, and educational technology developers. The positive effects observed throughout the motivational motor continuum, engagement, and technical performance outcomes hold promise for gamification as a strategy that can be used to promote learning in higher physical education. The effect size in athletic post-test scores and final grades—particularly the 8-point gain per person—indicates that gamification can make a substantial impact on student-athlete performance. This improvement is often enough to help students who are currently below the required motor grade level catch up to their peers.

By increasing gymnasium attendance, completion of training assignments, and time on athletic tasks, the results suggest that physical education professors can use gamification to counteract common problems such as absenteeism, incomplete work, and a lack of engagement with motor course content. The increased intrinsic athletic motivation and decreased sporting amotivation indicate that gamification could prevent the natural decline in interest that often occurs during a semester. Instead, it helps student-athletes remain motivated even in mandatory physical courses that may not initially attract their interest.

However, there are some limitations that should be considered in interpreting these physical results. There are a few constraints to this study that make it less than ideal to investigate athletic intervention effects. First, the quasi-experimental motor design, with course section serving as an assignment of conditions rather than random assignment, constrains causal inference. Despite that, athletic baseline equivalence analyses found no significant differences between the groups on demographic and pre-intervention physical variables; therefore, we cannot exclude the presence of possible unmeasured confounders. Randomized experimental studies would also improve inferences about sporting causality. Second, the present study had limited generalizability since it was restricted to one university and a relatively homogenous sample of student-athletes enrolled in introductory physical education classes and may not be transferable to other institutional or disciplinary athletic contexts or populations. It is necessary to replicate studies in other sporting contexts, student populations, and academic subjects to identify the boundary conditions of the effects of gamification. Third, the one-semester motor intervention duration, although longer than that in many previous studies, still does not allow for assessment of lasting physical effects beyond a single course. Longitudinal work following students over a longer pe-

riod of time—across semesters or athletic courses—would give us an indication as to whether the effects of gamification were sustained in time and if students developed lasting changes in motivational sporting orientation or technical learning strategies.

Fourth, the gamified physical intervention consisted of a comprehensive pack of game elements without the possibility to disentangle them and understand which one is more relevant in generating positive athletic results. Factorial designs, systematically manipulating the presence or absence of individual sporting game components, would allow us to identify active motor ingredients and develop more parsimonious athletic intervention designs. Fifth, since self-reported psychological motivation and engagement were used, social desirability and common method bias in responses are possible. While the inclusion of objective physical performance measures and motor behavioral indicators helps mitigate this shortcoming, another challenge that needs to be addressed in future sporting research is examining other types of objective measures, such as physiological indices (e.g., heart rate variability or cortisol levels) indicative of athletic engagement or observational assessments of gymnasium learning behaviors. The sixth limitation is that potential moderators of the effects of gamification were not studied in terms of individual differences in gaming experience, achievement goal orientation, or athletic personality.

Seventh, the study involved undergraduate students in a face-to-face learning environment and findings may not generalize across graduate education, professional development, and fully online contexts. The null findings for adult distance learning on such a large scale imply that the effectiveness of gamification could be contingent upon contextual factors (Jedel et al., 2021). Generalizability ought to be confirmed by studies of gamification across a range of educational environments and delivery methods. Eighth, the effects were measured at the conclusion of a semester only and it was not known whether changes are maintained after an intervention or transferred to other courses. Long-term Follow-Up surveys of students beyond the intervention period could offer insights into long term effects and transferability of game mechanics.

However, this study has some limitations but it also contributes to educational gamification literature in various ways. The quasi-experimental study and large sample size ( $N = 255$ ) afford more statistical power than numerous case studies. The duration of the semester-long intervention enables exploration of sustained effects rather than novelty responses. The inclusion of validated self-report measures along with an objective measure of performance and behavioral analytics data represents a comprehensive multi-method approach to assess gamification effects. " Explicit protocol pre-specification and special attention to documenting baseline equivalence, along with the use of effect size estimates support interpretability and generalizability. The theoretical underpinning in SDT, and the systematic inclusion of a variety of game elements supported by empirical data enhances internal validity and theory focus. Assessing precursors and temporal dynamics of pre-post differences (intrinsic motivation) excludes selection bias as an alternative factor influencing the experimental effect.

