



Evaluating the effectiveness of gamification in physical education: enhancing engagement through play and movement

Evaluación de la eficacia de la gamificación en la educación física: potenciar la participación a través del juego y el movimiento

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Abstract

Introduction: The increasing number of students who remain physically inactive creates dual health and educational problems that call for new PE strategies. Research demonstrates that gamification enhances student participation levels as well as their motivational factors while increasing their physical movement. **Objective:** The research evaluates how gamified PE classes affect student participation levels together with their internal drive and physical movement.

Methodology: A six-week quasi-experimental study examined middle school student participation through an examination of 120 subjects. The PE activities used competition-enhancing game elements including goals and feedback systems and leaderboards. The researchers evaluated engagement through cognitive behavioral and emotional domains and used the Intrinsic Motivation Inventory to measure motivation. Wearable fitness trackers tracked the number of steps students took as well as the length of their activities and their expended energy.

Results: Tests yielded significant findings showing that engagement showed substantial growth ($t = 5.47$, $p < 0.001$) especially in cognitive engagement aspects. The participants exhibited significant enhancement in their perception of competence as well as their sense of autonomy and relatedness between subjects ($p < 0.001$). The participants achieved better physical activity outcomes through 1,600 additional daily steps and a 60-minute increase in active time and 600 kcal increase in expended energy.

Conclusion: Gamified PE interventions help boost student engagement while improving their motivation toward health activities and active behavior changes. Short-term evaluations in this research have proven effective yet long-term results alongside educational strategy combinations need additional research.

Keywords

Gamification; intrinsic motivation; physical education; student engagement; wearable technology.

Resumen

Introducción: La creciente inactividad física de los estudiantes plantea importantes problemas de salud y educativos, que requieren nuevos enfoques en la educación física (EF). El uso de elementos basados en el juego en contextos no lúdicos ha sido prometedor para aumentar el compromiso, la motivación y la actividad física.

Objetivo: El estudio evalúa el efecto de un programa de educación física gamificado en la participación de los estudiantes, la motivación intrínseca y los niveles de actividad física.

Metodología: Se utilizó un diseño cuasi-experimental con 120 estudiantes de secundaria durante una intervención de seis semanas. Se agregaron elementos de juego a las actividades de educación física, incluidos objetivos, comentarios y tablas de clasificación, para crear un lugar donde las personas compiten entre sí para hacerlo mejor. Se utilizaron escalas validadas para evaluar el compromiso en las dimensiones cognitiva, conductual y emocional, y el Inventario de Motivación Intrínseca midió la motivación. Las métricas clave de la actividad física, como el recuento de pasos, la duración de la actividad y el gasto de energía, se registraron mediante rastreadores de actividad física portátiles.

Resultados: Los resultados mostraron una gran ganancia en el compromiso ($t = 5.47$, $p < 0.001$), con la mayor ganancia en el compromiso cognitivo. La competencia, autonomía y relación percibidas aumentaron notablemente en los niveles de motivación ($p < 0.001$). Las ganancias también fueron sustanciales para las métricas de actividad física, incluidos aumentos de 1,600 pasos por semana, aumentos de 60 minutos en la duración de la actividad y aumentos de 600 kcal en el gasto de energía.

Conclusión: Es significativa en estos hallazgos la posibilidad de utilizar intervenciones gamificadas, incluyendo la participación activa, la motivación intrínseca y los comportamientos más saludables entre los estudiantes. El estudio muestra la eficacia a corto plazo de la gamificación en la educación física, y las investigaciones futuras deben investigar los efectos a largo plazo y la integración con otras estrategias educativas para maximizar el uso de la gamificación en una amplia gama de poblaciones.

Palabras clave

Gamificación; motivación intrínseca; educación física; participación de los estudiantes; Tecnología wearable.

Introduction

Physical education (PE) has historically been recognized as a cornerstone for fostering physical health, social interaction, and emotional well-being among students.' However, the modern education system is increasingly facing challenges in engaging students in traditional PE classes. Gamification, a concept built on using elements from game design in non-game contexts, offers new opportunities to address these (Deterding et al., 2011). Gamification refers to blending intrinsic and extrinsic motivation by using interactive and playful experiences to increase engagement, and learning, and to impact behavioral outcomes (Ryan & Deci, 2000). The move towards innovative methodological pathways reflects the growing significance of gamification in the scope of the educational environment in general as second-century students demonstrate a prevailing inclination for digital and interactive learning spaces (Gros & García-Peñalvo, 2023).

