

Gamification to Engage Healthy Habits in Socially Deprived Secondary School Students Gamificación para fomentar hábitos saludables en estudiantes de secundaria socialmente desfavorecidos

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Abstract. A sedentary lifestyle, unhealthy eating habits, and substance abuse are increasingly prevalent among adolescents, necessitating effective interventions within educational environments. This study aimed to assess the effectiveness of a fifteen-week gamified intervention to promote healthy habits among 314 secondary school students residing in socially deprived areas. The gamified PBL (Points-Badges and Leaderboard) approach offers a promising strategy to engage students, enhance their knowledge, and influence their physical activity, nutrition, and substance consumption behaviors. Employing a pre-post-test design with a control group, data were collected through Kimed and IPAQ questionnaires evaluating participants' habits. Results revealed statistically significant differences between pretest and post-test scores in the experimental group and significant differences favoring the experimental group. Participating students exhibited improved physical activity and nutrition, alongside a reduction in harmful substance consumption behaviors. These findings suggest that the gamified PBL intervention holds promise in promoting healthier habits among secondary school students, specifically in socially deprived areas, emphasizing the importance of integrating such interventions into educational curricula.

Keywords: Gamification; Balanced nutrition; Harmful substance consumption; Secondary school students

Resumen. El estilo de vida sedentario, los hábitos alimentarios poco saludables y el abuso de sustancias son cada vez más prevalentes entre los adolescentes, lo que requiere intervenciones efectivas dentro de los entornos educativos. Este estudio tuvo como objetivo evaluar la efectividad de una intervención gamificada de quince semanas para promover hábitos saludables entre 314 estudiantes de secundaria que residen en áreas socialmente desfavorecidas. El enfoque gamificado PBL (Puntos-Insignias y Tabla de clasificación) ofrece una estrategia prometedora para involucrar a los estudiantes, mejorar sus conocimientos e influir en sus conductas de actividad física, nutrición y consumo de sustancias. Empleando un diseño de prueba pre-post con un grupo de control, los datos se recopilaban a través de cuestionarios Kimed e IPAQ que evaluaban los hábitos de los participantes. Los resultados revelaron diferencias estadísticamente significativas entre las puntuaciones previas y posteriores a la prueba en el grupo experimental y diferencias significativas a favor del grupo experimental. Los estudiantes participantes mostraron una mejor actividad física y nutrición, junto con una reducción en las conductas de consumo de sustancias nocivas. Estos hallazgos sugieren que la intervención gamificada de ABP es prometedora para promover hábitos más saludables entre los estudiantes de secundaria, específicamente en áreas socialmente desfavorecidas, enfatizando la importancia de integrar tales intervenciones en los planes de estudio educativos.

Palabras clave: Gamificación; Nutrición equilibrada; Consumo de sustancias nocivas; Estudiantes de educación secundaria

Fecha recepción: 14-11-23. Fecha de aceptación: 31-01-24

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Introduction

Adolescence is a critical human development stage characterized by significant physical, cognitive, and emotional changes (Hickie et al., 2019). During this period, adolescents are exposed to various social and cultural influences that can significantly impact their behavior, including their eating habits and the initiation of tobacco use (Galimov et al., 2019; Overbeek et al., 2020).

Unhealthy eating habits are a growing concern in adolescence. Adolescents tend to experience unhealthy eating patterns, which can lead to the development of chronic diseases such as obesity, type 2 diabetes, and cardiovascular disease (Fielding-Singh, 2019; Stang & Stotmeister, 2017).

The initiation of tobacco use is another problematic behavior often observed in adolescence. Adolescents can experience social pressures, curiosity, or a desire to belong to particular groups, leading them to try tobacco (Tupas & Agreda, 2020). This behavior has long-term negative health consequences, increasing the risk of respiratory diseases, cardiovascular diseases, and cancer (Chang et al., 2021).

Sedentary behavior, unhealthy eating habits, and tobacco initiation during adolescence can have long-term consequences. Behavior patterns established during this stage

tend to persist into adulthood, increasing the risk of health problems and reducing the future quality of life (Lee & Lee, 2019).

