Journal of Teaching Physical Education in Elementary School

Journal homepage: https://ejournal.upi.edu/index.php/tegar/index

# Effects of Roblox-Based Gamification on Elementary Students' Physical Activity: A Quasi-Experimental Study

*Yusuf Dwi Meirianto*, Teguh Satria, Herdiansyah Herdiansyah, Devtio Dwiwahyudi, Wulan Nurlaela*

Universitas Cipasung Tasikmalaya, Indonesia
*Correspondence: E-mail: yusufdmeirianto@uncip.ac.id

**ABSTRACT**

The decline in physical activity among elementary school students in the digital era highlights the need for innovative approaches to physical education. This study examined the effect of Roblox-based gamification on students' physical activity and active habits. A quasi-experimental design with purposive sampling was applied. Participants included 116 fifth-grade students aged 9-12 years from two elementary schools in South Tangerang, Indonesia. Two private elementary schools in Tangerang Selatan participated in this study, with 60 students from School A and 56 from School B. The intervention was conducted over six weeks (12 sessions). The experimental group engaged in Roblox-based gamified activities, including running, jumping, balance, coordination, and team challenges, while the control group received conventional physical education. Data were collected using the Physical Activity Questionnaire for Children (PAQ-C) and structured observation sheets. Statistical analyses included descriptive statistics, paired-sample t-tests, and independent-samples t-tests. Results showed a significant improvement in physical activity in the experimental group, with PAQ-C scores increasing from 2.61 ± 0.42 to 3.78 ± 0.51, compared to 2.58 ± 0.39 to 2.95 ± 0.46 in the control group. Active habits and student engagement also improved throughout the intervention. These findings indicate that Roblox-based gamification effectively enhances physical activity and promotes active habits in elementary physical education.

**ARTICLE INFO**

***Article History:***
*Submitted/Received April 2026*
*First Revised April 2026*
*Accepted May 2026*
*Publication Date May 2026*

***Keyword:***
Active Habits; Physical Activity; Roblox-Based Gamification.

## INTRODUCTION

The proliferation of digital devices and the entrenchment of screen-based recreational behaviours have contributed to a measurable reduction in habitual physical activity among school-aged children worldwide. Global surveillance data indicate that approximately 41% of children and adolescents currently fail to meet international recommendations for daily moderate-to-vigorous physical activity, generating substantial concern about long-term cardiometabolic, musculoskeletal, and psychosocial health trajectories (Wang et al., 2024). Within this context, conventional physical education models face increasing pressure to demonstrate relevance and effectiveness for a generation of learners whose primary leisure experiences are mediated through interactive digital technologies.

Gamification-broadly defined as the deliberate application of game-design elements, mechanics, and motivational principles within non-game educational settings-has emerged as a potentially powerful pedagogical response to declining student engagement in physical education (Camacho-Sánchez et al., 2023; Ferraz et al., 2024). By embedding features such as mission-based challenges, progress indicators, reward systems, and collaborative competition into instructional activities, gamification aims to satisfy students' psychological needs for autonomy, competence, and relatedness-the foundational conditions identified by Self-Determination Theory as prerequisites for intrinsic motivation and sustained behavioural engagement (Rice, 2025; Sotos-Martínez et al., 2024). Systematic reviews and meta-analytic syntheses consistently report that gamification interventions in educational settings are associated with meaningful improvements in motivation, participation, and physical activity levels (Arufe-Giráldez et al., 2022; Mazéas et al., 2020; Mercan & Selçuk, 2024).

Among contemporary digital platforms, Roblox occupies a distinctive position as both a massively popular gaming environment and a potentially versatile educational medium. The platform's capacity to support collaborative problem-solving, mission-based task completion, and creative engagement within immersive virtual environments has attracted scholarly interest in its educational applications (Hong et al., 2024). When adapted for physical education purposes, Roblox-inspired activities can be restructured around movement objectives-integrating real-world locomotor tasks such as running, jumping, balance, and coordination challenges with digital narrative frameworks that contextualise and motivate physical participation. Prior evidence from exergaming and digital game-based learning research supports the plausibility of this approach: Ketelhut et al. (2022) demonstrated that regular participation in structured exergaming sessions produced significant improvements in elementary school children's physical fitness relative to conventional physical education, while Antonopoulos (2024) documented positive associations between digital gamification and physical activity engagement among school-aged students.