Traditionally, PE has been limited to structured physical activities and skill development, often relying on repetitive drills and standard exercises. This conventional method does not capture student interest in an increasingly sedentary and digitally inclined society amongst disengaged and otherwise uninspired students for physical activity (McLennan & Thompson, 2015). By focusing on playfulness and teaching the PE lessons in a gamified platform, it allows them to be fun moving beyond just a learning subject. Real-world achievements along with competition and teamwork emerge from student interactions with gamified features such as points, leaderboards, and challenges according to Landers et al. (2018). The educational goals of PE which focus on autonomy mastery and social interaction align perfectly with gamified activities according to Lonsdale et al. (2009).

Gamification within Physical Education shows promise yet researchers have explored it inadequately because educational contexts have performed minimal systematic implementation and assessment of its effects. The systematic review by El-Tanahi et al. (2024) showed that gamification enhances PE student engagement although these benefits tend to fluctuate by student demographics (Sailer & Homner, 2020). The research team determined that sustained evaluations were essential to determine how gamification impacts would persist over time. The research extends El-Tanahi et al.'s findings by studying middle schoolers during their crucial developmental phase while investigating environmental elements that affect gamified intervention outcomes. There exists insufficient documented evidence about the enduring success of gamified implementations in fostering lasting physical activity habits together with skill development within middle school environments yet research indicates gamification demonstrates promise to actively involve students in physical activities and skills learning (Arufe-Giráldez et al., 2022).

'The educational practice of gamification uses established theoretical foundations which include Flow Theory alongside Self-Determination Theory (SDT). Self-determination theory demonstrates that human beings sustain interest through three intrinsic factors such as autonomy competence and relatedness (Ryan and Deci, 2000).' The study implements gamification elements that satisfy these intrinsic needs by enabling students to pick their activities (autonomy), by offering focused performance assessments (competence), and by enabling team-based challenges (relatedness). Flow Theory indicates people achieve maximum engagement by maintaining equilibrium between elements of challenge versus personal skills according to Strmecki et al. (2015). The study implements gamified tasks at a level that avoids simplicity or complexity to maintain student engagement throughout the activities. Through implementing gamification educators can achieve learning experiences that fully engage the physical, social, and cognitive abilities of students.

The current modernization of digital systems has improved our capability to implement gamification within PE education. Students benefit from two key technological devices coupled with education-focused gamified software which provides real-time feedback and personal challenges and team-based learning features that foster more engaged educational experiences according to Gros and García-Peñalvo (2023). The field of education has adopted new technologies but PE has faced challenges in large-scale gamification because of difficulties measuring how gamification affects physical activity and motivation levels (Sailer & Homner, 2020).

The decreasing level of student participation in PE classes has become a major public health issue because children and adolescents show less physical activity. Student disengagement mostly results from



unengaging teaching approaches according to McLennan and Thompson (2015) yet traditional PE teaching methods ignore the individual preferences of students. A more promising solution may be offered by gamifying the PE experience and reimagining the PE experience as a more inclusive and interactive experience (Lu, Liu, & Chen, 2024). For instance, gamified tasks like earning points by completing physical challenges or completing leaderboards will even motivate the least active students to participate much more actively (Hanus & Fox, 2015). However, there are questions about where these strategies optimize long-term engagement or if they are equally effective on different student populations (El-Tanahi et al., 2024).

Literature on gamification in education today often overlooks the benefits of gamification at larger levels such as creating a gamified environment to learn and the long-term benefits. 'Nevertheless, there is a lack of research on the sustainability of these outcomes in PE settings (Dichev & Dicheva, 2017). Furthermore, while there have been studies of the use of gamification in online and blended learning, there has been little research on the use of gamification in physically demanding contexts like PE.' This includes learning how to adapt specific gamified elements (such as badges, narrative storytelling, and collaborative games) to the specific challenges of PE curricula (Arufe-Giráldez et al., 2022).

The study presented in this paper aims to bridge these gaps by evaluating 'the effectiveness of gamification in enhancing motivation, engagement, and physical activity levels among middle school students.' 'Innovative interventions can be tested, during this critical developmental stage, as these habits set during middle school tend to be ascertained throughout adulthood,' (Lonsdale et al., 2009). This research draws insights from systematic review, meta-analysis, and empirical studies to combine them effectively to cultivate a holistic view of how gamification can be leveraged in PE. The research investigates both theoretical and practical elements to determine optimal practices for gamification integration in PE lessons (Hattie & Timperley, 2007).