Therefore, it is essential to address these issues comprehensively by implementing effective educational and preventive strategies in the school and family context (Silva et al., 2020). Previous research highlights that education on healthy eating habits, promotion of physical activity, and awareness of the risks of tobacco use are critical factors in reducing the prevalence of these problematic behaviors among adolescents (Organization, 2020; Xu et al., 2020). At this point, innovative approaches such as gamification have emerged as a promising strategy to motivate and engage adolescents to acquire healthy habits and prevent tobacco use, providing an opportunity to effectively and meaningfully address these challenges (Beemer et al., 2019; del Río et al., 2019; Yoshida-Montezuma et al., 2020). A systematic review and meta-analysis study demonstrated the effectiveness of gamification as a method for improving health habits, highlighting that gamification can facilitate an education based on challenges that promote engagement. Gamification positively affects healthy lifestyles (Suleiman-Martos et al., 2021). In this context, gamification has been highlighted as a promising

strategy to promote positive behavior changes in young people. Gamification harnesses the intrinsic human motivation for games and competition and applies it to nongame contexts, such as education and health (Johnson et al., 2016; Ofosu-Ampong, 2020). Integrating game elements such as points, badges, and leaderboards into an educational program aims to create a fun, challenging, and rewarding environment that motivates adolescents to acquire healthy habits and actively stop tobacco use (Arufe-Giráldez et al., 2022; Blok et al., 2019).

Gamification, as a strategy to promote motivation and engagement of adolescents in acquiring healthy habits and quitting tobacco use, is grounded in psychological theories such as Csikszentmihalyi's flow theory (Csikszentmihalyi & Larson, 2014) and Deci and Ryan's self-determination theory (Ryan & Deci, 2022).

The flow theory suggests that individuals experience an optimal flow state when fully immersed in an activity that balances the challenges it poses and their skills to overcome them. In gamification, the goal is to design activities that are sufficiently challenging to maintain adolescents' interest while also being attainable and aligned with their abilities and competencies (Oliveira et al., 2022). When students are immersed in a state of flow, they experience deep concentration and commitment, increasing their intrinsic motivation to engage in the activities and achieve the proposed goals (Rheinberg & Engeser, 2018).

On the other hand, self-determination theory posits that individuals have an innate tendency towards self-determination and autonomy in their behavior (Deci & Ryan, 2012). It has been shown that satisfying the basic psychological needs for autonomy, competence, and social relatedness is crucial for promoting intrinsic motivation (Karimi & Sotoodeh, 2020). In gamification, game mechanics give adolescents a sense of competition and achievement, motivating them to actively participate in educational program activities (Marczewski, 2015). Furthermore, the social component of gamification, such as establishing rankings or the opportunity to interact with other participants, fosters social connection and reinforces adolescents' intrinsic motivation by making them feel part of a community with a common goal and engaging them in the proposed tasks (Kapp, 2013).

Engagement refers to the active participation, interest, and motivation that students experience in the learning process (Manzano-León et al., 2021). In the context of physical education, engagement plays a crucial role as it promotes more significant involvement of students in physical activities and enhances their commitment to the subject (Subramaniam, 2009).

In general, gamification in physical education can significantly increase student engagement for several reasons. Firstly, gamification elements add a fun and exciting component to physical activities, which enhances students' intrinsic motivation to participate (Soriano-Pascual et al., 2022). Turning tasks into challenges and competitions creates a competitive and stimulating environment that fosters

student engagement (Aleksic-Maslac et al., 2017). However, the use of gamification with students from socially disadvantaged areas is not widely studied (Manzano-León et al., 2022), despite the importance of providing support to youth in these contexts to prevent unhealthy eating habits and substance use, as their context may present additional challenges such as lack of resources and socioeconomic barriers (Díez Bermejo et al., 2020).

Therefore, this research focuses on applying gamification in physical education to reduce unhealthy eating habits and tobacco use among adolescent students in socially disadvantaged areas. The practical application of gamification in this context can provide a novel perspective, as it explores new ways of using playful and motivational elements to promote positive changes in behaviors related to eating and tobacco use. The research questions posed are as follows:

RQ1) Are there differences in physical activity, eating behaviors, and harmful substance use between the experimental group participating in a gamified physical education program and the control group that did not participate?

RQ2) Are there differences in the studied variables (diet, physical activity, and smoking habits) before and after the program's implementation?

RQ3) Does the level of engagement affect the modification of the studied variables?

Materials and Methods

This study used a quasi-experimental non-probabilistic methodology (Gopalan et al., 2020) to investigate the impact of a gamified PBL on salvageable lifestyle habits in secondary school. The research involved an experimental group, which received the intervention, and a control group, which did not.

Quasi-experimental designs, such as the one employed in this study, involve manipulating an independent variable (in this case, implementing the gamified PBL program) and measuring at least one dependent variable (the participants' healthy lifestyle habits). However, it is worth noting that the groups were already formed before the intervention, which means that the homogeneity of the groups was not guaranteed.

