frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 21 October 2025
DOI 10.3389/feduc.2025.1531651

OPEN ACCESS

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RECEIVED 20 November 2024
ACCEPTED 16 September 2025
PUBLISHED 21 October 2025

CITATION
Ezeddine G, Souissi N, Abaidia R, Masmoudi L, Trabelsi K, Ammar A, Jahrami H, Husain W, Tannoubi A, Kurnaz M, Altınkök M and Mrayah M (2025) Game-based physical education: a pathway to increased student motivation and greater learning outcomes.
Front. Educ. 10:1531651.
doi: 10.3389/feduc.2025.1531651

Game-based physical education: a pathway to increased student motivation and greater learning outcomes

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Purpose: The aim of this study was to examine the effects of game-based learning (GBL) on students' motivation and academic performance in physical education.

Methods: Over a five-week period, a total of 51 first-year secondary school students in Tunisia (mean age = 15.0 ± 0.1 years, 50% female) were randomly assigned to an experimental group (EG) or a control group (CG). The EG received physical education instruction through a GBL approach, while the CG followed conventional, teacher-centered instruction. Learning outcomes were evaluated through Learning Time Analysis System video analysis at T0 (pre-intervention), T1 (mid-intervention), and T2 (post-intervention). Motivation was assessed pre- and post-intervention using the Situational Motivation Scale.

Results: Compared to the CG, the EG had significantly higher levels of identified regulation (5.42 ± 1.68 at T0 and 5.7 ± 0.92 at T2 for the EG vs. 4.4 ± 1.12 at T0 and 4.23 ± 1.85 at T2 for CG; $p < 0.001$; $\eta_p^2 = 0.26$) and intrinsic motivation (5.52 ± 1.61 at T0 and 5.32 ± 1.37 at T2 for EG vs. 3.29 ± 1.34 at T0 and 4.37 ± 2.13 at T2 for CG; $p < 0.001$; $\eta_p^2 = 0.28$). The EG also improved academic performance through improved motor engagement (50.7 ± 42.3 at T0 to 81.3 ± 20.2 at T1, to 131.4 ± 2.7 at T2; $p < 0.001$; $\eta_p^2 = 0.346$) and reduced waiting time (82.9 ± 2.9 at T0 to 57.5 ± 3.5 at T1 and 50.3 ± 2.1 at T2; $p < 0.001$; $\eta_p^2 = 0.90$) at both middle and post-intervention which was not always the case in the CG.

Conclusion: GBL significantly improved students' motivation and engagement in physical education relative to conventional instruction. While these findings support the use of GBL as an effective pedagogical approach, the relatively small sample size suggests the need to replicate the study with larger and more diverse student populations, while also examining the long-term impact of GBL on skill retention and academic outcomes across different educational environments.

KEYWORDS

play, academic performance, secondary school, motor engagement, active learning, motivation

Introduction

For decades, physical education (PE) has largely relied on conventional, teacher-centered instruction, where the teacher serves as the primary source of knowledge and students are positioned as passive recipients (Gill and Kusum, 2017). In such approaches, learners are viewed as having "knowledge gaps" that must be filled through direct knowledge transmission (Gill and Kusum, 2017; Novak, 2010). While this method can effectively deliver information, it often limits active participation, engagement, and autonomy, leading to reduced motivation and less meaningful learning experiences (Bi et al., 2019; Emaliana, 2017).

In response to these limitations, innovative pedagogical strategies have emerged to create more dynamic, student-centered environments. Among them, game-based learning (GBL) has gained prominence for its capacity to enhance motivation, engagement, and skill acquisition (Bodsworth and Goodyear, 2017; Fernandez-Rio et al., 2020; Anane, 2024). Jääskä et al. (2022) show that GBL uses actual games or structured play activities to teach concepts and develop skills, fostering an enjoyable and interactive learning atmosphere that contrasts with the passivity often associated with traditional methods. Additionally, Zin et al. (2009) define GBL as the integration of games into learning and development processes, incorporating key elements such as complexity, decision-making, rules, enjoyment, and unpredictability (Chouinard and Archambeault, 2010; Alcaraz-Muñoz et al., 2020). Classroom applications can take various forms, including serious games, instructional games, reward-based activities, and computer-based games (Taub et al., 2019). It is important to distinguish GBL from gamification, a concept often confused with it. While GBL uses games directly to achieve learning objectives (Camacho-Sánchez et al., 2023), gamification applies game-like elements (e.g., points, badges, and leaderboards) in non-game contexts to enhance motivation without employing actual games (Khoshnoodifar et al., 2023). In the present study, GBL refers specifically to structured physical game scenarios designed to meet PE learning goals.

Games not only foster engagement but also support comprehension and knowledge retention. They help make content more meaningful and connected to real-life situations, while developing transferable skills such as collaboration, problem-solving, and decision-making (Jääskä and Aaltonen, 2022; Jarrett and Light, 2019). These cognitive benefits are closely connected to GBL's role in enhancing student motivation by creating captivating and participatory learning environments (Alotaibi, 2024). Motivational features such as setting clear expectations, allowing mistakes, and providing timely, relevant feedback encourage persistence in diverse and authentic learning contexts (Adipat et al., 2021; Chouinard and Archambeault, 2010). The GBL effectiveness has been demonstrated across disciplines such as mathematics, physics, history, and language (Easterday et al., 2016; Kim and Ke, 2017; Letsa-Agbozo et al., 2023). Given that student motivation is a critical predictor of academic success and engagement (Yu et al., 2021; Papastergiou, 2009), GBL, through its interactive and playful nature, promotes intrinsic motivation in a challenging yet rewarding learning environment (Kiili, 2005; Ab Jalil et al., 2020; Hwang and Wu, 2012).