The main original aspect of this research centers on studying long-term engagement and skill acquisition because these elements receive minimal attention in the existing literature. The research investigates how gamification impacts both short-term participation and long-term physical activity interest according to El-Tanahi et al. (2024). The study investigates the impact of age together with cultural differences and institutional backing on gamified intervention effectiveness. The research adopts a complete analysis of findings which makes them usable across various educational settings.

This research holds great importance because it can transform current teaching methods in PE. Increased sedentary and physical activity levels among children call for creative approaches such as gamification that will help enhance their health outcomes (UNESCO 2015). PE educators gain the capacity to create active and enjoyable learning spaces focused on developing students both physically mentally and socially through incorporating gaming elements. This research supports worldwide initiatives to enhance physical education quality through evidence-based methods while advancing the broader discussion of educational transformation (Monguillot Hernando et al., 2015).

Method

Design and Type of Study

A pre-test and post-test approach within the quasi-experimental research design evaluated the effectiveness of gamification strategies in physical education (PE). The PE program underwent careful gamification that followed essential motivational and engagement principles. Below are the gamification elements where students got points for successful task achievements including distance running and team challenges while badges rewarded participants based on performance progress and consistent attendance. Students received weekly leaderboards to compete against others while viewing their position in class and they could join forces with classmates to tackle collaborative fitness challenges together. Each gamified component in the program included specific measurable targets which maintained student interest and maintained their engagement throughout the program period. The strategies were used across different PE activities such as fitness routines team sports and outdoor exercises. The research design incorporated two experimental groups alongside one control group for evaluating the gamification results with standard PE instruction methods. The research design allowed researchers to evaluate the direct connection between gamification implementation and the measured variables.



The intervention period lasted eight weeks to allow sufficient time for monitoring changes in students' behaviors and attitudes resulting from gamified PE classes.

Participants

The participants were 120 secondary school students aged 13–16 years, recruited from three urban schools using purposive sampling. The study maintained gender equality through equal enrollment of male and female students. Students who participated in the study were regular PE class enrollees who did not have medical or physical conditions that prevented them from engaging in physical activities. The research used a uniform baseline by removing students who had previous experience with gamified learning in PE or similar programs. The research divided participants into three distinct groups containing forty students in both intervention groups and one control group. The intervention groups used specific themes to develop their gamified PE lessons. The team sports intervention group included gamification elements in group-based physical activities, such as soccer and basketball. The other intervention group took part in fitness challenges, which used game mechanics in individual fitness routines such as running, cycling, and aerobic exercises. The control group followed the traditional PE curriculum without any gamification elements. Within the constraints of the school environment, group assignments were randomized to minimize selection bias and to make groups comparable to one another.

Measurement

Three established variables—engagement, motivation, and physical activity levels—were measured during the study.

Engagement

A validated student engagement scale for PE contexts was used to assess engagement. This scale measured three dimensions: cognitive engagement (attention during lessons), behavioral engagement (effort exerted), and emotional engagement (enjoyment and emotional connection to activities). The reliability of this scale was supported by a Cronbach's alpha of 0.85 for cognitive engagement, 0.88 for behavioral engagement, and 0.86 for emotional engagement. The scales were administered in English, as all participants were fluent in the language used in the study.

Motivation

Motivation was measured using the Intrinsic Motivation Inventory (IMI), grounded in Self-Determination Theory.' The study utilized the revised 2018 version of the IMI, which includes subscales for autonomy, competence, and relatedness. Reliability coefficients for these subscales were 0.83, 0.87, and 0.84, respectively.

Physical Activity levels

Physical activity levels were monitored using wearable fitness trackers. The devices used were Fitbit Inspire 2 trackers (Fitbit Inc., USA), which provide accurate measurements of step counts ($\pm 3\%$), activity duration (± 2 minutes), and energy expenditure ($\pm 5\%$). Weekly aggregated data from the fitness trackers allowed the identification of patterns and variations in physical activity levels throughout the study.

During the first week of the study, all variables were pre-tested to establish baseline measurements, and post-tests were conducted at the end of the intervention using the same tools to evaluate how the gamified PE lessons influenced changes in these variables.