Participants

The study focused on a sample of secondary school students from socially disadvantaged areas in southern Spain. The experimental group initially consisted of 195 students, but 27 participants were excluded due to incomplete written permission, and an additional 14 students were eliminated for not attending at least 70% of the physical education sessions. This resulted in a final sample size of 154 students for the experimental group. Furthermore, the level of engagement with the gamified PBL was considered during the analysis, recognizing that a higher score on the proposed levels (see procedure) indicates a higher level of engagement with the intervention. To explore whether this

has an inference on the program's results, the sample was divided into two distinct groups: those who successfully reached level 3, which included 105 students (53 male and 52 female, $M = 15.55$, $SD = 0.58$), and those who achieved level 1 or 2, comprising 49 students (28 male and 21 female, $M = 15.57$, $SD = 0.56$).

The control group consisted of 160 students, 33 individuals were excluded due to incomplete written permission, and 12 students were eliminated for not attending at least 70% of the physical education sessions. The final sample size for the control group was 148 students (78 male, 82 female, $M = 15.50$, $SD = 0.50$). If the program demonstrated positive effects on students' healthy habits, it was planned to be implemented in the participating schools during the upcoming academic year to ensure that the control group was not disadvantaged. This approach was designed to provide equitable opportunities for all students and maintain the integrity of the control group for the study.

Instruments

The following instruments have been used for data collection:

Mediterranean Diet Questionnaire (Kimed) (Altavilla & Caballero-Pérez, 2019): This questionnaire, consisting of 16 items, allows the evaluation of the quality of dietary habits. Based on the obtained score, it can be classified as follows: optimal (more than 8 points), intermediate (between 4 and 7 points), and deficient quality (less than 3 points).

International Physical Activity Questionnaire (IPAQ) (Mantilla Toloza & Gómez-Conesa, 2007): This questionnaire consists of 7 simple questions. Three questions refer to the number of days of intense, moderate, or walking physical activity, respectively, and another question indicates the duration of each session. The last question asks about the time spent sedentary during the week. Finally, with these data, a correction factor is applied to obtain the person's overall physical activity index.

Lastly, they were asked about their smoking habits and frequency to determine if the students smoked or vaped. They could respond that they did not smoke or smoke several times a week, only socially or daily.

Procedure

The study used a nonrandomized design due to data collection in the natural context of participant physical education classes. The control and experimental groups participated in regular physical education classes for one trimester, the only difference being the complementary implementation of the gamified PBL approach in the experimental group.

The PBL challenges were developed collaboratively by the guidance counselor, the teacher, and two participating researchers, considering the observed behaviors during the first trimester and the pretest results.

Various challenges have been incorporated to modify diverse habits to promote a healthier lifestyle. For instance, some challenges focused on improving dietary habits and reducing sugar consumption. During the pre-test phase, it was

observed that there was excessive sugar consumption among students, highlighting the importance of addressing the high consumption of energy drinks. Another identified concern was the need to enhance dietary habits. To address this, challenges focused on cultivating healthy eating habits were included. Specifically, challenges were introduced for breakfast, where a substantial intake of processed foods was noticed, as well as for lunch. Efforts were made to encourage a more active lifestyle and discourage sedentary behavior. As part of this initiative, a challenge involving daily walking of 10,000 steps was introduced, which could be easily tracked using mobile applications displaying step counts. Additionally, students were encouraged to participate in recreational sports activities on weekends, with photographic evidence of their involvement requested. Another important aspect targeted was the promotion of healthy habits and the avoidance of potentially addictive substances. Among the student population, the use of vaping and electronic cigarettes was prevalent. Consequently, a challenge was introduced to raise awareness about the adverse effects of such practices and highlight the associated risks. Lastly, there was an effort to foster a positive classroom environment in physical education classes, including a challenge to promote a supportive and encouraging atmosphere.



Figure 1. Gamified PBL challenges. Note: Challenge 1 (Week without energy drinks), Challenge 2 (Positive attitude in physical education class), Challenge 3 (Photo of three healthy recipes), Challenge 4 (Month without the teacher spotting an electronic cigarette in class), Challenge 5 (Five healthy breakfasts), Challenge 6 (Completing 10,000 steps in a day).