According to the Self-Determination Theory (SDT), developed by Deci and Ryan (1985), intrinsic motivation stems from three fundamental psychological needs, including autonomy, competence, and relationships. Motivation is classified into intrinsic (driven by enjoyment), extrinsic (driven by external rewards or pressures), and amotivation (a lack of motivation). These distinctions help in analyzing how GBL activates various motivational processes (Ryan and Deci, 2000; González-Cutre et al., 2020). Recent studies in educational psychology and PE show that GBL supports these three psychological needs by offering meaningful choices, setting clear goals, and encouraging cooperation (Camacho-Sánchez et al., 2023; Behzadnia et al., 2025). These elements promote intrinsic motivation and identified regulation, which are two forms of self-determined motivation (Vansteenkiste et al., 2020; Moreno-Murcia and Sánchez-Latorre, 2015; Abós et al., 2021).

In PE, GBL allows educators to integrate physical activity with academic goals, emphasizing the development of motor skills and reducing inactive time during sessions (Dyson et al., 2004). Previous studies have noticed this pattern, highlighting the importance of adapting GBL approaches to maximize motor engagement in PE (Vidoni et al., 2014; Wang et al., 2010). However, PE research must move beyond motivation to assess practical outcomes such as movement quality and session flow (Kirk, 2009). Existing studies suggest that GBL's impact on PE-specific metrics (e.g., skill retention, equitable participation) still requires further empirical validation (Sameeran et al., 2024).

Despite these established benefits, the implementation of GBL in PE remains limited (Alotaibi, 2024). Research by Casey (2014) and Alotaibi (2024) shows that PE teachers rarely adopt GBL methods. Nevertheless, the discipline could greatly benefit from applying GBL principles to improve motivation and learning outcomes, increase motor engagement, and optimize classroom management. Therefore, it is essential to conduct thorough research to better understand and implement this approach in PE contexts.

The purpose of this study is to investigate the impact of GBL on the motivation and academic PE performance of first-year secondary school students. We hypothesize that GBL would positively affect motivation and academic learning outcomes in PE.

Method

Participants

This study involved 51 students aged 15 to 16 years (mean age = 15 ± 0.1 years) enrolled in their first year of secondary education in Tunisia. Participants were randomly selected using a hazard randomization procedure. Students were excluded if they were repeating the academic year, engaged in extracurricular handball activities, or absent from any of the intervention sessions. The experimental group consisted of 28 students (14 boys and 14 girls) who received instruction through a GBL approach, whereas the control group consisted of 23 students (10 boys and 13 girls) who were taught using a conventional teacher-centered approach.

In Tunisia, the official PE curriculum for students aged 15 to 16 years emphasizes the acquisition of basic technical skills (passing, dribbling, shooting, and defending in handball), understanding tactical principles through small-sided games, and developing cooperation and decision-making. These objectives framed the intervention design and ensured ecological validity.

In Tunisia, official handball PE programs (for students aged 15 to 16) emphasize the acquisition of basic technical skills (passing, dribbling, shooting, and defense), the understanding of tactical principles and the development of cooperation (Figure 1).

Procedure

Before the experiment began, participants were thoroughly informed about the equipment and experimental procedures to foster a positive and supportive learning environment. This initial step was crucial to familiarize students with the setup and to mitigate any anxiety related to the presence of cameras and observers. To reduce the potential influence of the observer effect, researchers conducted one week of test recordings. This preliminary filming helped students