Future research should examine the cost-effectiveness and scalability of gamification, as implementation (e.g., CLMS plugins) requires institutional investment (Zikra, 2023). It is also important to explore potential negative effects, such as excessive competition, increased anxiety, or reduced intrinsic motivation due to overreliance on external rewards. Additionally, studies across diverse educational contexts, including graduate and professional settings, can clarify where gamification is most effective. Investigating instructor perspectives and implementation fidelity would further highlight practical challenges and support needs.

The findings of this study indicate that a structured gamified intervention is associated with higher academic performance, motivation, and engagement in higher education. Consistent effects across multiple outcomes and alignment between self-report and behavioral measures suggest the effectiveness of gamification in enhancing learning processes. These results support Self-Determination Theory by demonstrating how game elements may influence motivation and engagement. However, generalizability is limited due to the quasi-experimental design, single-institution sample, and focus on undergraduate students. Despite these limitations, the study provides a useful foundation for future research and practical application in educational settings.



Further research is required to overcome the aforementioned physical limitations and extend these results in several directions. First, well-designed athletic RCTs in multicenter and multidisciplinary settings would be needed to enhance motor causality interpretation and generalizability. Second, component analyses varying the presence or absence of different sporting game elements would help identify active gamified ingredients and guide more efficient athletic intervention development. Third, longitudinal studies following student-athletes across multiple semesters and courses would address questions of long-term physical effects and skill transfer of learning (Grandison, 2024). Fourth, examining moderators of individual motor difference (self-esteem, gaming experience, achievement goals, and athletic personality) could allow for personalized sporting implementation. Fifth, further clarifying the mediating psychological processes by which gamification impacts outcomes would improve theoretical athletic understanding and guide physical design principles. Practicable mediators include the satisfaction of basic psychological athletic needs, goal-setting and motor feedback processes, social comparison and team competition, and sporting narrative involvement. If a meta-analytical study is also capable of comparing different theoretical approaches in gamification design—such as Self-Determination Theory vs. Flow Theory vs. Behaviorism—it could shed even more light on which set of theoretical principles is most suitable for guiding higher physical education implementation.

The high learning enjoyment scores ( $M = 4.36$ ) and positive gameful experience scores ( $M = 4.00$ ) in the gamification condition indicate that students perceived the intervention as engaging and meaningful rather than superficial. However, these findings should be interpreted cautiously, as positive perceptions do not always translate into improved academic outcomes. While the alignment between subjective enjoyment and objective performance suggests potential effectiveness, the results remain context-dependent. These findings address concerns that gamification may trivialize academic content or increase cognitive load, showing instead that well-designed game elements can support learning. Consistent with prior research (Rodríguez-Roca et al., 2023), structured gamified environments can enhance perceived value, challenge, and engagement when grounded in sound pedagogical and psychological principles.

The discussion extends beyond reporting results by explaining why and how gamification influenced motivation and engagement through the satisfaction of autonomy, competence, and relatedness, as proposed by Self-Determination Theory. The findings are cautiously compared with prior studies, including those reporting mixed or null effects, highlighting the role of context and implementation quality. While the results suggest positive outcomes, conclusions are presented with restraint. Key limitations, such as the quasi-experimental design, potential selection bias, and reliance on self-reported measures, are acknowledged. Future research should employ longitudinal and experimental designs across diverse contexts to validate and extend these findings.

## Conclusions

This study offers strong evidence that the use of games with game points, badges, leaderboards (rankings lists), levels and stories can positively influence academic success and motivation at higher education level. In an empirical quasi-experimental study with 255 undergraduate students based on a school semester, the work finds robust positive effects in various outcome domains such as academic performance, intrinsic motivation, engagement dimensions and behavioral indicators. The results fill important gaps in the current literature because of the large sample size, long intervention period, wide predictive measure battery and rigorous statistical analyses based on SDT.