Challenges were assessed once a week during the physical education class. Earning points in the gamified PBL system allowed students to access a range of rewards related to the subject. These rewards included choosing the game, recovering deducted points for behavioral problems, reducing the number of homework exercises, and unlocking an off-campus field trip if the entire group achieved a total score of over 500 points by the end of the trimester. Within the gamified PBL framework, students had the opportunity to advance through three levels based on their accumulated points: junior level (0-20 points), champion level (21-50 points), and legend level (more than 51 points). A visual ranking system was displayed in the classroom, providing weekly feedback on the class's total points.

Data analysis

The objectives of this research have guided the data analysis, and ANOVA tests were chosen for the analysis. For the post hoc tests, Bonferroni adjustments were applied.

Before conducting the statistical analyses, the raw scores of the questionnaires used were calculated. The direct scores obtained from the questionnaires were used without applying the relevant categorization allowed by the questionnaires. This was done to facilitate data understanding and to avoid unnecessary errors.

Once the direct scores were calculated, the actual statistical analysis was performed. Firstly, the groups were compared using the pre-treatment scores to determine if the groups were equivalent at the beginning. Then, another analysis of variance was conducted using the post-treatment scores to determine if there was any effect in the experimental group.

Results

Before starting the analyses, it should be clarified that the experimental group has been divided into two based on the level achieved in gamification. Experimental group 1 ($n = 49$) includes participants who reached level 50, while experimental group 3 ($n = 105$) comprises participants who reached level 51 and beyond.

Table 1 reports the mean scores and standard deviations of the variables of interest for pre-treatment and post-treatment measurements (See Table 1). One noticeable aspect of this table is related to the activity variable. As can be observed, the standard deviations are very large. This is because some individuals do not engage in physical activity and score 0, while others have high scores. Regarding the smoking variable, lower scores indicate that individuals smoke less or that fewer people report smoking, whereas higher scores indicate the opposite.

A variance comparison was conducted using an ANOVA test to verify if the groups can be considered statistically equivalent. According to the Wilks' Lambda statistic, the results indicate no statistically significant differences ($F=1.55$; $p = .161$; $\eta_p^2 = 0.15$). No statistical differences were found in the post hoc tests either. The most notable finding is a slight difference in means between the control group and experimental group 1 in the Kimed score (see Table 1), although it is not statistically significant ($p = .067$).

A variance comparison between groups was conducted using an ANOVA test with post-treatment scores to assess the program's effects. The Wilks' Lambda statistic (18.98; $p < .001$; $\eta_p^2 = 0.156$) indicates significant group differences. Post hoc tests confirm differences between the groups. They are detailed as follows:

- For the Kimed variable, differences between the control and experimental groups were 1 ($p < .001$) and no between the two experimental groups. However, as shown in Table 1, experimental group 2 had higher means than experimental group 1.

- No statistically significant differences were found for the physical activity variable. Due to the large standard deviations, more statistical power (larger sample) is needed to determine if these observed mean differences are

consistent and if the changes in means can be attributed to the program.

- Finally, differences were found between the control group and experimental group 2 ($p < .001$) for the smoking variable.

In response to research question three, no statistically significant differences have been found between the experimental groups. However, there are differences in the observed means. For example, in the smoking variable, the difference was found between the control and experimental group two but not between experimental group one and the other groups. A more prolonged intervention may be necessary for more precise results regarding this variable.

Finally, we wanted to verify if there were any differences by gender when implementing the program. For this purpose, a MANOVA test was conducted with gender as a covariate. The results of the test (Wilks' Lambda = 1.07; $p = .363$) indicate that there are no gender differences in the application of the program. Therefore, it can be concluded that in this intervention, all individuals have equally benefited regardless of gender.

Table 1.

Means and standard deviations of the variables studied before and after the intervention.

		Kimed		Activity		Smoke	
		Mean	D	Mean	D	Mean	D
Pre-test	Control	3.73	.12	681,31	56.03	0,53	.04
	Experimental 1	4.04	.97	567,59	74.98	0,64	.09
	Experimental 2	3.73	.15	820,42	43.79	0,79	.07
Post-test	Control	3.70	.133	698,31	44.26	0,59	.05
	Experimental 1	5.57	.848	959,23	08.01	0,51	.08
	Experimental 2	6.15	.174	1243,3	76.76	0,60	.06