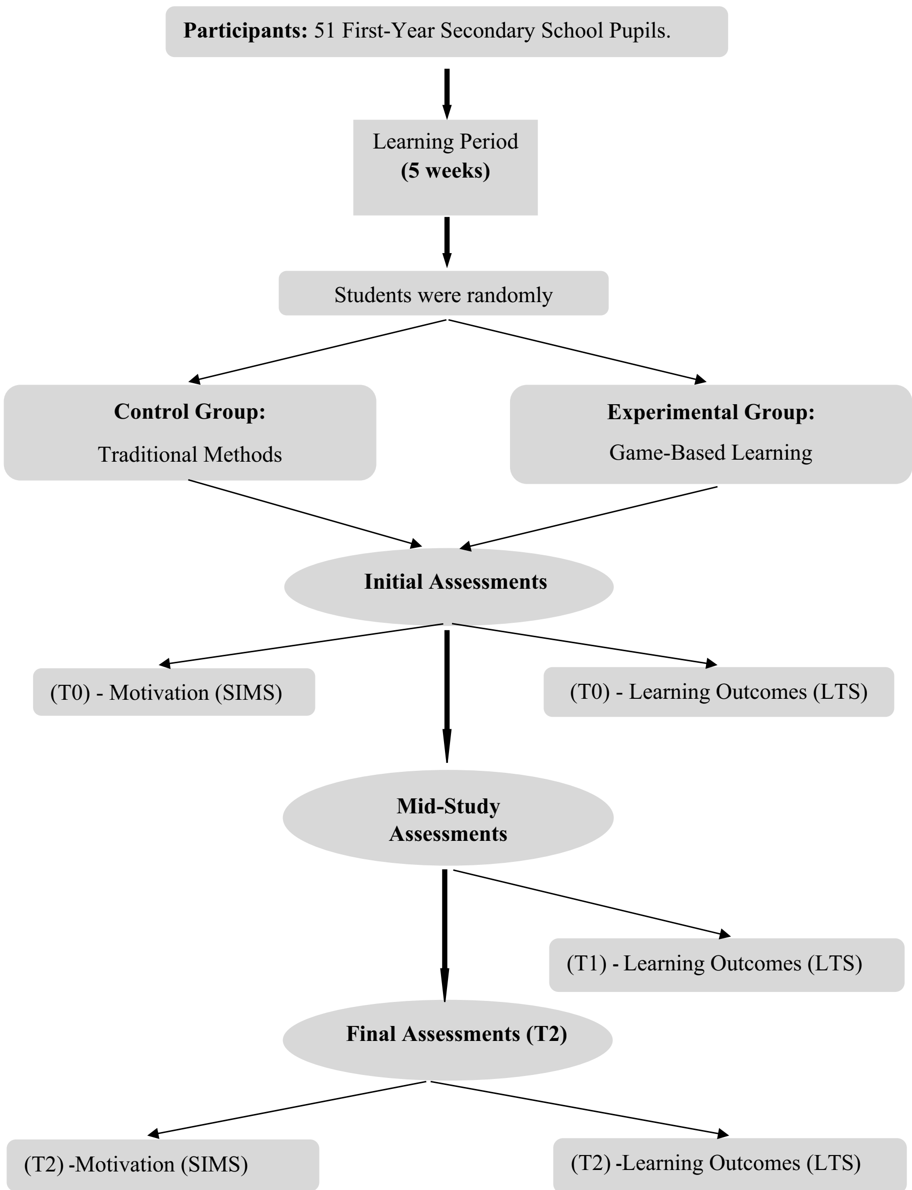

FIGURE 1
Flow diagram of the study.

acclimate to the recording environment, minimizing behavioral changes during the main sessions. To ensure the effective application of the GBL approach, the PE teacher assigned to the experimental group participated in a targeted training program prior to the intervention. This training consisted of 10 h of instruction and practical workshops, delivered by two members of the research team with expertise in pedagogical innovation and GBL methodology. The training covered core GBL principles, the design and structuring of learning games, integration of learning objectives into play, and methods for promoting autonomy, feedback, and active student engagement. The instructional cycle lasted five weeks and consisted of ten PE sessions, held twice weekly in the mornings from 8:00 a.m. to 9:00 a.m. Each session lasted 50 min and was structured around a specific learning objective to ensure clarity and targeted instruction.

Participants were randomly assigned to one of two groups. As detailed in Tables 1, 2, the experimental group received instruction based on a GBL method, which encourages active participation through play. In contrast, the control group was taught using conventional methods as typically applied in this school context. These methods were characterized by direct instruction, teacher-led demonstrations, and structured drills, with limited opportunities for student interaction. This instructional approach, observed during the study, reflects a traditional, teacher-centered pedagogy widely described in PE literature, where the teacher acts as the primary source of knowledge and learners tend to adopt a more passive role (Ali et al., 2010; Nid and Dakhia, 2021; Metzler, 2017). Throughout the intervention, the teacher followed standardized lesson plans co-developed with the research team to ensure methodological consistency. Additionally, all sessions were video recorded and later analyzed using the Learning Time Analysis System (LTAS) to monitor fidelity to the GBL framework and verify alignment between intended and observed instructional practices.

The LTAS tool was specifically adapted to reflect the objectives of the Tunisian PE handball curriculum. It allowed for analysis of student participation in relation to time spent on technical, tactical, and engagement tasks, thereby aligning observed performance with expected curricular learning outcomes.

To ensure unbiased group formation, participants were individually and randomly allocated to either the experimental or control group using a hazard randomization procedure (Random.org; Haahr, 1998), rather than maintaining their original class groupings. This reallocation was limited exclusively to PE sessions and was conducted with full approval and coordination from the school administration. The re-grouping did not interfere with students' regular academic schedules and was implemented solely during the scheduled PE time slots. This approach allowed for balanced group composition in terms of gender and prior experience and enhanced internal validity by reducing potential biases arising from pre-existing academic or social dynamics within original class groupings. Students in both the experimental and control groups were enrolled in the national Tunisian curriculum, which is traditionally based on conventional, teacher-centered methods of instruction. As a result, participants had no prior exposure to the GBL approach before the start of the study. This absence of familiarity was taken into account in the initial sessions, during which time was allocated to gradually introduce students to the structure and objectives of the GBL methodology. While the lack of prior experience could have influenced students' initial responsiveness to the intervention, it also allowed for a more realistic assessment of the feasibility and motivational impact of implementing GBL as a novel pedagogical method in a typical school setting. All PE sessions were conducted on a handball field measuring 40 meters by 20 meters. Learners completed motivation questionnaires based on the Situational Motivation Scale (SIMS; Guay et al., 2000) both at the beginning and end of the teaching cycle to assess the impact of instructional methods on student motivation. This pre- and post-assessment allowed for evaluation of changes in motivation levels attributable to different teaching methodologies employed.

In addition, activities were videotaped using two cameras to capture the dynamics of each session. These cameras were putted to

TABLE 1 Example of activities for different sessions.

Game-based learning method	Traditional method
T0	T0
Initial cycle assessment	*Initial cycle assessment*
The students engage in a 7 vs. 7 match, spanning the entire HB pitch. Each team strives to outmaneuver their opponents and make their way to the goal to score.	The pitch is divided into four sections. The students are divided into four teams and play 3#3. The winning teams play each other.
T1	T1
middle cycle assessment	*middle cycle assessment*
Situation 1 Students play 3#3 on a quarter of a pitch. They try to surpass members of the opposing team and score in the goal.	Situation 1 The pitch is divided into two parts (lengthways). The exercise is done by cascading and doing broken-arm passes while moving forwards.
Situation 2 Students play 3#4 on a quarter of a pitch. They try to surpass members of the opposing team and score in the goal.	Situation 2 The pitch is divided into two parts (lengthways). The exercise involves cascading and passing with broken arms, followed by slalom dribbling and finally shooting into the goal.
Situation 3 Students play 6#6, with a single goalkeeper, on one half of the pitch. They try to overtake the opposing team and score in the goal.	Situation 3 The work is done on a half-court, with the pupils divided into four groups along the half-court line, passing a ball to each other, dribbling and then shooting toward the goal.
T2	T2
Final cycle assessment	*Final cycle assessment*
The students engage in a 7 vs. 7 match, spanning the entire HB pitch. Each team strives to outmaneuver their opponents and make their way to the goal to score.	Situation 1 The work is done in a half-court. The pupils will take the ball up in threes: the first becomes a passive defender on the six-meter line, the second becomes a goalkeeper and the last dribbles in a slalom, moving away from the defender to shoot toward the goal before changing roles.
	Situation 2
	The students play a half-match of 5#5.