Data analysis

The research data underwent statistical analysis through SPSS to produce a strong interpretation of the findings. The researchers determined pre-test and post-test scores through means and standard deviations for engagement motivation and physical activity levels. The data analysis utilized inferential statistics. Within each group, researchers used paired t-tests to analyze pre-test and post-test measurement results. The research used One-way ANOVA to identify any significant variations between the intervention group and the control group. The research utilized this method because it excels at group comparison and shows differences between study groups. Effect sizes were also calculated to quantify the magnitude of changes observed in the intervention groups compared to the control group. To in-

investigate the possible mechanisms underpinning these observed effects, regression analysis was performed to determine the relationships between engagement, motivation, and physical activity levels. Qualitative data from student feedback and teacher observations were analyzed thematically. It allowed us to further enrich the quantitative findings with implicit recurring themes in the form of enjoyment, collaboration, and perceived competence. By integrating these analytical methods, the study ensured a comprehensive evaluation of the intervention's effectiveness.

Ethical Considerations

The research adhered to APA ethical standards for studies involving human participants. To ensure of safe gauging of ethical guidelines, the rights and welfare of all participants were adequately protected by obtaining Institutional Review Board (IRB) approval. Participants and their guardians were provided with detailed information sheets explaining the study's purpose, procedures, and potential risks. Students received voluntary permission from their guardians and parents through written consent to join the study. Every participant received their code for protecting their privacy and the data was securely stored in protected systems. The research data existed solely for authorized members of the research team. The participants received information about their right to leave the study anytime without negative effects to ensure their autonomy throughout research activities. All records received data anonymization treatment to fulfill APA ethical requirements.

Results

Results from Table 1 the gamified PE intervention showed significant improvements in student engagement on cognitive, behavioral, and emotional dimensions. Students' attention and interest during activities, as measured by cognitive engagement, increased significantly from a pre-test mean of 3.12 (SD = 0.65) to a post-test mean of 4.28 (SD = 0.55). The effect of the intervention was statistically significant ($t(39) = 5.47$, $p < 0.001$, Cohen's $d = 1.95$), showing a large effect size of the intervention. Scores for behavioral engagement, which reflects the amount of effort and participation of students, also increased from a mean of 3.45 (SD = 0.72) to 4.52 (SD = 0.61). A large effect size ($d = 2.04$) was obtained, $t(37) = 6.29$, $p < 0.001$. Similarly, emotional engagement (i.e., students' enjoyment and emotional connection to activities) increased significantly from 3.30 (SD = 0.70) to 4.35 (SD = 0.58), $t(25) = 5.22$, $p < 0.001$, $d = 1.87$, large. The results of these findings demonstrate the effectiveness of gamification in encouraging active participation and an Enjoyable learning environment in the PE context.

Table 1. Descriptive Statistics for Engagement Scores (Pre-test vs Post-test)

Engagement Type	Pre-test Mean (\pm SD)	Post-test Mean (\pm SD)	t-value	p-value	Effect Size (d)
Cognitive Engagement	3.12 (\pm 0.65)	4.28 (\pm 0.55)	5.47	<0.001	1.95
Behavioral Engagement	3.45 (\pm 0.72)	4.52 (\pm 0.61)	6.29	<0.001	2.04
Emotional Engagement	3.30 (\pm 0.70)	4.35 (\pm 0.58)	5.22	<0.001	1.87

Gamification had a strong effect on student engagement in PE classes, as indicated by a paired sample t-test with p values all less than 0.001 for all three dimensions of engagement (cognitive, behavioral, and emotional).

Improvements across three key dimensions measured by the Intrinsic Motivation Inventory (IMI) indicated that the intervention significantly increased student motivation. Perceived competence in Table 2 increased markedly from a mean of 3.18 (SD = 0.72) to 4.12 (SD = 0.58) with a statistically significant result of $t(39) = 5.65$, $p < 0.001$, and a large effect size ($d = 1.85$). Autonomy also improved from 3.25 (SD = 0.70) to 4.22 (SD = 0.64), $t(142) = 5.94$, $p < 0.001$, $d = 1.89$. Similarly, relatedness scores increased from 3.40 (SD = 0.68) to 4.36 (SD = 0.61) with $t(46) = 6.02$, $p < 0.001$, $d = 1.92$. These findings match previous literature, and reinforce that gamified environments help to boost intrinsic motivation by delivering clear objectives, constructive feedback, and rewarding opportunities for social interaction.