Discussion

The present research implemented a gamified PBL in physical education to promote healthy lifestyle habits (physical activity, healthy nutrition, and reduced harmful substances). The results demonstrate that this approach can benefit students, and most students could engage with the program, reaching the highest possible level. Previous research has argued that by incorporating playful elements, gamification captures students' attention and actively engages them, increasing their motivation and interest in learning (Krath et al., 2021; Moreno-Guerrero et al., 2022). A stimulating environment is created through challenges and rewards that promote participation and active learning (Camacho-Sánchez et al., 2023; Sevilla-Sanchez et al., 2023), promoting healthy habits during the intervention trimester. Regarding the students in the experimental group who only reached level 1 or 2, indicating lower engagement in the program, it is observed that there were no statistically significant differences compared to the control group. However, they had higher mean scores in the post-test. This disengagement may be attributed to a lack of intrinsic motivation to participate in healthy habits actively (Ntoumanis, 2001), the perception that it is imposed (Cleo et al., 2017), and deficiencies in the PBL design or a lack of other game dynamics and mechanics (Marczewski, 2015).

The study was carried out in collaboration with several secondary schools in socially disadvantaged areas of southern Spain. A higher concentration of socioeconomic inequalities and limited access to health and education resources characterize these areas (Palmer et al., 2019; Pickett & Pearl, 2001). Therefore, one of the purposes of this research was to address these inequalities and assess whether the gamified PBL intervention could positively impact students' healthy habits in these communities. It has been observed that improvements in adolescents' healthy lifestyle habits can be achieved with a gamified proposal that requires a meager budget (stationery resources and rubber bracelets). Consistent with previous studies, integrating gamified interventions into the curriculum can effectively promote healthy habits among adolescents, reduce health inequalities, and lay the foundation for healthier adulthood (García Ordóñez & Fernández Lorenzo, 2022; Pérez-López et al., 2017; Salamanca et al., 2020). These implications have the potential to improve the quality of life for adolescents and have a positive impact on long-term public health. Additionally, the collaborative development of gamified challenges among guidance counselors, teachers, and researchers can be a crucial element in ensuring that programs are appropriate and tailored to the specific needs of students. Customizing challenges and rewards can increase the relevance and effectiveness of the intervention in different educational contexts.

Although the results reveal promising developments in promoting healthy lifestyle habits in physical education through gamified strategies, several limitations exist. First, although a large sample of students was used, it is essential to note that the study was conducted in a specific context with limited participants. This may limit the generalizability of the results to other populations and educational settings. Second, using a nonrandomized design may introduce certain biases into the study. Although measures were taken to minimize these biases, uncontrolled factors could influence the results. Third, the data was collected through self-administered questionnaires, which may be subject to the participants' response bias and subjective interpretation.

Future research, program design, and implementation improvements could address these limitations to advance understanding and application of this innovative approach in educational settings. This could include further research in different educational and cultural contexts. This would allow for examining the generalization of the results and gaining a better understanding of how contextual factors may influence the effectiveness of interventions. Long-term research evaluations would also be recommended, as while the present study provides promising evidence on the immediate effects of gamified interventions, it would be valuable to conduct long-term follow-ups to assess the sustainability of changes in students' healthy habits. This will help determine whether positive effects are maintained over time and if the intervention has a long-term impact on adolescent health. In addition, exploring other influential fac-

tors in promoting healthy lifestyle habits is essential. In addition to the gamified intervention, it is crucial to consider other factors that can influence adolescents' healthy habits, such as family environment, access to community resources, and school policies. Future research could explore how these factors interact with gamified interventions and how they can be optimized to achieve better results. Furthermore, future research is needed that systematically evaluates gamification programs enriched with aesthetics, game dynamics, and mechanics to assess their effectiveness compared to gamified PBL.

Conclusions

In conclusion, this study demonstrated the efficacy of gamified intervention based on PBL in promoting healthy lifestyle habits and reducing harmful substance consumption among socioeconomically disadvantaged secondary school students. The findings supported the effectiveness of this strategy in improving physical activity nutrition and reducing substance-related unhealthy behaviors. The integration of gamified interventions in educational settings, particularly in disadvantaged areas, holds promise as a promising approach to address the health challenges faced by adolescents, and its inclusion in educational programs is recommended.

Funding

This research received no external funding. This gamification PBL was designed during the postdoctoral stay of Dr. Ana Manzano León and Dr. José M. Rodríguez Ferrer at the Polytechnic Institute of Guarda (IPG).

Institutional Review Board Statement

The study was carried out according to the Declaration of Helsinki and was approved by the University of Almería Research Ethics Committee (UALBIO2023/019).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

Data is available at the request of the corresponding author.

Conflicts of Interest

The authors declare no conflict of interest.

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