TABLE 2 The teacher's roles in each teaching method.

Aspect	Teacher's role in game-based learning method (Experimental Group)	Teacher's role in conventional method (Control Group)
Pedagogical Position	Facilitator, mediator, and active organizer of engaging learning situations.	Knowledge holder, primary transmitter of content (teacher-centered).
Main Function	Guides students in discovery, encourages interaction, stimulates participation and creativity.	Delivers content via explanations and clear instructions, controls the flow of the lesson.
Interaction with Students	Promotes collaboration, provides immediate feedback, asks open-ended questions, practices active listening.	More limited interaction, mainly instruction delivery and responses to questions, often one-way.
Activity Management	Organizes games and playful activities that foster experimentation and problem-solving.	Conducts sessions focused on lectures, directed exercises, and traditional assessments.
Learning Objectives	Develop autonomy, creativity, intrinsic motivation, and practical skills via experimentation.	Transmit specific knowledge, promote memorization and mastery of targeted content.
Feedback Modalities	Constant, formative feedback embedded within activities (both teacher-to-student and peer feedback).	More formal feedback, often given after exercises, based on corrections and written assessments.
Pedagogical Adaptation	Adjusts activities in real time according to students' responses and needs, encourages group dynamics.	Follows a structured, predetermined lesson plan with less flexibility for immediate student needs.

record all movements and acts of pupils, ensuring complete coverage of the instructional process.

Researchers analyzed recorded sessions with the LTAS grid (Brunelle et al., 1988) to measure individual learning results. A comprehensive examination gave insights into the amount of time students spent in learning activities, allowing researchers to evaluate the efficiency of the GBL method compared to conventional approaches.

The entire study followed the principles of the Declaration of Helsinki. Ethical approval was granted by the Committee for the Protection of Southern People (C. P. P. SUD) in Sfax, Tunisia (Approval ID: 0295/2021).

Data collection and analysis

Motivation questionnaire

The Situational Motivation Scale (SIMS) was used to assess the pupils' situational motivation. This questionnaire measures intrinsic motivation, identified regulation, external regulation, and amotivation. The SIMS has shown strong reliability and validity in the setting of PE (Lonsdale et al., 2011). The questionnaire had 16 items graded on a 7-point Likert scale. Cronbach's alpha was used to determine the internal consistency of the scales. Cronbach's alphas in the current study were 0.810 for intrinsic motivation, 0.860 for identified regulation, 0.827 for external regulation, and 0.748 for amotivation. The questionnaire was handed out individually to participants at the beginning and end of a PE cycle. Participants were asked to respond honestly and informed that their responses would be kept confidential.

Camcorders

Audiovisual data was collected using two Sony camcorders equipped with wireless mics. The recordings were made over the course of five weeks, with three catches for each class at distinct time points (T0, T1, and T2). Two researchers received training on video capturing procedures and techniques. The cameras were positioned diagonally to record the behaviors of the students.

Learning time analysis system (LTAS)

Brunelle et al. (1988) developed the LTAS grid, which was utilized to evaluate the videos. This grid measures individual learning by categorizing observable factors of behaviors in learning contexts. The grid categorizes the numerous types of situations presented to the group by the teacher, as well as the target participant's behavior. Observations and coding of behaviors were carried out at regular intervals (6 s) to assess the quantity and quality of student engagement in the assigned tasks. The observations focused on the sort of circumstance presented to the group (preparatory, knowledge growth, and motor development), as well as the target participant's conduct.

Statistical analysis

Statistical analyses were conducted using SPSS software version 26.0 for Windows (SPSS Inc., Chicago, IL, USA). All data were presented as means ± standard deviations in the text and table. The Shapiro–Wilk test was used to verify the normality of distributions prior to applying parametric tests.

A mixed-design two-way ANOVA with repeated measures was used to examine the interaction between group (Control vs. Experimental) and time. The ANOVA for learning characteristics compared two groups (Control and Experimental) across three time intervals (T0, T1, and T2).

The ANOVA compared two groups (Control and Experimental) at two time points (T0 and T2) to analyze motivational dimensions.

When the ANOVA indicated a significant effect, a Bonferroni post-hoc test was employed to compare specific experimental pairings. An independent or paired student's T-test was employed as necessary. Effect sizes (ES) were computed using partial eta-squared (η_p^2) to evaluate the data's significance and meaning. Lakens (2013) identified small, moderate, and large effect sizes based on η_p^2 values of 0.01, 0.06, and 0.13. All detected differences were considered statistically significant when the probability criterion was $p < 0.05$. For parametric data, Cohen's d was calculated using the "effsize" package (Torchiano and Torchiano, 2020) and interpreted as follows: an effect size between 0.2 and 0.5 was considered small, between 0.5 and 0.8 was considered medium, and greater than 0.8 was considered large (Cohen, 2013).

Results

Learning

For deviant behavior, Table 3 demonstrates that the experimental group showed significantly fewer instances of disruptive behavior than the control group at all three time intervals (T0, T1, and T2; all $p < 0.001$). Both groups demonstrated significant reductions in deviant behaviors at T1 and T2 when compared to T0 ($p < 0.001$). The analysis of variance (ANOVA) showed a significant main effect for group, demonstrating that the teaching method influenced behavior. The analysis revealed a significant main effect for learning. The interaction between group and learning was also significant.