Despite these promising signals, a substantive gap remains in the empirical literature. Existing studies have predominantly examined gamification effects on motivation and short-term engagement rather than sustained physical activity behaviour and the formation of active lifestyle habits (Arufe-Giráldez et al., 2022; Mercan & Selçuk, 2024). Questions also persist regarding the transferability of gamification-induced motivation to habitual physical activity beyond the lesson context-a dimension of critical importance given that childhood physical activity patterns are predictive of adult health behaviour (Navarro-Patón et al., 2024; Wang et al., 2024). Furthermore, research specifically investigating the effectiveness of Roblox-based gamification as a structured instructional strategy within elementary school physical education remains scarce, particularly in the Indonesian educational context (He et al., 2025).

DOI: https://doi.org/10.17509/tegar.v9i2.98976
p- 2797-2038 e- ISSN 2614-5626

The present study was designed to address this gap by examining the effect of a six-week Roblox-based gamification intervention on two complementary outcomes: students' physical activity levels during physical education, as measured by the Physical Activity Questionnaire for Children (PAQ-C), and the development of active lifestyle habits as assessed through structured behavioural observation. By adopting a quasi-experimental design with a matched control group and documenting outcomes across both within-session participation and habitual activity patterns, the study contributes empirical evidence relevant to educators, curriculum designers, and policymakers seeking effective, technology-integrated approaches to elementary school physical education in the digital era.

## METHODS

### Research Design

A quantitative quasi-experimental design incorporating a pretest-posttest control-group structure was adopted to evaluate the effect of Roblox-based gamification on elementary school students' physical activity and active habits. This design permits systematic comparison of pre- and post-intervention outcomes across conditions without requiring full random assignment at the individual level, rendering it well-suited to real-classroom research settings in which logistical and ethical constraints preclude complete randomisation (Cheng et al., 2025). Quasi-experimental designs have been widely applied in physical education gamification research and have demonstrated sufficient internal validity for evaluating behavioural change in student populations (Arufe-Giráldez et al., 2022; Grech, 2024). Effect sizes were calculated using Cohen's d to quantify the practical significance of observed between-group differences, in accordance with current recommendations for educational intervention research (Lakens, 2022).

### Participants

The study population comprised fifth-grade students enrolled during the second semester of the 2023 academic year at two private elementary schools in South Tangerang, Indonesia. A total of 116 students participated: 60 students (27 boys, 33 girls) from Global Islamic School 2 Serpong, which served as the experimental group, and 56 students (24 boys, 32 girls) from Mutiara Harapan Islamic School Bintaro, which constituted the control group. All participants were aged between 9 and 12 years, aligning with the validated age range for the PAQ-C instrument (Makai et al., 2023) and representing a developmental stage characterised by heightened motor learning plasticity and responsiveness to game-based instructional approaches (Camacho-Sánchez et al., 2023).

### Sampling Procedure

Purposive sampling was employed, with participant selection governed by the following inclusion criteria: (1) current enrolment in fifth grade at a school implementing a national standard physical education curriculum; (2) regular attendance in scheduled physical education classes; (3) availability of adequate digital infrastructure at the school to support gamification-based activities; and (4) provision of written parental consent. The two schools were selected on the basis of their comparable physical education curricula, weekly lesson schedules, and instructional time allocations, which minimised the risk that structural differences between groups would confound outcome differences attributable to the intervention. School A was assigned to the experimental condition and School B to the control condition. Purposive sampling is an established and appropriate approach in quasi-experimental physical education research when the objective is to ensure between-group

DOI: https://doi.org/10.17509/tegar.v9i2.98976
p- 2797-2038 e- ISSN 2614-5626

equivalence in participant characteristics and learning context (Hamari et al., 2014; Guan et al., 2024).

**Research Instruments and Materials**

Physical activity was assessed using the Physical Activity Questionnaire for Children (PAQ-C), a validated, self-administered instrument designed to measure moderate-to-vigorous physical activity across multiple domains in school-aged children. The PAQ-C yields scores on a 1-5 scale, with higher values indicating greater physical activity levels. The instrument demonstrates acceptable internal consistency (Cronbach's $\alpha$ = 0.70-0.89) and satisfactory construct validity for use in intervention-based physical education research (Makai et al., 2023). Active habits were assessed through structured observation sheets developed for this study, enabling systematic recording of student engagement across each of the 12 sessions. Physical education equipment (balls, cones, jump ropes, and mats) was used to support movement activities across stations. All data were analysed using IBM SPSS Statistics version 25.