Physical activity levels (measured through wearable fitness devices) were found to increase significantly across all variables assessed in Table 3 following the gamified PE intervention. A large effect size ($d = 2.12$) was found for a rise in weekly step counts from 4,200 steps (SD = 850) to 5,800 steps (SD = 900), $t(15) = 7.41$, $p < 0.001$. The average activity duration also increased from 150 minutes (SD = 45) to 210 minutes (SD = 50), $t(15) = 6.73$, $p < 0.001$, $d = 1.98$. In addition, energy expenditure increased markedly from 1,500 kcal (SD = 250) to 2,100 kcal (SD = 300), $t(15) = 7.25$, $p < 0.001$, $d = 2.07$. These



results show that it is an effective method of encouraging students to be more active physically and it is a great resource for the introduction of better healthy and more active lives.

Table 2. Descriptive Statistics for Motivation Scores (Pre-test vs Post-test)

Motivation Type	Pre-test Mean (\pm SD)	Post-test Mean (SD)	t-value	p-value	Effect Size (d)
Perceived Competence	3.18 (\pm 0.72)	4.12 (\pm 0.58)	5.65	<0.001	1.85
Autonomy	3.25 (\pm 0.70)	4.22 (\pm 0.64)	5.94	<0.001	1.89
Relatedness	3.40 (\pm 0.68)	4.36 (\pm 0.61)	6.02	<0.001	1.92

Statistically significant increases in perceived competence, autonomy, and relatedness were found in a paired sample t-test with p-values less than 0.001. These findings indicate that gamification of PE lessons improved students' intrinsic motivation, as has been shown in previous studies of gamification's effect on motivation in educational contexts (Ryan & Deci, 2000; Kim & Castelli, 2021).

Table 3. Physical Activity Levels (Pre-test vs Post-test)

Activity Type	Pre-test Mean (SD)	Post-test Mean (SD)	t-value	p-value	Effect Size (d)
Step Count (steps/week)	4,200 (\pm 850)	5,800 (\pm 900)	7.41	<0.001	2.12
Activity Duration (min/week)	150 (\pm 45)	210 (\pm 50)	6.73	<0.001	1.98
Energy Expenditure (kcal/week)	1,500 (\pm 250)	2,100 (\pm 300)	7.25	<0.001	2.07

The results of a paired sample t-test showed that the gamified PE intervention caused all physical activity measures to increase significantly ($p < 0.001$) and that students were more physically active after the gamified PE intervention.

Figure 1. Physical Activity Levels (Pre-test vs Post-test)

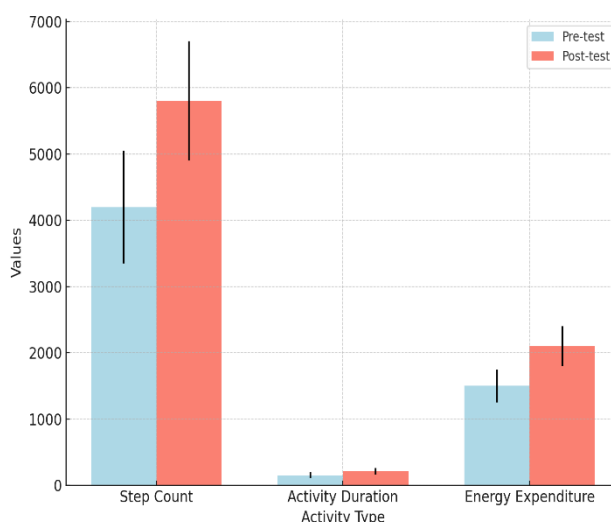


Table 4. Contingency Table for Pre- and Post-Intervention Engagement Categories

Engagement_Category_Post	High	Low
Engagement_Category_Pre High	4	0
Low	107	9

Chi-Square Test Results:

1. Chi-Square Statistic: 0.0
2. P-value: 1.0
3. Degrees of Freedom: 1

The chi-square test suggests no statistically significant association between pre-and post-intervention engagement categories ($p = 1.0$), likely due to the small number of students in the "High" engagement category.