The post-hoc results show that the GBL group revealed significantly less deviant behavior than the control group at (T1) and (T2), with mean differences of 30.54 ($p < 0.001$).

The analysis of variance of two factors with repeated measures showed that appropriate engagement was significantly enhanced by group types, the learning process, and their interaction. The experimental group demonstrated notably higher levels of appropriate engagement at T1 and T2 compared to T0, with all differences being statistically significant ($p < 0.05$). In contrast, the control group experienced a significant decline in appropriate engagement during the same timeframe ($p < 0.05$). At both T1 and T2, the experimental group demonstrated substantially greater levels of appropriate engagement than the control group ($p < 0.05$). An analysis of variance (ANOVA) revealed a significant effect for group, indicating that the teaching method had a substantial impact on engagement. The ANOVA showed a significant impact for learning, suggesting that engagement increased over time. The interaction between group and learning was significant.

The post-hoc test results show that the game-based group had a higher level of engagement than the control group at the middle (T1) and end (T2) of learning sessions ($p < 0.001$).

For waiting time, analysis revealed a significant effect of group, learning and interaction between them. The control group showed significantly longer waiting times at T1 and T2 compared to T0 ($p < 0.001$). In contrast, the experimental group showed a significant decrease in waiting time at both T1 and T2 compared to T0, with all differences being statistically significant ($p < 0.001$). Notably, the experimental group recorded shorter wait times at T2 than at T1 ($p < 0.001$). Furthermore, the experimental group consistently had significantly shorter wait times than the control group at all three time points ($p < 0.001$). Regarding waiting time, analysis of variance (ANOVA) indicated a significant effect for group, suggesting that the instructional method had a profound impact on waiting time. In addition, ANOVA revealed a significant effect for learning and group-learning interaction.

The results of the post-hoc test revealed significant differences between the control group and the GBL group at different points in time for the variable "waiting time." The GBL group was significantly more involved than the control group in the middle (T1) (mean difference = 37.50, $p < 0.001$) and at the end (T2) (mean difference = 55.0, $p < 0.001$). The GBL group showed a significant improvement in engagement from the beginning (T0) to the end (T2) (mean difference = 20.41, $p < 0.001$).

TABLE 3 Comparison of learning variables using two teaching methods in physical education.

Variables	Groups	Means ± SD			Groups Effect			Learning effect			Groups × Learning interaction		
		T0	T1	T2	$F_{(1,49)}$	p	η_p^2	$F_{(1,49)}$	p	η_p^2	$F_{(1,49)}$	p	η_p^2
Deviant behavior	Control group	40.7 ± 15	38.9 ± 11	30.3 ± 11.5#$	96.694	< 0.001	0.668	47.970	< 0.001	0.500	3.702	0.028	0.072
	Experimental group	25.1 ± 3.8*	16.6 ± 4*#	8.3 ± 4.9*#$									
Appropriate engagement	Control group	68 ± 10.9	64.3 ± 10	57.5 ± 5.4#$	47.426	< 0.001	0.497	3.717	0.028	0.072	38.268	<0.001	0.444
	Experimental group	75.6 ± 3.6	73.4 ± 2.2*	80.4 ± 2.6*#									
Waiting time	Control group	82.9 ± 2.9	87.9 ± 3#	97 ± 3.5#$	6408.181	< 0.001	0.993	23.894	<0.001	0.332	477.730	< 0.001	0.909
	Experimental group	57.5 ± 3.5*	50.3 ± 2.1*#	42 ± 1.1*#$									
Motor engagement 2	Control group	14.2 ± 25.7	20.9 ± 19	61.1 ± 33.8#$	108.239	< 0.001	0.346	95.575	< 0.001	0.666	6.731	0.002	0.123
	Experimental group	50.7 ± 42.3*	81.3 ± 20.2*#	131.4 ± 2.7*#$									
Motor engagement 3	Control group	45.9 ± 25.4	40.2 ± 18.9	18 ± 31.8#$	1.166	0.286	0.024	36.933	< 0.001	0.435	2.670	0.074	0.053
	Experimental group	49.5 ± 42.7	36.7 ± 20.9	0.5 ± 1.9#$									
Organized during	Control group	13.1 ± 2.3	12.5 ± 1.3	11 ± 4.2#	112.963	< 0.001	0.702	2.478	0.089	0.049	5.601	0.005	0.105
	Experimental group	16.4 ± 1.4*	16.4 ± 1.2*	16.7 ± 0.6*									

* Significantly different from control group at $p < 0.05$.
# Significantly different from T0 at $p < 0.05$.
$ Significantly different from T1 at $p < 0.05$.

For Motor engagement 2, analysis demonstrates significant effects for the interaction between group and learning, as well as for group and learning.

The "Motor Engagement 2" variable after the *post hoc* analysis shows that the GBL group has much better motor engagement at the halfway point (T1) (mean difference = −30.67, $p < 0.001$) and at the end of the learning session (T2) (mean difference = −80.67, $p < 0.001$) compared to the beginning (T0). This group showed considerably stronger motor engagement than the control group, with values of −60.50 ($p < 0.001$) at the midpoint (T1) and −70.28 ($p < 0.001$) at the end of the session (T2).

For Motor engagement 3, there were a non-significant effect for Group, a significant effect for learning, and a significant interaction Group x learning.

The post-hoc test revealed that motor engagement 3 dimension decreased significantly in both groups after the learning session vs. before learning (for GBL group: means difference = 49.56, $p < 0.001$) (for control group: means difference = 27.83, $p = 0.025$).

Table 3 demonstrates a Significant effect for group, interaction of group and learning, but there was no significant effect on learning for "Organized During Activity" variable.

Post-hoc analysis of the "Organized During Activity" variable revealed significant differences between the control and GBL group at different moments. In the middle, the GBL group was more efficiently organized than the control group (mean difference = −2.48, $p < 0.001$). Last, the GBL group showed a slight improvement, without reaching significance (mean difference = 1.67, $p = 0.092$).