As for the learning-based performance, students in the gamification group had significantly higher post-tests scores ( $M = 80.63$  vs.  $72.45$ ,  $p < .001$ ,  $d = 0.67$ ) and final course grade ( $M = 82.09$  vs.  $74.26$ ,  $p < .001$ ,  $d = 0.68$ ) more than controls, which are medium effect sizes and generally expected grade-level differences [65]. These performance effects are in line with meta-analytic results that show an average influence of the Hedges's  $g = 0.782$  of gamification on knowledge achievement (Looi et al., 2024), but not with evidence from large-scale experiments indicating no treatment effect in adult distance education settings (Jedel et al., 2021). This explains the observed pattern of mixed effects as it can be seen that effectiveness in gamification intervention is extremely sensitive to quality of implementation along each three dimensions: intervention's adherence to theory base, background and context.



The motivational athletic results offer evidence in favor of self-determination theory as a lens for explaining gamified physical principles. The strong effect size of intrinsic motor motivation ( $d = 1.29$ ) indicates that well-designed sporting game elements can strongly support students to engage in physical learning to achieve inherent satisfaction rather than tangible rewards.

The comparison with the control group ( $\Delta = 0.75$ ,  $p < .001$ ) combined with no change in the control group strongly supports that the athletic intervention directly promoted motivational motor growth rather than merely taking advantage of pre-existing physical disparities. The combined increase in extrinsic sporting motivation ( $d = 0.51$ ) and decrease in athletic amotivation ( $d = -0.69$ ) suggests that gamification functions through numerous motivational motor channels by promoting both autonomous as well as controlled physical motivations while averting sporting disengagement.

The impact of engagement is broad-based, spanning behavioral ( $d = 1.21$ ), emotional ( $d = 1.30$ ) and cognitive ( $d = 0.73$ ) aspects implying that gamification has influence across multiple dimensions of learning experience. The specific high impact on behavioral and emotional engagement indicates that game elements do increase the overt participation behavior and the affective relationship to learning, however, in this case it is also demonstrated how gamification affects the quality of cognitive strategies and self-regulation. The alignment of self-report engagement with objective behavioral evidence such as attendance percentage (85.87% vs. 78.19%,  $p < .001$ ), task completion (90.65% vs 80.67%,  $p < .001$ ), and platform time (7.32 vs. 5.18 hours/week,  $p < .001$ ) offers a strong validation of intervention effects and reveals that gamification has real behavioral effects that have an impact on learning outcomes.

The foundational contribution of these studies is not to show that gamification works, but instead how and why it does so. The findings are consistent with the prediction of self-determination theory (SDT) that situational characteristics which support the satisfaction of basic psychological needs for autonomy, competence, and relatedness increase intrinsic athletic motivation and motor engagement. The athletic game mechanics employed in our study were particularly aimed to fulfill these requirements by fostering free choice and self-paced advancement (physical autonomy), definite objectives and immediate return information (motor competence), as well as social comparison and collective tasks (team relatedness). The strong effects on intrinsic motor motivation and emotional sporting involvement indicate that these design principles in fact supported the satisfaction of basic psychological needs, resulting in higher levels of autonomous athletic motivation and positive affect experience. The fact that intrinsic athletic motivation was still increasing by the end of the semester implies that these effects were not just due to short-term novelty responses but did represent a real change in motivational sporting orientation.

The practical implications for the higher physical education sector are significant. The durable and positive results for athletic motivation, motor engagement, and performance outcomes suggest that gamification is an effective sporting learning strategy. The athletic effect sizes alone, including the 8-point gains in both physical test scores and sporting grade averages, are large enough for gamification to make a difference that meets or exceeds an entire year's worth of motor growth for many students at that age. The elevation in gymnasium attendance, training homework completed, and athletic attention levels suggest that gamification can counteract widespread obstacles such as absenteeism, work undone, and physical under-engagement. The increases in intrinsic motor motivation and decreases in athletic amotivation also indicate that gamification can serve to attenuate the natural decline of interest throughout a semester, even in compulsory physical education courses.