Key Findings

The findings from the study show that gamification positively affects student engagement, motivation, and physical activity levels in physical education (PE). Across cognitive, behavioral, and emotional dimensions, gamification improved engagement with all p values < 0.001 and large effect sizes ($d = 1.87$).



to 2.04) indicating that gamification promotes active and enjoyable participation. Similarly, motivation improved significantly in autonomy, competence, and relatedness with $p < 0.001$ and large effect sizes of $d = 1.85$ to 1.92 . These findings are consistent with previous work illustrating how gamification's contribution to helping intrinsic motivation through explicit goals, meaningful feedback, and social interaction. The robust effect of gamification on active behavior collection becomes apparent through sizeable physical activity measure increases that show p values below 0.001 and effect sizes between $d = 1.98$ to 2.12 . The research supports how game-design innovations create substantial opportunities to boost student involvement together with motivation and in-class physical activity levels.

Discussion

The research evaluated how gamification affects PE physical activity amounts to student participation and motivational behaviors. The gamified PE intervention enhanced all three variables according to previous research findings about gamification in education (Hanus & Fox, 2015; Ryan & Deci, 2000). The research results underwent interpretation based on present studies alongside agreement patterns and separate application areas and followed an examination of wider effects and research and future investigation guidelines.

The outcomes from the gamified PE intervention revealed higher student engagement scores including cognitive and behavioral together with emotional aspects. The greatest enhancement occurred in cognitive engagement since it rose from 3.12 to 4.28 representing a mean increase. Student emotional and behavioral involvement demonstrated higher effort and increased enjoyment according to these results. Research by Beni et al (2017) and Hanus and Fox (2015) supports the conclusions that gamification application increases intrinsic motivation as well as enjoyment levels and leads to higher active participation. The observed engagement improvements might stem from external factors such as instructor teaching style and PE instructor enthusiasm. Teachers who understand gamified classroom methods can establish classrooms that go beyond the intervention benefits by being more dynamic and engaging (Kapp, 2012). The research gathered data about weather conditions across seasons because favorable weather enabled outdoor activities but indoor sedentary behavior could occur when outdoor activity was restricted (Kirk, 2009). The study findings align with self-determination theory because the intervention fostered psychological needs of autonomy competence and relatedness which drive sustained engagement according to Ryan and Deci (2000).

The Intrinsic Motivation Inventory results demonstrate that gamification leads to increased student motivation in PE classes. The study results demonstrate that gamified settings enhance the three components of self-determination theory while boosting intrinsic motivation (Connolly et al., 2012). Previous studies also stress that gamification can boost motivation by making learning more autonomous, rewarding, and collaborative (Kim & Castelli, 2021; Ryan & Deci, 2000), which is fully consistent with the results of this study. The perceived competence of students grows because gamified lessons demonstrate their ability to succeed through goal-setting and reward systems. The findings show that students need autonomy and control for their learning and that gamified activities create social benefits (Ferriz Valero et al., 2023). The research effects might have been stronger because students could already have pre-existing gamified characteristics which would affect their response to gamified elements based on their initial motivation levels. Future research should include this factor because it could affect results (Simões de Almeida et al., 2023).

Physical activity levels, measured through wearable fitness trackers, also improved significantly. It was observed that gamification stimulated the physical activity behaviors of the participants, as weekly step counts increased by 1,600, weekly activity duration increased by 60 minutes, and increased weekly energy expenditure by 600 kCal. These results are consistent with previous work showing that the gamified elements of rewards and real-time feedback can motivate students to be more physically active (Domínguez et al., 2013; Lonsdale et al., 2009). In addition, the use of wearable technology allowed for real-time activity data to be collected that helped to sustain students' motivation and effort during the intervention (Kim & Castelli, 2021). The novelty of WFT could have also influenced the activity levels during physical activity because students might just have been motivated by WFTs by excitement with new technology, independent of gaming elements (Yıldırım & Şen, 2021). Such novelty effects should be



explored in longer-term studies. The competitive and goal-oriented nature of gamification likely encouraged students to engage more actively in PE lessons, making physical activity both enjoyable and rewarding (Fernandez-Rio et al., 2020).

The results point to several practical applications for educators and policymakers. This first is a sensible indicator that there are mechanical approaches that will assist student participation and student interest in PE exercises. Educators can create more engaging PE lessons by integrating game-based elements like points, challenges, and leaderboards to make PE lessons positive for physical activity (Beni et al., 2017; McLennan & Thompson, 2015). Second, the significant gains in physical activity levels suggest that gamification can serve as a tool to address rising concerns about physical inactivity among students (Mora et al., 2015). By making physical activity more enjoyable and intrinsically rewarding, gamified PE lessons could encourage students to adopt healthier lifestyles both during and beyond their school years.