Motivation

Results of the motivational dimensions in the control group and the experimental group recorded at T0 and T2 are presented in Figures 2–5.

Figure 2 illustrates a significant effect of group ($F_{(1.49)} = 18.88$; $p < 0.001$; $\eta_p^2 = 0.28$) and a significant interaction between group and learning ($F_{(1.49)} = 5.30$; $p = 0.026$; $\eta_p^2 = 0.10$), but there was no significant main effect of learning alone ($F_{(1.49)} = 2.53$; $p = 0.118$; $\eta_p^2 = 0.05$). The analysis revealed that intrinsic motivation increased in the control group while remaining stable in the experimental group over time. The experimental group demonstrated higher levels of intrinsic motivation than the control group at both T0 ($p = 0.026$) and T2 ($p < 0.001$).

The multivariate analysis of the results from the pairwise post-hoc comparison tests indicated that the GBL group had a significant effect, with a higher score compared to the control group, showing a mean difference of −1.59 (Cohen's $d = 0.975$, $t = -4.345$, and $p < 0.001$). Additionally, the control group before the learning session demonstrated lower scores for the intrinsic motivation variable when compared to the GBL group after learning, with a mean difference of 2.028 (Cohen's $d = 1.246$, $t = -4.461$, and $p < 0.001$).

Figure 3 reveals that identified regulation increased in the experimental group from T0 to T1, but it declined in the control group during the same time period; Statistical results revealed a significant group effect ($F_{(1.49)} = 17.42$; $p < 0.001$; $\eta_p^2 = 0.26$) but no significant effect of learning ($F_{(1.49)} = 0.04$; $p = 0.851$; $\eta_p^2 = 0.00$) or group-learning interaction ($F_{(1.49)} = 0.68$; $p = 0.413$; $\eta_p^2 = 0.01$).

The post-hoc test results indicated that the GBL group after the learning session had a significant effect, with a higher score compared to the control group after the learning session, showing a mean difference of −1.49 (Cohen's $d = 1.023$, $t = -3.688$, and $p = 0.003$).

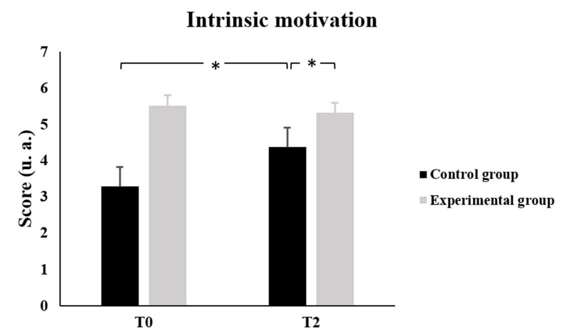

FIGURE 2
Intrinsic motivation means and standard deviations. *Statistically significant difference at $p < 0.05$.

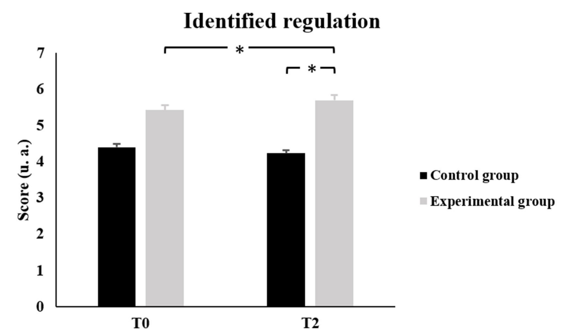

FIGURE 3
Identified regulation means and standard deviations. *Statistically significant difference at $p < 0.05$.

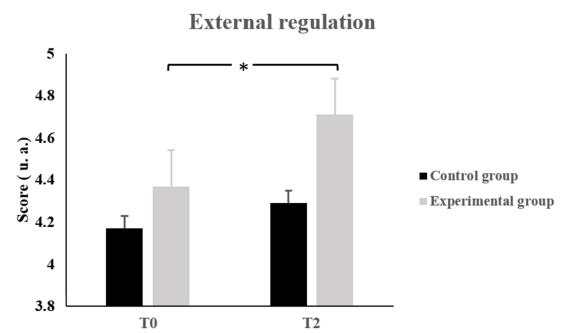

FIGURE 4
External regulation means and standard deviations. *Statistically significant difference at $p < 0.05$.

Additionally, the GBL group before the learning session revealed lower scores for the identified regulation dimension when compared to the GBL group after learning, with a mean difference of −1.24 (Cohen's $d = 0.866$, $t = -4.174$, and $p < 0.001$).

Figure 4 demonstrates that both groups had an increase in external regulation between T0 and T1, with the experimental group showing a more significant increase. However, toward the end of the cycle, the statistical analysis revealed no significant effect of external regulation. The ANOVA showed: a non-significant effect for Group

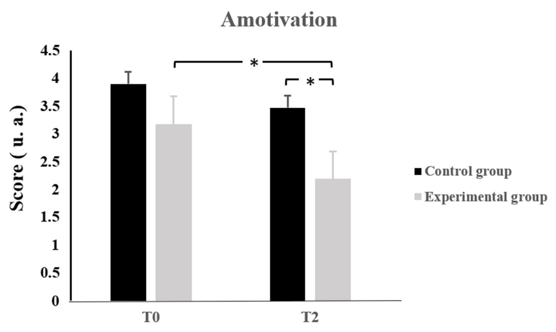

FIGURE 5
Amotivation means and standard deviations. *Statistically significant difference at $p < 0.05$.