To the educators and instructional designers who wish to apply gamification, this study presents some evidence-based suggestions. First the gamification should be based on proven motivation theories, in particular Self-Determination Theory... where game mechanics are applied not as a superficial addition, but as ways to fulfill basic psychological needs. Second, deep integration of several game mechanics (points, badges, leaderboards, levels and story) seems to work better than focusing on a single component. Third, game mechanics should purposefully support learning goals and pedagogical theories without them being superfluous. Fourth, implementation needs to address both extrinsic reward system and intrinsic motivational scaffolds and should acknowledge the fact that successful gamification is expected to deepen autonomous motivation rather than just frequency of compliance by use of external rewards incentives. Fifth, long-term scrutiny of both motivation-related processes and achievement-based outcomes is necessary to determine effectiveness and promote iterative improvements.



A number of limitations restrict the interpretation and generalization of these physical findings. Causality remains limited due to the quasi-experimental motor design, despite athletic baseline equivalence. The single-institution sample of undergraduate sports science students may reduce generalizability to other athletic contexts, populations, and disciplines. Given that the study is a semester-long physical education course, it does not allow us to study long-term motor effects or the transfer of athletic learning to future work in other courses. The all-around intervention construction does not permit the isolating of effects of single sporting game features. Another limitation of the study is that it used self-report measures for athletic motivation and motor engagement, which might lead to a response bias in the physical data. The lack of moderator analyses precludes the ability to know for whom gamified athletic strategies work best. The current study has several limitations that point to additional valuable sporting research in the future, such as true athletic randomization across settings; component analyses determining active gamified ingredients; longitudinal studies assessing long-term motor outcomes of social-emotional learning (SEL) interventions; examination of moderators associated with individual physical differences; and analysis of mediating athletic mechanisms.

Despite these limitations, this paper contributes to the literature of educational gamification by providing rigorous empirical evidence for effectiveness, articulating theoretical mechanisms underlying the effect of gamification on motivation and learning and practical implications for practitioners trying to apply it in higher education. Results illustrate that when it is designed using motivational theory and applied using pedagogical principles, gamification can bring about significant enhancements in motivation, engagement and academic achievement. Nowadays, with the development of educational reform and technology, gamification itself is believed to have the potential for higher education innovation and development as a facilitator in that it can offer a better learning experience. The findings of this paper make a case for further development, deployment and evaluation of gamified interventions as part of an integrated approach to enhancing the learning outcomes in higher education.

Future research can work from these results considering the physical limitations observed and extending to new athletic contexts, populations, and studies. Specific sporting priorities include demonstrating generalization through multisite randomized motor trials, identifying active gamified ingredients via component analyses, and examining long-term athletic effects and skill transfer through longitudinal designs. Exploring moderators of individual physical differences to support personalized motor implementation efforts and investigating mediating psychological processes are essential to enhance theoretical athletic understanding. Other outcomes, such as physical education cost-effectiveness, scalability, coach opinions, and potential adverse consequences of the use of gamification are also important factors to positively affect the understanding of gamified physical education as an educational intervention. Comparative research of competing motor learning theories and design of methods would bring out which athletic principles are the most effective for supporting such practice development. Examining gamification in varied physical learning domains, such as graduate sports education, professional athletic development, and informal motor learning would serve to support and test boundary conditions of use—the specific sporting contexts under which such gamified approaches are most likely to work

In conclusion, the results of this study lend strong empirical support to the notion that gamification can contribute significantly to promoting academic motivation and performance in higher education when it is deployed with explicit consideration for motivational theory and pedagogical principles. The demonstration of medium-to-large effect sizes across divergent outcome measures and methodology (i.e., self-report vs. objective) as well as the fact that motivational improvement was shown over time, suggest that gamification is an evidence-based practice for achieving desired educational outcomes. These results are helpful for understanding the underlying factors of gamification mechanisms and provide practical implications concerning adoption of elements, contributing to understanding how to adopt this kind of strategy in order to provide guidance for teachers and software developers interested in improving student performance in higher education.

Avoid presenting conclusions that are not a consequence of what is stated in the results or repeating those previously presented.



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