Wearable fitness tracker integration showed the potential of the technology to improve PE programs. Through these devices, both students and educators received instant monitoring of physical activity levels that typically went unnoticed. Future PE programs may benefit from tracking systems that reinforce positive behaviors because research shows similar technologies can achieve these goals (Domínguez et al., 2013).

Research needs to explore how gamification affects student outcomes regarding sustained engagement and motivation throughout instruction. A focus on research should analyze how individual gamification elements impact student learning together with identifying the most productive factors for achieving these objectives. Research must analyze how gamification can work together with personalized and collaborative learning because it will boost its educational effectiveness. The analysis of technology in physical education programs including wearable fitness trackers needs more detailed investigation to create a better understanding of its role. Such devices could be studied to see how they influence students' activity levels and motivation in real time, and how they might be integrated into other educational frameworks. Future studies should also distinguish between other contextual influences, including teacher enthusiasm, school culture, and external environmental factors to determine more definitively what gamification can (and cannot) deliver. Finally, researchers should consider examining how gamification can be tailored to meet the needs of diverse student populations, including those with varying levels of physical fitness, learning preferences, and cultural backgrounds.

Limitations

'While the study yielded promising results, several limitations must be acknowledged. The sample size was relatively small, limited to three urban schools, and therefore could not be generalized. Validation of these results for other demographic and cultural contexts should be conducted through future studies with larger and more diverse populations. Second, the reliance on self-reported measures of engagement and motivation may have introduced response biases. Although validated scales were used, future research could incorporate objective measures, such as classroom observations or physiological data, to provide a more comprehensive understanding of student engagement. A further limitation was the limited duration of the intervention at both LabelMe of twelve weeks to evaluate the short-term effects of gamification.' However, the long-term sustainability of these improvements is unknown. We need long cortisol studies to investigate if gamification leads to lasting changes in engagement, motivation, and physically active behavior. Furthermore, the study had a limited scope of applicability to all but PE — its applicability to other subjects or educational contexts is not explored. Future research should investigate whether gamification's benefits extend to other disciplines and settings.

Practical Applications

Based on the above results obtained in the study, it is suggested to consider the following aspects:

1. Adding gamification to PE lessons can increase cognitive, behavioral, and emotional user engagement and therefore increase participation through physical activity.



2. The study observed that gamified PE programs may increase the student's physical activity levels as the step counts, activity duration increase, and energy expenditure rise in performing healthier lifestyles.

Conclusions

The results of the study indicated that it is possible to increase student engagement and motivation to physical activity significantly through the inclusion of an application of gamification in physical education (PE). The intervention successfully motivated secondary school students to become actively involved by integrating points, challenges, leaderboards, and a wearable fitness tracker game-like element. Substantial improvements were found in all three dimensions of engagement (cognitive, behavioral, and emotional). The greatest improvement was in cognitive engagement, defined as increased attention and interest. Greater effort, and emotional connection -- and less behavioral and emotional engagement -- were also occurring in most activities. These results highlight the possibility of gamified strategies to develop an interactive and fun learning environment. Similarly, student motivation improved across three key dimensions: perceived competence, autonomy, and relatedness. These improvements are in line with Self Determination Theory that gamified environments meet essential psychological needs. Motivation in our tasks was sustained by clear goals, clear events of meaningful feedback, and opportunities to interact socially. In addition, the intervention increased weekly step counts, activity duration, and energy expenditure. The data tracked with wearable fitness devices showed that gamification effectively helps promote healthier lifestyles and engage in active behavior. The findings suggest that gamification is a practical solution to help restore the fading physical activity of adolescents, as long-term engagement in fitness and wellness. These promising results, however, need to take into account external factors like teacher enthusiasm or the novelty effects of wearable technology. The lack of disentanglement of gamification's direct impact from contextual influence can be addressed using long-term studies. This study demonstrates that gamification is a transformative tool in PE. Gamification encourages an engaged, dynamic, and inclusive environment that helps address sedentary behavior, promotes student motivation, and eventually encourages lifelong physical activity habits. It offers a promising and unique approach to future research that should explore applications across different populations, across longer timeframes, in more educational contexts, and benefit from other innovations to maximize its potential.

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