($F_{(1.49)} = 1.223$; $p = 0.274$; $\eta_p^2 = 0.024$), a non-significant effect for learning ($F_{(1.49)} = 1.740$; $p = 0.193$; $\eta_p^2 = 0.34$) and a non-significant interaction Group x learning ($F_{(1.49)} = 0.399$; $p = 0.531$; $\eta_p^2 = 0.008$).

Figure 5 illustrates that amotivation decreased in the experimental group between T0 and T1, but it increased in the control group over the same period. Statistical results revealed a significant group effect ($F_{(1.49)} = 20.89$; $p < 0.001$; $\eta_p^2 = 0.30$) and a significant learning effect ($F_{(1.49)} = 8.81$; $p = 0.005$; $\eta_p^2 = 0.15$) but no significant group-learning interaction effect ($F_{(1.49)} = 1.34$; $p = 0.252$; $\eta_p^2 = 0.03$).

The post-hoc test results indicated that the GBL group after the learning session had a significant effect, with a lower score compared to the control group after the learning session, showing identically a mean difference of 1.280 (Cohen's $d = 1.108$, $t = 4.150$ and $p < 0.001$). Additionally, the control group before the learning session showed higher scores for the amotivation dimension when compared to the GBL group after learning, with a mean difference of 1.71 (Cohen's $d = 1.484$, $t = 5.248$, and $p < 0.001$).

Discussion

The primary aim of this study was to investigate the impact of the GBL approach on students' motivation and learning in PE, in comparison to a conventional, teacher-centered methodology. By examining multiple motivational constructs such as intrinsic motivation, identified regulation, external regulation, and amotivation, this study sought to provide a more nuanced understanding of how GBL affects student behavior, engagement, and cognitive-emotional outcomes. Our findings revealed that the GBL approach significantly reduced average waiting time and deviant behaviors while increasing students' time spent on appropriate engagement. The ESs for group and learning differences were large ($\eta_p^2 = 0.66$; $\eta_p^2 = 0.50$, respectively), and medium for interaction ($\eta_p^2 = 0.07$), indicating a meaningful practical impact. These results suggest that GBL fosters a more inclusive and interactive learning environment, in which learners are actively involved in constructing knowledge through gameplay and collaboration, supporting findings from Bédard (2010) and Jarrett and Light (2019). This can be explained by learners' active involvement in knowledge building through conversations and games, as reported by Bédard (2010) and Jarrett and Light (2019). This increases learner motivation, resulting in increased activity participation and a decrease in deviant behaviors and disengagement (Bédard, 2010). Indeed, when deviant behaviors and waiting times decreased, time spent on appropriate engagement increased. In contrast, adopting the previous method increased average waiting time, resulting in less time allocated to appropriate engagement (Bédard, 2010). Likewise, the GBL method increased engagement time, while the traditional method decreased it. This indicates that the GBL method has a positive effect on reducing deviant behavior and suggests a favorable long-term influence on participant engagement. This finding is in line with the recent study of Anane (2024).

The results also revealed that motor engagement 3 required less engagement time than motor engagement 2 (η_p^2 range between 0.12 and 0.66). This could be explained by the fact that learners who initially struggled to complete the learning activities (T0) were able to solve problems and succeed at the end of the cycle (T2). This transition from motor engagement 3 to motor engagement 2 can be linked to learners' interest for the subject and active participation in the GBL method (Astuti et al., 2019; Buijs and Admiraal, 2013; Taurina, 2015). Furthermore, the GBL method has gained popularity for its capacity to boost academic achievement (Parry, 2014). In addition, Wouters et al. (2013), Cook and Artino (2016), and Greipl et al. (2020) found that the GBL method is more effective in terms of learning than the traditional method, which limits teachers' ability to engage all students in the activity. The traditional approach frequently results in passive learning with a limited understanding of essential concepts (Goldstein, 2016). Indeed, studies have demonstrated that the GBL approach is used in the learning process and adds to its improvement (Huang et al., 2019; Burguillo, 2010; Ahmad et al., 2010; Gürbüz et al., 2014).

However, it is crucial to recognize that multiple factors, such as motivation, may influence the learning process. In this context, our findings showed that the GBL method could increase student motivation. Numerous researchers have found a link between motivation, investment in studies, and academic accomplishment (Fortier et al., Lieury and Fenouillet, 2013; Kusurkar et al., 2013; Byusa et al., 2022). These studies often rely on self-determination theory (Deci and Ryan, 1985), which holds that there are several types of motivation that may be classified along a self-determination continuum based on how much people believe they are the cause of their own conduct. Intrinsic motivation is the most self-determined motivation, allowing learners to engage voluntarily in an activity because they are interested in and like doing it (Ryan and Deci, 2020). Specifically, intrinsic motivation increased significantly in the GBL group, with high ESs for group and learning comparisons ($\eta p^2 = 0.28$; $\eta p^2 = 0.10$), and medium for interaction ($\eta_p^2 = 0.05$). These students engaged in learning not for external rewards, but because they found the activities enjoyable and inherently interesting, an essential characteristic of sustainable motivation (Chedru, 2015; Filgona et al., 2020). The self-determination model distinguishes between distinct types of extrinsic motivation, which allow students to participate in an activity for instrumental reasons. Extrinsic motivation by identified regulation is the most self-determined kind, allowing learners to participate in an activity that is personally meaningful to them (Chedru, 2015; Deci and Ryan, 1985; Louvet and Duret, 2017; Filgona et al., 2020). This type of motivation, while extrinsic (since learners do not engage in the activity for its own sake but because they believe it is essential), can be called self-determined when learners choose to participate in an activity, they believe is relevant. Identified regulation, the most self-determined form of extrinsic motivation, also increased in the GBL group ($\eta_p^2 = 0.26$ for group), suggesting that learners found the activities personally meaningful. Although ESs for learning and interaction were small ($\eta_p^2 = 0.00$; $\eta_p^2 = 0.01$), the GBL environment likely supported internalization of learning goals, allowing students to value the activities beyond mere compliance. The second type of extrinsic motivation is external regulation, which is non-self-determined and entails participating in an activity because of an external responsibility. It is distinguished by a low level of self-determination. External factors, such as receiving incentives or avoiding sanctions, influence the learner's behavior (Chedru, 2015; Deci and Ryan, 1985; Louvet and Duret, 2017; Filgona et al., 2020). For this variable, the ES was high for learning ($\eta_p^2 = 0.34$) and small for groups and interaction ($\eta_p^2 = 0.02$; $\eta_p^2 = 0.008$, respectively). In this regard, the average of this measure fell in the intrinsically driven experimental group. They do not require any incentives to work and are not afraid of punishment because they are self-confident. Finally, amotivation is positioned on the other end of the self-determination spectrum. It refers to a complete lack of motivation, in which learners participate in an activity without knowing why. This unmotivated student is more likely to feel negative emotions (Banerjee and Halder, 2021; David, 2010), have low self-esteem (Deci and Ryan, 1995), and be at risk of dropping out of school (Blanchard et al., 2005; Vallerand et al., 1997). In our research, the decrease in amotivation demonstrated a high ES for groups and learning ($\eta_p^2 = 0.30$; $\eta_p^2 = 0.15$, respectively), but was minor for interaction ($\eta_p^2 = 0.03$), showing that the teaching method utilized (GBL vs. traditional) had a substantial impact on amotivation levels. Additionally, students in the experimental group show a higher reduction in amotivation than those in the traditional group, reinforcing the positive influence of GBL on sustaining student engagement and diminishing disengagement.