**Data Collection Procedures**

Prior to commencing data collection, the research team coordinated with school administrations, developed Roblox-adapted physical education modules aligned with the national physical education curriculum, and validated all research instruments. A pretest was subsequently administered to establish baseline physical activity levels and active habit profiles across both groups using the PAQ-C and structured observation sheets.

The intervention period extended across six weeks, comprising 12 sessions delivered at a frequency of twice per week, consistent with each school's existing physical education timetable. The experimental group received Roblox-adapted gamified physical education instruction, in which movement tasks-including running, jumping, balance exercises, coordination challenges, and team-based physical missions-were embedded within a digital narrative framework drawing on Roblox game conventions such as missions, levels, and team challenges. All activities were conducted under direct teacher supervision, with structured educational objectives and controlled session durations to minimise risks associated with excessive screen exposure. The control group received standard physical education instruction aligned with the school curriculum, without gamification elements. Student physical activity was monitored through structured observation in each session to verify treatment fidelity. A posttest using identical instruments was administered upon completion of the intervention to quantify within- and between-group changes in physical activity and active habits.

**Data Analysis**

Data were analysed using IBM SPSS Statistics version 25. Descriptive statistics, including means, standard deviations, and gain scores, were computed to characterise the distribution of physical activity and active habit scores at each measurement occasion. Prior to inferential testing, data normality was evaluated using the Kolmogorov-Smirnov and Shapiro-Wilk tests, and homogeneity of variance between groups was assessed using Levene's test. Where parametric assumptions were satisfied, paired-samples t-tests were applied to examine within-group pre-to-post changes, and independent-samples t-tests were used to assess between-group differences in improvement. Where normality was violated, the Wilcoxon signed-rank test and Mann-Whitney U test were employed as non-parametric alternatives. A

DOI: https://doi.org/10.17509/tegar.v9i2.98976
p- 2797-2038 e- ISSN 2614-5626

significance threshold of α = 0.05 was applied throughout. Cohen's d was calculated to quantify effect magnitude for all significant comparisons (Lakens, 2022).

## RESULTS

### Physical Activity (PAQ-C)

Table 1 presents the descriptive statistics for PAQ-C scores in both groups across the pretest and posttest measurement occasions. The experimental group demonstrated a mean increase of 1.17 points across the intervention period, from 2.61 ± 0.42 at pretest to 3.78 ± 0.51 at posttest. The control group recorded a substantially smaller gain of 0.37 points, rising from 2.58 ± 0.39 to 2.95 ± 0.46. The two groups were approximately equivalent at baseline, confirming pretest comparability.

**Table 1**. PAQ-C Scores: Pretest, Posttest, and Gain Scores by Group

| Group | Pretest Mean ± SD | Posttest Mean ± SD | Gain Score |
|---|---|---|---|
| Experimental (n = 60) | 2.61 ± 0.42 | 3.78 ± 0.51 | 1.17 |
| Control (n = 56) | 2.58 ± 0.39 | 2.95 ± 0.46 | 0.37 |

Independent-samples t-test results confirmed a statistically significant between-group difference in posttest PAQ-C scores ($p < 0.05$), indicating that the Roblox-based gamification intervention produced meaningfully greater physical activity gains than conventional instruction. The substantially larger gain score in the experimental group (1.17 vs. 0.37) further substantiates the superior impact of the gamification condition

### Active Habits

Corresponding improvements in active lifestyle habits were recorded alongside the PAQ-C results. As shown in Table 2, the experimental group's mean active habit score increased from 2.74 ± 0.44 to 3.65 ± 0.49 (gain = 0.91), compared with a more modest increase from 2.69 ± 0.41 to 2.97 ± 0.45 in the control group (gain = 0.28). These results indicate that participation in Roblox-based gamified physical education was associated not only with higher within-lesson physical engagement but also with broader improvements in students' habitual active behaviour extending beyond the formal lesson context.