Given the effectiveness of the GBL method, PE teacher training programs should include modules on the use of GBL methods. This would allow future instructors to obtain the necessary pedagogical abilities to adopt this approach, hence improving student learning and motivation. Furthermore, PE teachers can benefit from trading and sharing best practices for using the GBL approach by attending frequent meetings, seminars, or workshops where they can discuss and exchange ideas on effective teaching strategies. In addition, action research is a collaborative effort by instructors and researchers to explore and assess the effectiveness of GBL methods in specific circumstances. By encouraging action research in PE, instructors can obtain reliable information on the impact of using the learning through play method and increase their confidence in its effectiveness. In addition, it is important to make decision-makers and school leaders aware of the benefits of learning through play in PE. Organizing presentations, conferences, or publications based on positive research findings and teacher testimonials on the benefits of GBL can help to develop institutional support for its adoption and integration into school curricula.

Implementing these principles will enable us to create a supportive and favorable environment for the successful implementation of GBL in PE. This approach improves student engagement, broadens learning opportunities, and encourages a healthy and active lifestyle among students.

Limitations

This study is among the first to apply a GBL approach to PE in the Tunisian secondary school context; however, several limitations should be acknowledged. First, the absence of a mixed-methods design restricted the depth of analysis. Indeed, integrating both quantitative and qualitative data could have provided richer perspectives and a more comprehensive comparison between traditional and game-based teaching methods. Second, the study did not include gender or age group comparisons, which might have revealed potential differences in GBL effectiveness across diverse student populations. Third, the relatively small sample size was constrained by the typical class capacity in secondary schools (a maximum of 30 students) and was further reduced by absences, exemptions, and participation in extracurricular activities. Fourth, the short intervention period and the single-school setting in Tunisia may limit the generalizability of the findings to other educational contexts. Finally, although the study examined the influence of GBL on overall student engagement and behavior, it did not assess specific behavioral outcomes such as disruptive conduct or attention levels, which could yield a more detailed understanding of the method's impact.

Conclusion

The present study, involving 51 first-year secondary school pupils, demonstrated that GBL can significantly enhance intrinsic motivation and academic achievement in PE compared to conventional, teacher-centered approaches. Students in the GBL group not only reported higher motivation but also engaged for a greater proportion of lesson time in meaningful, learning-oriented activities. These findings suggest that GBL can foster dynamic, enjoyable, and student-centered learning environments that align closely with learners' psychological needs for autonomy, competence, and relatedness, which are essential for sustaining long-term engagement and performance.

Future research could investigate how GBL functions in different PE domains, such as team sports, individual skill development, and fitness activities, and compare the effects of various game formats (e.g., competitive vs. cooperative, digital vs. physical, structured vs. open-ended). Extending research to larger, more diverse populations and different educational contexts beyond Tunisia would help evaluate the broader applicability of this approach. Longitudinal studies could examine its sustained effects on skill retention, participation equity, and specific behavioral outcomes such as disruptive conduct or attention levels. Such work would deepen understanding of GBL's potential and support its adoption as a scalable, evidence-based strategy in PE programs worldwide.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Ethics Committee of the Tunisian Ministry of Education provided this study the approval number CPPSUD: 0295/2021. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

GE: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft. NS: Conceptualization, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – review & editing. RA: Data curation, Investigation, Software, Validation, Visualization, Writing – review & editing. LM: Formal analysis, Software, Validation, Visualization, Writing – review & editing. KT: Conceptualization, Methodology, Project administration, Validation, Visualization, Writing – review & editing. AA: Conceptualization, Formal analysis, Funding acquisition, Methodology, Project administration, Validation, Visualization, Writing – review & editing. HJ: Methodology, Validation, Visualization, Writing – review & editing. WH: Methodology, Validation, Visualization, Writing – review & editing. AT: Writing – review & editing. MK: Methodology, Validation, Visualization, Writing – review & editing. MA: Methodology, Validation, Visualization, Writing – review & editing. MM: Conceptualization, Methodology, Project administration, Supervision, Validation, Visualization, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Acknowledgments

We are grateful to all of the students who participated so willingly in the study and physical education teaching teachers from the 15 November 1955 Secondary School, who generously shared their time and experience for the proposes of this study.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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