**Table 2.** Active Habit Scores: Pretest, Posttest, and Gain Scores by Group

| Group | Pretest Mean ± SD | Posttest Mean ± SD | Gain Score |
|---|---|---|---|
| Experimental | 2.74 ± 0.44 | 3.65 ± 0.49 | 0.91 |
| Control | 2.69 ± 0.41 | 2.97 ± 0.45 | 0.28 |

### Session-by-Session Engagement Observations

Structured observational data collected across all 12 sessions revealed a progressive increase in student engagement in the experimental group throughout the intervention. Active engagement levels rose from 62% in Sessions 1-3 to 91% by Session 12, indicating a sustained and accelerating trajectory of participation as students developed familiarity with the gamification format. In contrast, the control group's engagement level increased only marginally over the same period, from approximately 60% to 67%. This pattern suggests that the motivational structures embedded within Roblox-based gamification, including mission progression, team challenges, and reward mechanisms, were effective in sustaining and

DOI: https://doi.org/10.17509/tegar.v9i2.98976
p- 2797-2038 e- ISSN 2614-5626

amplifying student engagement over the duration of the intervention, rather than producing a novelty effect that attenuated over time.

## DISCUSSION

### Gamification and Physical Activity Enhancement

The results of this study provide clear empirical support for the effectiveness of Roblox-based gamification in enhancing physical activity levels among elementary school students. The substantially larger PAQ-C gain score recorded in the experimental group relative to the control group (1.17 vs. 0.37) confirms that integrating Roblox-inspired game mechanics into physical education lessons produces qualitatively different motivational and behavioural outcomes compared with conventional instruction. These findings are consistent with systematic review evidence indicating that game-design features such as challenge systems, progressive difficulty levels, and reward structures reliably increase student motivation and active participation in physical education contexts (Camacho-Sánchez et al., 2023; Arufe-Giráldez et al., 2022).

The mechanism underlying these improvements aligns with the predictions of Self-Determination Theory (Sotos-Martínez et al., 2024). By situating physical tasks within structured, goal-directed narrative frameworks, Roblox-based activities appear to have fulfilled students' psychological needs for competence (through achievable mission objectives and visible progress), autonomy (through choice and collaborative decision-making within team challenges), and relatedness (through shared physical missions). These conditions collectively strengthen intrinsic motivation and reduce reliance on external compulsion as the primary driver of participation-a dynamic documented across gamification contexts by Rice (2025) and Ferraz et al. (2024).

### Active Habit Formation and Behavioural Transfer

Particularly notable is the improvement observed in the active habits dimension, which extended beyond lesson participation to encompass students' broader daily physical behaviour. The experimental group's active habit gain score (0.91) substantially exceeded that of the control group (0.28), suggesting that the motivational gains produced by gamification were not confined to the structured lesson environment but contributed to more generalised shifts in students' activity-related attitudes and routines. This finding is particularly significant given the established relationship between childhood physical activity patterns and adult health outcomes: interventions that succeed in shaping active habits during the elementary school years may generate cumulative health benefits extending well into adulthood (Navarro-Patón et al., 2024; Wang et al., 2024). Zhang et al. (2025) similarly found that gamified learning environments producing strong need-satisfaction experiences were associated with sustained engagement that persisted beyond the immediate intervention context, suggesting a plausible mechanism for the habit formation observed in the present study.

### Progressive Engagement Across Sessions

The session-by-session observational data reveal an important pattern: student engagement in the experimental group increased progressively throughout the intervention rather than exhibiting the attenuating novelty effect that sometimes characterises digital technology interventions. Engagement rose from 62% in the initial sessions to 91% by Session 12, indicating that the motivational architecture of the gamification design, with escalating challenges, team-based missions, and iterative reward structures, was sufficiently dynamic to maintain and amplify participation over time. This trajectory is consistent with Guan et al.

DOI: https://doi.org/10.17509/tegar.v9i2.98976
p- 2797-2038 e- ISSN 2614-5626

(2024), who identified sustained engagement as a hallmark of well-designed game-based learning interventions, and with Dartini et al. (2024), who documented that embedding physical activity within contextually meaningful game structures fosters deeper student involvement than decontextualised drills. The stability and gradual growth of engagement across 12 sessions also supports the feasibility of Roblox-based gamification as a scalable component of routine physical education programming.

**Limitations and Future Directions**

Several limitations of this study should inform the interpretation and generalisation of its findings. The sample was restricted to two schools in a single urban district, limiting the representativeness of the findings across different socioeconomic, cultural, and educational contexts. The six-week intervention window, while adequate for detecting short-term effects, does not permit conclusions about the durability of observed gains; follow-up assessments at three and six months post-intervention would be required to establish whether improvements in physical activity and active habits persist after the withdrawal of gamification stimuli. Reliance on the PAQ-C as the primary physical activity measure introduces the potential for self-report bias among younger students; future studies should supplement questionnaire data with objective measures such as accelerometry. Furthermore, contextual variables including students' home environment, access to digital devices outside school, and parental supervision of technology use were not controlled and may have introduced unaccounted variability in active habit outcomes. Future investigations should address these limitations by incorporating larger, geographically diverse samples, longer intervention durations, objective physical activity monitoring, and multi-informant outcome assessment. Comparative studies examining the relative effectiveness of Roblox-based versus other digital gamification platforms-as well as investigations of optimal screen-time dosage and supervision protocols-would further strengthen the evidence base for technology-integrated elementary physical education.

## CONCLUSION

This study demonstrates that a six-week Roblox-based gamification intervention significantly enhances physical activity levels and active lifestyle habits among elementary school students relative to conventional physical education instruction. The experimental group recorded meaningfully larger improvements in PAQ-C scores, active habit ratings, and observed lesson engagement across all 12 intervention sessions, with engagement increasing progressively from 62% to 91% over the intervention period. These results confirm that Roblox-inspired game mechanics, when embedded within structured, teacher-supervised physical education activities with clear educational objectives, can effectively mobilise the motivational conditions necessary for sustained and growing student participation in movement-based learning. Roblox-based gamification accordingly represents a viable and innovative instructional approach for elementary school physical education in the digital era, with implications for both lesson design and broader curriculum development.

## IMPLICATION

The findings carry practical implications across multiple stakeholder groups. For physical education teachers, Roblox-based gamification offers a structured, replicable framework for creating student-centred learning environments that increase active participation and reduce the disengagement commonly observed in conventional lesson formats. Mission-based challenges, reward mechanisms, and collaborative physical tasks can be integrated into

DOI: https://doi.org/10.17509/tegar.v9i2.98976
p- 2797-2038 e- ISSN 2614-5626

existing curriculum frameworks without requiring wholesale instructional redesign, provided that screen use is appropriately supervised and bounded by explicit movement objectives.

For school administrators and curriculum developers, the results provide empirical justification for investing in digital infrastructure and teacher training that enables gamification-based physical education delivery. Policy frameworks should nonetheless include clear guidance on screen-time management and the primacy of real-world movement over digital engagement, ensuring that technology serves as an enabling medium rather than a substitute for physical activity itself. Parents and caregivers represent a further important constituency: their active support for balanced digital engagement and active lifestyle habits at home would reinforce and extend the gains achieved within the school setting.

Theoretically, this study enriches the growing evidence base on gamification in physical education by providing experimental evidence for the effectiveness of a specific, commercially available platform-Roblox-in an elementary school context, and by documenting improvements in both within-lesson physical activity and broader active habit formation. These contributions position Roblox-based gamification as a productive focus for future intervention research, comparative platform studies, and longitudinal investigations of technology-mediated physical activity promotion in childhood.

## AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

## REFERENCES

Antonopoulos, N. (2024). Digital gamification and physical activity of students. *IOSR Journal of Sports and Physical Education*, *11*(6), 46–59. https://doi.org/10.9790/6737-1106014659

Arufe-Giráldez, V., Sanmiguel-Rodríguez, A., Ramos-Álvarez, O., & Navarro-Patón, R. (2022). Gamification in physical education: A systematic review. *Education Sciences*, *12*(8), Article 540. https://doi.org/10.3390/educsci12080540

Camacho-Sánchez, R., Manzano-León, A., Rodríguez-Ferrer, J. M., Serna, J., & Lavega-Burgús, P. (2023). Game-based learning and gamification in physical education: A systematic review. *Education Sciences*, *13*(2), Article 183. https://doi.org/10.3390/educsci13020183

Cheng, J., Lu, C., & Xiao, Q. (2025). Effects of gamification on EFL learning: A quasi-experimental study of reading proficiency and language enjoyment among Chinese undergraduates. *Frontiers in Psychology*, *16*, Article 1448916. https://doi.org/10.3389/fpsyg.2025.1448916

Dartini, N. P. D. S., Sutajaya, I. M., Suja, I. W., & Astawa, I. B. M. (2024). Representation of tri hita karana in megoak-goakan game and its implementation in physical education. *Jurnal Ilmu Keolahragaan*, *7*(2), 149–161. https://doi.org/10.26418/jilo.v7i2.88572

Ferraz, R., Ribeiro, D., Alves, A. R., Teixeira, J. E., Forte, P., & Branquinho, L. (2024). Using gamification in teaching physical education: A survey review. *Montenegrin Journal of Sports Science and Medicine*, *20*(1), 31–44. https://doi.org/10.26773/mjssm.240304

Grech, E. M. (2024). *Gamification: A marketing strategy - Empirical investigations in the context of physical activity* [Doctoral dissertation, University of Malta]. University of Malta Library. https://www.um.edu.mt/library/oar/handle/123456789/119634

Guan, X., Sun, C., Hwang, G. J., Xue, K., & Wang, Z. (2024). Applying game-based learning in primary education: A systematic review of journal publications from 2010 to 2020.

*Interactive Learning Environments*, *32*(2), 534–556. https://doi.org/10.1080/10494820.2022.2091611

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? A literature review of empirical studies on gamification. In *Proceedings of the 47th Hawaii International Conference on System Sciences* (pp. 3025–3034). IEEE. https://doi.org/10.1109/HICSS.2014.377

He, H., Yang, Y., Sun, J., Wang, F., Zhang, W., & Zhu, F. (2025). Effects of school-based physical activity on academic achievement in children and adolescents: A systematic review and meta-analysis. *Frontiers in Public Health*, *13*, Article 1651883. https://doi.org/10.3389/fpubh.2025.1651883

Hong, S., Eom, T., & Park, J. (2024). Exploratory study on the learning activities data in virtual worlds through a scoping literature review: Focusing on Roblox. *The Journal of Educational Information and Media*, *30*(3), 861–884. https://doi.org/10.15833/kafeiam.30.3.861

Ketelhut, S., Röglin, L., Martin-Niedecken, A. L., Nigg, C. R., & Ketelhut, K. (2022). Integrating regular exergaming sessions into a school setting increases physical fitness in elementary school children: A randomized controlled trial. *Journal of Clinical Medicine*, *11*(6), Article 1570. https://doi.org/10.3390/jcm11061570

Lakens, D. (2022). Sample size justification. *Collabra: Psychology*, *8*(1), Article 33267. https://doi.org/10.1525/collabra.33267

Makai, A., Prémusz, V., Dózsa-Juhász, O., Fodor-Mazzag, K., Melczer, C., & Ács, P. (2023). Examination of physical activity patterns of children, reliability and structural validity testing of the Hungarian version of the PAQ-C questionnaire. *Children*, *10*(9), Article 1547. https://doi.org/10.3390/children10091547

Mazéas, A., Duclos, M., Pereira, B., & Chalabaev, A. (2020). *Does gamification improve physical activity? A systematic review and meta-analysis*. Center for Open Science. https://doi.org/10.17605/OSF.IO/X2483

Mercan, G., & Selçuk, Z. V. (2024). Investigating the impact of game-based learning and gamification strategies in physical education: A comprehensive systematic review. *Journal of Interdisciplinary Education: Theory and Practice*, *6*(1), 1–14. https://doi.org/10.47157/jietp.1389843

Navarro-Patón, R., Rodríguez-Negro, J., Muíño-Piñeiro, M., & Mecías-Calvo, M. (2024). Gender and educational stage differences in motivation, basic psychological needs and enjoyment: Evidence from physical education classes. *Children*, *11*(12), Article 1503. https://doi.org/10.3390/children11121503

Rice, J. (2025). *The effect of a gamified motor skill intervention on emotional intelligence in 9-10-year-old disadvantaged primary school children* [Doctoral dissertation, Liverpool John Moores University]. https://researchonline.ljmu.ac.uk/id/eprint/27654

Sotos-Martínez, V. J., Ferriz-Valero, A., García-Martínez, S., & Tortosa-Martínez, J. (2024). The effects of gamification on the motivation and basic psychological needs of secondary school physical education students. *Physical Education and Sport Pedagogy*, *29*(2), 160–176. https://doi.org/10.1080/17408989.2022.2039611

Wang, K., Li, Y., Liu, H., Zhang, T., & Luo, J. (2024). Can physical activity counteract the negative effects of sedentary behavior on the physical and mental health of children and adolescents? A narrative review. *Frontiers in Public Health*, *12*, Article 1412389. https://doi.org/10.3389/fpubh.2024.1412389

Zhang, H., Li, F., & Yan, H. (2025). Causal mechanisms of the psychological needs for online gamified learning and the impact on learning engagement among college students.

*Interactive Learning Environments*, *33*(3), 2597–2618. https://doi.org/10.1080/10494820.2024.2412088

DOI: https://doi.org/10.17509/tegar.v9i2.98976
p- 2797-2038 e- ISSN 2614-5626